

**FCND DISCUSSION PAPER NO. 61**

**DOES GEOGRAPHIC TARGETING OF NUTRITION  
INTERVENTIONS MAKE SENSE IN CITIES?  
EVIDENCE FROM ABIDJAN AND ACCRA**

Saul S. Morris, Carol Levin, Margaret Armar-Klemesu,  
Daniel Maxwell, and Marie T. Ruel

**Food Consumption and Nutrition Division**

**International Food Policy Research Institute**

**2033 K Street, N.W.**

**Washington, D.C. 20006 U.S.A.**

**(202) 862-5600**

**Fax: (202) 467-4439**

**April 1999**

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## **ABSTRACT**

Although most developing country cities are characterized by pockets of substandard housing and inadequate service provision, it is not known to what degree low incomