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RESEARCH PAPER

The impact of urbanization on children's diets: longitudinal evidence from Cebu

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Abstract
We investigate the longitudinal relationship between urbanization and children's dietary diversity using a large, detailed survey conducted in Cebu, Philippines, during its period of rapid transformation in the 1990s. Using a panel of 1840 children observed at ages 8, 11, and 15, we model children's weekly consumption of food items included in the meat, seafood, rice, vegetables, beans, tubers, fruits, and dairy groups. Within child-household variation in the characteristics of urban communities (barangays) during this period helps us to empirically identify potential causal relationships. We find that urbanization is significantly positively associated with children's consumption of meat, fruit, and meals prepared at home and negatively associated with the consumption of vegetables and sweets. Models allowing for interactions between household socioeconomic status (SES) and local community urbanization reveal nuanced relationships with children's dietary outcomes. Children from lower SES households have greater dietary diversity if living in communities with greater urbanization and consume significantly larger amounts of meat, fruits, and dairy. Urbanization is also associated with more frequent consumption of meals prepared at home and less consumption of sweet foods, on average. Overall, the findings suggest that the urbanization of local communities during this stage of development contributes to improvements in children's diets.

Keywords Child nutrition · Urbanization · Diet diversity

JEL Classification I12 · R20

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Introduction

During the 1990s, the city of Cebu in the Philippines underwent considerable growth in the development of manufacturing, housing, business, and transportation infrastructure, and this transformational period is locally known as "Ceboom." Relatively rapid changes associated with the Ceboom phenomena were possible due to a worldwide deregulation of finance and investment policies, and shifts in the local political climate beneficial to pursuing economic growth (Law 1997; Sajor 2001). The Metro Cebu Development Project Office (MCDPO) was specifically created to coordinate among various national and local organizations, and to improve the transportation infrastructure by constructing new arterial roads, enlarging existing roads, and establishing a better traffic management system (Kishiue et al. 2003). At the time, Cebu was the second largest city in the Philippines, and the actions implemented directly facilitated growth by improving traffic congestion and community access to services (Japan International Cooperation Agency, 2002).

In many countries, strong growth in economic output also frequently coincides with a transformation of the urban environments in which children grow up. What has been previously described as the "urbanization" of cities and neighborhoods involves a variety of changes for the local communities (Dahly and Adair 2007). Surroundings that can change during this stage include the landscape (e.g., buildings and vegetation), infrastructure (e.g., roads, water and sewer systems, and energy networks), and resident characteristics (e.g., criminal activity, education, and income). It is of interest to understand the pathways in which urbanization has the potential to change individual behavior, particularly developing children. Ruel, Garrett, and Haddad (2008); (1999) identify some of the key lifestyle factors that are shaped by an emerging urban environment such as greater employment opportunities and greater reliance on markets for food. However, the positive relationships between food prices and urbanization, and between household incomes and urbanization, complicate our understanding of potential changes in household diets; if incomes increase faster than food prices then purchasing power improves and households can more easily consume a diverse diet (Ambikapathi et al. 2022). Further, urban consumers with lower incomes can be relatively more responsive to changes in food availability and affordability (Musgrove 1988).

In fact, throughout the life cycle, the urban environment can shape growth by affecting dietary patterns, exercise frequency, morbidity (disease and illness spells), and other pathways (Adair et al. 2011; Bhargava 2015; Firestone et al. 2011; Gracey 2002). For instance, the availability of nutritious foods can affect the nutrient intake of essential vitamins and minerals, which affects the body's immune system (Scrimshaw and SanGiovanni 1997). Children with imbalances in nutrient intake generally experience more health problems and below-average growth. Improving family education and income levels are known to reduce the likelihood of adverse child outcomes. However, community infrastructure also plays a crucial role in promoting the commerce of food and other healthcare inputs such as physician and hospital services. Additionally, the environment of communities is an important factor in determining exercise patterns; certain variants of urban landscape and infrastructure facilitate higher rates of walking and other kinds of exercise via designated parks and outdoor recreation areas (Florentino et al. 2002). Drawing a more complete picture of how the urban environment affects young children's behavior and related household decisions can help in explaining later life outcomes. The persistence of early adversity and behavioral patterns suggests a better understanding of the role of neighborhood environments and can be useful from a policy standpoint. For example, the design of school meals and activity

programs can be augmented to complement potential nutritional effects of urbanization as household diets change.

The remainder of this paper is organized as follows. We discuss the research motivating our study in the section on "Background and related literature." A theoretical framework for understanding how urbanization can shape dietary choices of households and their children is outlined in the section on the "Theoretical framework." The data utilized in the analysis are described in the section on. "Data," and the estimation strategy we implement is specified in the section on "Estimation strategy." We present the results in the section on "Results" and conclude with a section on "Conclusions."

Background and related literature

The urbanization experience in Cebu was made possible by the MCDPO and its funding of infrastructure related projects. The changing political climate allowed for foreign sources of funding and more relaxed business regulations, therefore attracting an increasing number of local and foreign investors (Law 1997). The deregulation of finance and investment policies in many countries allowed countries like the Philippines to benefit from foreign capital investment. Specifically, Metro Cebu received most of the foreign investment in manufacturing, causing their exports to increase by 76% from 1987 to 1990. Due to the thriving economy, demand for housing and commercial properties rose significantly. Approximately 84% of the 251 real estate developments from 1988 to 2000 were residential subdivisions. Most of these residential developments attracted households from higher socioeconomic status and the expatriate population working for foreign businesses. As a result, urban land became more limited and more expensive.[1] Consequently, residential properties, including socialized housing, became unaffordable, causing shortages for locals from low-income and middle-income backgrounds. A key implication of rising housing costs is the potential reallocation of resources of households as relative purchasing power falls. Of further concern is that rising commercial property values also suggest higher opportunity costs that can eventually pass through to retail prices for consumers. The local price variation induced by urbanization can ultimately shape household diets through various pathways (Darmon et al. 2003, 2002; Drewnowski and Darmon 2005).

The booming economy also resulted in dramatic rural–urban migration, and the economic progress expanded the formal employment sector of Metro Cebu and the informal sector of the city. According to Sajor (2001), rural–urban migrants set up or help relatives with existing informal transport services such as jeepneys, tricycles and informal food and groceries services such as street food stalls and ambulant vending. Sajor (2001) argues that the rural–urban migration process creates a cycle of low-income households stuck working in informal sectors where they will continue to suffer from poor sanitary conditions. Despite such inequality in pay and living conditions, rural–urban migration persisted because of more job opportunities and improved quality of life. Differences in the extent of change involved and timing expose families to varying degrees of urban development and allow for longitudinal investigation into potential effects on young children.

[1] From 1989 to 1992, residential lot prices considerably increased by an annual average of 52.1%. Commercial and industrial lot prices in Metro Cebu increased as well by 33.2% and 24.6%, respectively.

As countries develop, disparities in nutritional status are known to emerge in populations based on household location and socioeconomic status (Popkin 2006). Firestone et al. (2011) analyze children ages 2–10 years in Thailand and find that undernutrition is less likely for families in urban environments. However, disparities in overnutrition (obesity) also emerge for children in urban areas. They further find that community characteristics such as greater wealth concentration and improved drinking water and sanitation services are positively correlated with overnutrition. In contrast, Kennedy et al. (2006) find that household wealth accounts for urban–rural nutritional disparities in young children living in Angola-Secured Territory, Central African Republic, and Senegal. Further, Brar et al. (2020) find that time-varying community characteristics underlying the urbanization process significantly improve the nutritional status of young children in Senegal and reduce urban–rural disparities.

One key mechanism underlying changes in children's nutritional status is the pattern of dietary intake. In general, as economies develop, there is greater access to food and a wider variety of options to choose from (Hawkes 2008). Aurino et al. (2017) examine the diets of adolescents in Ethiopia, India, Peru, and Vietnam between 2006 and 2013 and find that the types of food groups eaten daily correlate with urban household locations and socioeconomic status. However, even though the children are consuming diets with greater diversity, they also have significantly higher intakes of added sugars. Similarly, Ochola and Masibo (2014) highlight a common pattern in school-aged children's diets in developing countries, with less diversity in diets overall, less consumption of fruits and vegetables, and a greater reliance on foods and beverages considered energy dense. It is of interest to understand how changes in community characteristics influence the observed dietary patterns of children, and whether the substitution of foods with higher sugar and energy density is displacing healthier options.

The degree of urbanization present in a community depends on the existing infrastructure related to communication systems, transportation systems, educational facilities, healthcare service facilities, and markets (Dahly and Adair 2007). Children located in areas experiencing changes in urbanization will likely have greater access to food in general, but what types of foods are selected as a result remains an active area for research. Recent findings indicate that children's consumption patterns are linked to the social norms of communities (Pettigrew et al. 2015), family-related factors (Bogart et al. 2017), and socioeconomic status (Desbouys et al. 2020). Among adults migrating from rural to urban areas in Tanzania, Cockx et al. (2018) show that diet quality is primarily driven by the urbanization process as it relates to increasing opportunities for earning a higher income. Similarly, among children in sub-Saharan Africa, Headey et al. (2018) find that the urbanization process as it relates to access to health care, electricity, drinking water, and sanitation services explains dietary diversity. In what follows, we explore how children's diets are shaped over time by the interaction between the urbanization of communities and the socioeconomic status of families.

Theoretical framework

The dietary outcomes we study here are decisions made in response to a variety of interrelated characteristics of households and the economic environment. To illustrate some fundamental relationships, we follow Muellbauer (1977) and Deaton and Paxson (1998) and

think of each household as choosing its current consumption, conditional upon household composition, prices, and a given level of utility. We denote the household cost function as

$$x = c(u, p, n) \tag{1}$$

where x is total expenditure, u the utility level, p the current price vector, and n the household members or effective size. Since children typically consume less than adults, the effective household size is $n = A + \alpha K$ where A is the number of adult members, K is the number of children, and α indicates the fraction of an adult each child represents. A key insight consistent with optimizing behavior is that per capita food consumption depends in part on the relative sizes of the own-price and income elasticities of food. If lower-income households spend a larger share of the budget on food, then the income elasticity of food will typically be larger in magnitude relative to the price elasticity of food. However, as household incomes rise, economic theory suggests we may observe greater sensitivity to food prices. Barten (1964) emphasizes that with additive (or almost additive) household preferences all goods are effectively competing for a part of the total expenditure, and the observed purchases are a function of own-price elasticities, cross-price elasticities, income elasticities, and the marginal utility of income.

In the present study, we are focused on understanding how the degree of urbanization relates to the observed selection of a specific food group i by household h during time t such that

$$x_{iht}/n_{ht} > 0 \tag{2}$$

where a higher cumulative amount of food groups with positive per capita expenditure corresponds to greater range of diets for household members and their children. Following prior studies, we model the diversity of diets as a time-varying score reflecting the number of food groups consumed in a given time period and proceed with the understanding that there is evidence of higher scores corresponding with improved nutrient intakes (Guthrie and Scheer 1981; Habte and Krawinkel 2016; Kennedy et al. 2007). In this framework, it is important to note that the dietary outcomes and elasticities of demand for households are all potentially influenced by environmental factors related to urbanization. For example, Ruel et al. (2008) highlight how the process of urbanization changes both household incomes and food prices through market development and that there are also adjustments in preferences for activity patterns, cooking patterns, and other characteristics associated with the social norms of urban communities undergoing economic development. The interrelationships between these various sources are potentially nonlinear in relation to observed expenditures on the various food items available. We further explore this possibility by modeling diets as a function of the interaction of both urbanization and relative household socioeconomic status.

From a broader economic perspective, urbanization frequently corresponds with simultaneous growth in both opportunities for income from labor earnings and positive or negative changes in the affordability of food items. This creates challenges in using theory to directly predict the expected direction, for any changes in the quality or composition of household diets that may result. In particular, the price levels for food items tend to rise generally as a direct effect of increases in demand (assuming food groups are normal goods), and part of the increase is likely attributable to greater incomes and stronger labor markets in urban communities. However, for certain cases, household incomes may rise at a faster rate than the cost of food items, leading to greater affordability and hence a more diverse selection of items included in their diets (Ambikapathi et al. 2022). On the other

Table 1 Description of food groups from Cebu, Philippines, taken from the Cebu Longitudinal Health and Nutrition Survey. *Source:* Cebu Longitudinal Health and Nutrition Survey 1991, 1994, and 1998

Meat	Pork, beef, goat, dog, organ meat (liver, dinuguan), chicken, other poultry, and eggs
Fish and crustaceans	Fresh fish, dried fish, ginamos, squid, hipon, sardines, smoked fish, shrimp, clams, mussels, and crabs
Rice (Grains)	Rice, corn grits, rice-corn mix, lugaw, pan de sal, American bread, other bread, cookies/cracker (ogoy-ogoy, galyetas, etc.), hopia baboy, hopia munggo, cakes (mamon, etc.), rice cakes, other native products, pancit (mike, canton, bihon), sotanghon, miswa, and others
Vegetables	Green leafy (kamunggay, alugbati, etc.), kalabasang pula, carrots, ampalaya, eggplant, okra, togue, and others
Dried Beans, Nuts, and Seeds	Mongo beans, peanuts, bean products (tokwa, tahure), and others
Starchy Roots and Tubers	White tubers (gabi, kamoteng kahoy, white kamote, yellow tubers (kamoteng kahoy), violet tubers (ubi, kamote), and patatas
Fruits	Latundan, bungaw, cavendish, lakatan, gloria, murado, tindok, cooking banana, green mango, ripe mango, papaya, and others
Dairy	Fresh milk, condensed milk, evaporated milk, and powdered milk
Sweets	Sugar, syrups, candies, jams, sweet delicacies, honey
Snacks	Potato chips, ice candy, popcorn

hand, there is evidence that individuals in urban environments shift their choices away from traditional staple food options in favor of items only available in areas with a greater degree of urbanization, such as foods that are highly processed (Baker and Friel 2014; Mendez and Popkin 2004). The important conclusion that carries through from this line of research is that the process of urbanization is related to household member diets, primarily through changes in socioeconomic status associated with purchasing power (budget constraints) and the relative differences in magnitudes of substitution and income effects across the array of food items available for purchase. Our analysis proceeds by focusing specifically on the selection of food purchases, that households report feeding their child over time, in an environment experiencing significant changes in urbanization.

Data

Our study analyzes data acquired through the Cebu Longitudinal Health and Nutrition Survey (CLHNS). It began in 1983–84, by randomly selecting 33 communities (barangays) in metropolitan Cebu and interviewing 3327 pregnant women who were in their 6th to 7th month of pregnancy. This resulted in a baseline sample of 3080 nontwin children, of which 2260 were surveyed in the 1991–1992 follow-up study that was used as the starting point for our empirical analysis. Subsequent follow-up studies also occurred in 1994–1995 and 1998–1999, and we utilize a subsample of 1840 children observed during all of the three follow-up studies that have complete data on the relevant individual, household, and community characteristics incorporated into our empirical models.

The primary outcome of interest is children's dietary diversity, and we construct a measure based on eight food groups: meat, seafood, rice, vegetables, beans, tubers, fruits, and dairy. Table 1 provides examples of typical items included in each of the food groups. Mothers were interviewed regarding their child's usual intake of various food items, where

usual was defined as at least 3–4 times per week for items consumed at home and 2–3 times per week for items consumed at school. Based on the recorded food items, we mapped affirmative answers into dichotomous indicator variables for each of the eight food groups for each child in each survey round. A dietary diversity score was constructed by summing the eight food group variables, and the score ranges from 0 to 8. The Cronbach alpha of the diversity score is relatively low at 0.26 and suggests that the usual consumption of all eight food groups is not strongly interrelated (Cronbach 1951). Thus, we also treat each food group consumed by children as an outcome of interest. Additional information collected in the interviews with mothers allows us to further create indicator variables for whether the child eats sweets or snacks and how many meals per week were prepared at home or were purchased.[2]

For our key measure of urbanization, we construct an urbanicity score following the methodology presented in Dahly and Adair (2007). The CLHNS conducted surveys of the local communities (barangays) in which children reside in each follow-up round. We used 56 survey questions to create indicator variables measuring characteristics related to population size, population density, communications, transportation, educational facilities, health services, and markets. The set of indicator variables is summed to create a score measuring the degree of urbanization present in local communities. Given the sample time period 1991–1998, information regarding Internet accessibility, cable TV availability, and cellular phones was unavailable. The urbanicity score ranges from 4 to 56, and the Cronbach alpha is relatively high at 0.87.

Household characteristics used in the analysis include measures of the number of people living in the household, the mother's employment status, the mother's body mass index (BMI), the mother's years of education, and a socioeconomic index. We construct the socioeconomic index based on five categories that proxy for wealth: home ownership, vehicle ownership, number of rooms in the home, and the number of appliances and furniture items they possess. The socioeconomic index ranges from 1 to 25, and the Cronbach alpha is relatively high at 0.79.

Estimation strategy

We investigate the relationships between urbanicity and children's dietary behavior using subject-specific regression models. The first model postulated for the diet outcome i for child k observed at time t is given in Eq. 3:

$$\begin{aligned} \text{Diet}_{ikt} = & \beta_0 + \beta_1(\text{Urbanicity score})_{kt} \\ & + \beta_2(\text{Socioeconomic index})_{kt} \\ & + \beta_3(\text{Mothers education})_{kt} \\ & + \beta_4(\text{Mothers BMI})_{kt} \\ & + \beta_5(\text{Mothers employment status})_{kt} \\ & + \beta_6(\text{Household size})_{kt} + c_k + s_t + e_{kt} \end{aligned} \tag{3}$$

[2] The data were not surveyed in a way that allows for a finer categorization of consumed food items according to how processed the items were.

where Diet_{ikt} is assigned a value of one if $x_{iht}/n_{ht} > 0$ for each food group i, and dietary diversity is measured as a score equal to the sum total number of food categories with positive household expenditure reported for their child's current diet. The time-invariant subject-specific correlation among repeated outcomes, c_k, is explicitly modeled in the conditional mean (Zeger et al. 1988), as well as the subject-invariant correlation among children's outcomes within a survey round, s_t. This approach provides the least biased estimates of the effects of the explanatory variables by controlling for the influence of all unobservable and observed time-invariant factors affecting children's dietary behaviors. The estimated β_1 coefficient indicates the difference in diets for children from households that are in areas with greater urbanization. A limitation of the model in Eq. (3) is that any potential interactive relationship between socioeconomic status and urbanization on children's diets is assumed to be zero. To further investigate this assumption, we estimate the following expanded regression model given in Eq. 4:

$$\begin{aligned}\text{Diet}_{ikt} = &\beta_0 + \beta_1(\text{Socioeconomic index X Urbanicity score})_{kt} \\ &+ \beta_2(\text{Urbanicity score})_{kt} \\ &+ \beta_3(\text{Socioeconomic index})_{kt} \\ &+ \beta_4(\text{Mothers education})_{kt} \\ &+ \beta_5(\text{Mothers BMI})_{kt} \\ &+ \beta_6(\text{Mothers employment status})_{kt} \\ &+ \beta_7(\text{Household size})_{kt} + c_k + s_t + e_{kt}\end{aligned} \tag{4}$$

Results

Descriptive statistics

The sample means of selected characteristics of children, households, and communities are reported in Table 2. Average dietary diversity scores are relatively equal across the sample time period; however, there are clear trends in the component food groups. By 1998, a larger percentage of children were consuming meat, vegetables, and tubers; in contrast, a smaller percentage of children were consuming seafood, beans, fruits, and dairy. The percentage of children eating sweets and snacks was relatively higher in 1998 compared to 1991. Among households, we observe a small decrease in the average number of meals cooked at home and a small increase in the number of meals bought. During this period, the percentage of mothers employed increased from 69 to 77%, and average BMI and education remained equal. The socioeconomic index of households increased from 6.995 to 8.608. Similarly, at the community level, we observe an increase in the urbanicity score from 29.772 to 34.757.

Results for dietary behaviors

Table 3 presents the results from the fixed-effects model in Eq. 3 for children's dietary diversity score and each of the food groups. The results for rice are not reported because there is very little variation between children. The estimates indicate urbanization is not significantly associated with dietary diversity. Among the component groups, urbanization

Table 2 Descriptive statistics for children from the Cebu Longitudinal Health and Nutrition Survey observed in 1991, 1994, and 1998. *Source:* Cebu Longitudinal Health and Nutrition Survey

Variables	1991		1994		1998	
	Mean	SD	Mean	SD	Mean	SD
Dietary diversity score (0–8)	4.052	1.262	3.558	0.991	3.899	1.099
Diet includes food group (1 = yes, 0 = no)						
Meat	0.582		0.496		0.700	
Seafood	0.957		0.902		0.911	
Rice	1		1		1	
Vegetables	0.562		0.571		0.702	
Beans	0.337		0.241		0.234	
Tubers	0.094		0.205		0.262	
Fruits	0.333		0.047		0.022	
Dairy	0.188		0.096		0.083	
Consumption of sweets (1 = yes, 0 = no)	0.028		0.374		0.173	
Consumption of snacks (1 = yes, 0 = no)	0.026		0.189		0.172	
Number of meals prepared at home (*n*)	15.9	5.6	16.3	5.3	15.3	6.0
Number of meals bought (*n*)	4.3	5.1	4.9	5.1	5.1	5.6
Number of people per household (*n*)	6.9	2.2	7.1	2.3	6.9	2.4
Mother's employment status (1 = yes, 0 = no)	0.69		0.74		0.77	
Mother's BMI (*n*)	23.2	3.7	23.2	3.9	23.7	4.13
Mother's education (n)	7.5	3.9	7.4	3.9	7.5	3.9
Socioeconomic index (0–25)	6.995	3.581	7.204	3.586	8.608	3.597
Urbanicity score (0–56)	29.772	13.465	32.247	12.195	34.757	12.724

Sample means and standard deviations are reported by year for 1840 children observed in 1991, 1994, and 1998

is significantly associated with a higher probability of consuming meat and fruits and a lower probability of consuming vegetables. Socioeconomic status is the strongest household-level predictor of children's consumption patterns. It is significantly associated with great dietary diversity and higher vegetable and fruit consumption. Table 4 presents the results for additional dietary outcomes of interest. The estimates indicate that urbanization is significantly positively associated with the number of meals prepared at home and negatively associated with the probability of children consuming sweet foods. In contrast, socioeconomic status is significantly associated with children consuming sweet foods.

A potential limitation of the baseline model in Eq. 3 is that the effect of urbanization on children's diets could be simultaneously influenced by the socioeconomic status of their families. If greater urbanization leads to greater access to food for lower-income households relative to higher-income households, then the estimated coefficient on the urbanicity score would be biased downward, on average. Children from households with higher socioeconomic status could presumably have greater access to food independently of the urbanization of their local community. The model in Eq. 4 allows us to test potential interaction effects between socioeconomic status and urbanization.

Table 5 presents the results from the fixed-effects model in Eq. 4 for children's dietary diversity score and seven component food groups. Urbanization is significantly positively associated with children's dietary diversity scores; however, the interaction between

Table 3 Estimates from fixed-effects models of the effects of socioeconomic status and urbanicity on children's diets

Explanatory variables	Outcome							
	Dietary diversity score	Meat	Seafood	Vegetables	Beans	Tubers	Fruits	Dairy
Number of people per household	0.0144	0.0009	0.0067**	− 0.0007	0.0087	0.0020	0.0018	− 0.0103**
	(0.0144)	(0.0054)	(0.0032)	(0.0057)	(0.0054)	(0.0050)	(0.0040)	(0.0039)
Mother's employment status	0.0566	0.0222	0.0019	− 0.0130	0.0119	0.0166	0.0131	0.0053
	(0.0481)	(0.0177)	(0.0111)	(0.0197)	(0.0192)	(0.0167)	(0.0143)	(0.0137)
Mother's BMI	− 0.0142	0.0001	0.0017	− 0.0104*	− 0.0043	− 0.0031	− 0.0039	0.0036
	(0.0131)	(0.0049)	(0.0027)	(0.0055)	(0.0052)	(0.0047)	(0.0039)	(0.0038)
Mother's education	0.0084	− 0.0099	-0.0013	0.0246**	− 0.0335**	0.0051	0.0141	0.0099
	(0.0316)	(0.0102)	(0.0069)	(0.0124)	(0.0136)	(0.0086)	(0.0108)	(0.0122)
Socioeconomic index	0.0183*	0.0045	-0.0030	0.0122**	− 0.0041	0.0028	0.0077**	− 0.0019
	(0.0099)	(0.0039)	(0.0024)	(0.0041)	(0.0039)	(0.0036)	(0.0029)	(0.0030)
Urbanicity score	0.0035	0.0026*	− 0.0011	− 0.0043**	0.0022	− 0.0010	0.0036**	0.0019
	(0.0043)	(0.0015)	(0.0010)	(0.0017)	(0.0017)	(0.0014)	(0.0013)	(0.0013)

All models include year and child fixed effects. The results for rice are not reported because there is very little within child variation; Standard errors are in parentheses

*Significant at 10% level

**Significant at 5% level

Table 4 Estimates from models of the effects of socioeconomic status and urbanicity on children's household meal preparation and consumption of sweets and snacks

Explanatory variables	Outcome			
	Number of meals prepared at home	Number of meals bought	Consumption of sweets	Consumption of snacks
Number of people per household	− 0.0014	− 0.0014	0.1771**	− 0.1301**
	(0.0044)	(0.0042)	(0.0660)	(0.0603)
Mother's employment status	0.0026	− 0.0003	− 1.1364**	0.9680**
	(0.0160)	(0.0140)	(0.2053)	(0.1813)
Mother's BMI	− 0.0055	− 0.0001	− 0.0394	− 0.0102
	(0.0045)	(0.0039)	(0.0613)	(0.0568)
Mother's education	− 0.0151*	− 0.0036	0.0060	− 0.0732
	(0.0086)	(0.0085)	(0.1542)	(0.1364)
Socioeconomic index	− 0.0051	0.0050	0.0856*	− 0.0176
	(0.0033)	(0.0032)	(0.0489)	(0.0436)
Urbanicity score	0.0046**	− 0.0010	− 0.0314*	0.0074
	(0.0013)	(0.0012)	(0.0179)	(0.0162)

All models include year and child fixed effects; Standard errors are in parentheses

*Significant at 10% level

**Significant at 5% level

socioeconomic status and urbanicity score is significantly negative. The estimated coefficient for the urbanicity score is 0.0246 and for the interaction it is − 0.0027. In comparison, the estimated coefficient of urbanization in Eq. 3 (Table 3) is relatively lower at 0.0035. This suggests that urbanization contributes to greater dietary diversity, yet the positive effect diminishes with higher socioeconomic status. Among the component groups, we see a similar pattern for meat, fruits, and dairy. Table 6 presents the results for additional dietary outcomes of interest using the expanded model in Eq. 4, and the interaction effect is statistically insignificant. The estimates indicate that urbanization has a significantly positive effect on the number of meals prepared at home and a significantly negative effect on the probability of consuming sweet foods; and that these effects are independent from the socioeconomic status of children's families.

Conclusions

We longitudinally examine adolescent children's dietary outcomes in Cebu, Philippines, and how the early stages of urbanization influenced their consumption patterns during the time period spanning 1991 through 1998. Child fixed-effects models are estimated for outcomes measuring overall dietary diversity and the component food groups covering meat, seafood, vegetables, beans, tubers, fruits, and dairy. In addition, we model the number of meals prepared at home or purchased and the probability of children consuming sweets or snack foods. Key to our analysis was allowing for a potential interaction effect between the degree of urbanization and the socioeconomic status of children's families. Our findings

Table 5 Estimates from models of the effects of socioeconomic status and urbanicity interactions on children's diets

	Outcome							
Explanatory variables	Dietary diversity score	Meat	Seafood	Vegetables	Beans	Tubers	Fruits	Dairy
Number of people per household	0.0174	0.0019	0.0067**	− 0.0007	0.0090*	0.0022	0.0027	− 0.0097**
	(0.0143)	(0.0054)	(0.0032)	(0.0057)	(0.0054)	(0.0050)	(0.0039)	(0.0039)
Mother's employment status	0.0571	0.0224	0.0019	− 0.0130	0.0120	0.0166	0.0133	0.0054
	(0.0480)	(0.0176)	(0.0111)	(0.0197)	(0.0192)	(0.0167)	(0.0142)	(0.0136)
Mother's BMI	− 0.0112	0.0011	0.0018	− 0.0104*	− 0.0040	− 0.0029	− 0.0030	0.0042
	(0.0130)	(0.0049)	(0.0027)	(0.0055)	(0.0052)	(0.0047)	(0.0038)	(0.0038)
Mother's education	0.0116	− 0.0088	− 0.0013	0.0246**	− 0.0332**	0.0053	0.0150	0.0105
	(0.0317)	(0.0101)	(0.0069)	(0.0124)	(0.0137)	(0.0086)	(0.0109)	(0.0122)
Socioeconomic index	0.1086**	0.0337**	− 0.0026	0.0133	0.0051	0.0098	0.0351**	0.0156**
	(0.0211)	(0.0084)	(0.0045)	(0.0090)	(0.0083)	(0.0077)	(0.0062)	(0.0064)
Urbanicity score	0.0246**	0.0094**	− 0.0010	− 0.0040	0.0043*	0.0006	0.0100**	0.0059**
	(0.0061)	(0.0024)	(0.0014)	(0.0025)	(0.0025)	(0.0021)	(0.0019)	(0.0017)
Socioeconomic index X Urbanicity score	− 0.0027**	− 0.0009**	− 0.0001	-0.0001	-0.0003	− 0.0002	− 0.0008**	− 0.0005**
	(0.0006)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)

All models include year and child fixed effects. The results for rice are not reported because there is very little within child variation; Standard errors are in parentheses

*Significant at 10% level

**Significant at 5% level

Table 6 Estimates from models of the effects of socioeconomic status and urbanicity interactions on children's household meal preparation and consumption of sweets and snacks

Explanatory variables	Number of meals prepared at home	Number of meals bought	Consumption of sweets	Consumption of snacks
Number of people per household	− 0.0014	− 0.0016	0.1746**	− 0.1292**
	(0.0044)	(0.0042)	(0.0660)	(0.0602)
Mother's employment status	0.0026	− 0.0004	− 1.1368**	0.9682**
	(0.0160)	(0.0140)	(0.2054)	(0.1813)
Mother's BMI	− 0.0055	− 0.0003	− 0.0419	− 0.0093
	(0.0045)	(0.0039)	(0.0613)	(0.0569)
Mother's education	− 0.0151*	− 0.0038	0.0035	− 0.0723
	(0.0086)	(0.0085)	(0.1547)	(0.1366)
Socioeconomic index	− 0.0055	− 0.0030	0.0115	0.0081
	(0.0072)	(0.0072)	(0.0993)	(0.0895)
Urbanicity score	0.0046**	− 0.0028	− 0.0487*	0.0134
	(0.0020)	(0.0018)	(0.0269)	(0.0248)
Socioeconomic index X Urbanicity score	0.0001	0.0002	0.0022	− 0.0008
	(0.0002)	(0.0002)	(0.0027)	(0.0024)

All models include year and child fixed effects; Standard errors are in parentheses

*Significant at 10% level

**Significant at 5% level

indicate that urbanization is a significant predictor of dietary diversity, the consumption of meat, beans, fruits, and dairy, and the number of meals prepared at home. In contrast, urbanization is negatively associated with the probability of consuming sweets. At the margin, the positive effect of urbanization is diminished for overall dietary diversity and the consumption of meat, fruits, and dairy for children from families with higher socioeconomic status. This result is consistent with Musgrove (1988) who find a greater tendency of lower-income consumers to diversify their diet and take advantage of substitution possibilities as food affordability changes with urbanization in Brazil.

The pattern of our findings suggests that the process of urbanization increases children's access to food. However, the increased availability is likely determined by changes over time in both the local community environment and the labor market opportunities for families, particularly those with lower socioeconomic status. For example, urbanization may mean a greater access to more ingredients allowing for more meals to be prepared at home. It may also mean more or higher day-to-day expenses that could force families to prepare meals at home rather than purchase meals to save money. Furthermore, urbanization may also allow families greater access to opportunities that will allow them to choose the more desirable food options such as meats and fruits over vegetables. Our estimates indicate that it may also allow families to eat healthier by substituting sweets with fruits, although it is important to note that the survey data we analyze here does not allow for a finer classification of the quality of food according to how processed it is. Baker and Friel (2014) emphasize the adverse nutrient profile of processed foods and show that consumption has shifted toward processed foods among Asian countries experiencing economic growth.

A significant limitation of our study is that we do not observe how the continued economic growth and development of the urban environment changes food consumption patterns in more recent periods. It is possible that the positive effects we find from urbanization do not persist over time and may not predict the dietary diversity of children currently living in the Cebu metropolitan area. Our empirical analysis relies specifically on the variation in urban environments during the 1990s, which was a time period characteristic of earlier stages in the developmental process. Later, more advanced stages may yield different insights on the relationships we identify and would help us better understand how the influence on children's dietary diversity evolves with the urban environment. The additional limitations in the survey data we analyze also make it impossible to explore other pathways through which characteristics of the urban environment can augment children's dietary outcomes, such as changes in the nutritional quality or preparation of food. Even though our results align with prior research, suggesting that the Ceboom phenomena of rapid economic development in the early 1990s had a significant effect on its populace, further investigation during more recent years would be useful for constructing policies that target undernutrition persisting in the present day. For example, if greater access to job opportunities improves household dietary outcomes, then policymakers can implement policies to help streamline the job-matching process as local communities continue to develop. Or, if increased access to different markets or other institutions allows for greater food diversity, then policies designed to build more or enhance access to such establishments would be beneficial for young children.

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Declarations

Conflict of interest There are no conflicts of interest to declare.

References

Adair LS, Gultiano S, Suchindran C (2011) 20-year trends in Filipino women's weight reflect substantial secular and age effects. J Nutr 141(4):667–673. https://doi.org/10.3945/jn.110.134387

Ambikapathi R, Schneider KR, Davis B, Herrero M, Winters P, Fanzo JC (2022) Global food systems transitions have enabled affordable diets but had less favourable outcomes for nutrition, environmental health, inclusion and equity. Nat Food 3(9):764–779

Aurino E, Fernandes M, Penny ME (2017) The nutrition transition and adolescents' diets in low-and middle-income countries: a cross-cohort comparison. Public Health Nutr 20(1):72–81

Baker P, Friel S (2014) Processed foods and the nutrition transition: evidence from Asia. Obes Rev 15(7):564–577

Barten AP (1964) Consumer demand functions under conditions of almost additive preferences. Econometrica J Econ Soc 1:1–38

Bhargava A (2015) Protein and micronutrient intakes are associated with child growth and morbidity from infancy to adulthood in the Philippines. J Nutr 146(1):133–141. https://doi.org/10.3945/jn.115.222869

Bogart LM, Elliott MN, Ober AJ, Klein DJ, Hawes-Dawson J, Cowgill BO, Schuster MA (2017) Home sweet home: parent and home environmental factors in adolescent consumption of sugar-sweetened beverages. Acad Pediatr 17(5):529–536

Brar S, Akseer N, Sall M, Conway K, Diouf I, Everett K, Wigle J (2020) Drivers of stunting reduction in Senegal: a country case study. Am J Clin Nutr 112(Supplement_2):860S-874S

Cockx L, Colen L, De Weerdt J (2018) From corn to popcorn? Urbanization and dietary change: evidence from rural-urban migrants in Tanzania. World Dev 110:140–159
Cronbach LJ (1951) Coefficient alpha and the internal structure of tests. Psychometrika 16(3):297–334
Dahly DL, Adair LS (2007) Quantifying the urban environment: a scale measure of urbanicity outperforms the urban–rural dichotomy. Soc Sci Med 64(7):1407–1419
Darmon N, Ferguson EL, Briend A (2002) A cost constraint alone has adverse effects on food selection and nutrient density: an analysis of human diets by linear programming. J Nutr 132(12):3764–3771
Darmon N, Ferguson E, Briend A (2003) Do economic constraints encourage the selection of energy dense diets? Appetite 41(3):315–322
Deaton A, Paxson C (1998) Economies of scale, household size, and the demand for food. J Polit Econ 106(5):897–930
Desbouys L, Méjean C, De Henauw S, Castetbon K (2020) Socio-economic and cultural disparities in diet among adolescents and young adults: a systematic review. Public Health Nutr 23(5):843
Drewnowski A, Darmon N (2005) Food choices and diet costs: an economic analysis. J Nutr 135(4):900–904
Firestone R, Punpuing S, Peterson KE, Acevedo-Garcia D, Gortmaker SL (2011) Child overweight and undernutrition in Thailand: is there an urban effect? Soc Sci Med 72(9):1420–1428
Florentino RF, Villavieja GM, Laña RD (2002) Dietary and physical activity patterns of 8-to 10-year-old urban schoolchildren in Manila. Philipp Food Nutr Bull 23(3):267–273
Gracey M (2002) Child health in an urbanizing world. Acta Paediatr 91(1):1–8
Guthrie HA, Scheer JC (1981) Validity of a dietary score for assessing nutrient adequacy. J Am Diet Assoc 78(3):240–245
Habte T, Krawinkel M (2016) Dietary diversity score: a measure of nutritional adequacy or an indicator of healthy diet. J Nutr Health Sci 3(3):303
Hawkes C (2008) Dietary implications of supermarket development: a global perspective. Dev Policy Rev 26(6):657–692
Headey D, Stifel D, You L, Guo Z (2018) Remoteness, urbanization, and child nutrition in sub-Saharan Africa. Agric Econ 49(6):765–775
Japan International Cooperation Agency (2002) The study on the Cebu integrated port development plan in the Republic of the Philippines. https://openjicareport.jica.go.jp/pdf/11684776_01.pdf
Kennedy G, Nantel G, Brouwer ID, Kok FJ (2006) Does living in an urban environment confer advantages for childhood nutritional status? Analysis of disparities in nutritional status by wealth and residence in Angola, central African republic and Senegal. Public Health Nutr 9(2):187–193
Kennedy GL, Pedro MR, Seghieri C, Nantel G, Brouwer I (2007) Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. J Nutr 137(2):472–477
Kishiue A, Narashinodai F, Amano K, Lidasan HS (2003) The transformation of Cebu City through the development of its transportation infrastructure (1521–1990). J East Asia Soc Transp Stud 5:3286–3302
Law L (1997) Cebu and Ceboom: The political place of globalisation in a Philippine City. In: Rimmer PJ (ed) Pacific rim development: integration and globalisation in the Asia-Pacific economy. Allen & Unwin, Sydney, pp 240–266
Mendez MA, Popkin BM (2004) Globalization, urbanization and nutritional change in the developing world. eJADE Electron J Agric Develop Econ 1(853-2016–56106):220–241
Muellbauer J (1977) Testing the Barten model of household composition effects and the cost of children. Econ J 87(347):460–487
Musgrove P (1988) Basic food consumption in north–east Brazil: effects of income, price, and family size in metropolitan and rural areas. Food Nutr Bull 10(1):1–10
Ochola S, Masibo PK (2014) Dietary intake of schoolchildren and adolescents in developing countries. Ann Nutr Metab 64(Suppl. 2):24–40
Pettigrew S, Jongenelis M, Chapman K, Miller C (2015) Factors influencing the frequency of children's consumption of soft drinks. Appetite 91:393–398
Popkin BM (2006) Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases–. Am J Clin Nutr 84(2):289–298
Ruel MT, Haddad L, Garrett JL (1999) Some urban facts of life: implications for research and policy. World Dev 27(11):1917–1938
Ruel MT, Garrett JL, Haddad L (2008) Rapid urbanization and the challenges of obtaining food and nutrition security. In: Semba RD, Bloem MW, Piot P (eds) Nutrition and health in developing countries. Nutrition and health series. Humana Press, pp 639–656. https://doi.org/10.1007/978-1-59745-464-3_22
Sajor EE (2001) The real estate boom in the 1990s and land use allocation for socialized housing in Metro Cebu, Philippines. Urban Management Programme, Regional Office for Asia and the Pacific

Scrimshaw NS, SanGiovanni JP (1997) Synergism of nutrition, infection, and immunity: an overview. Am J Clin Nutr 66(2):464S-477S

Zeger SL, Liang K-Y, Albert PS (1988) Models for longitudinal data: a generalized estimating equation approach. Biometrics 44(4):1049–1060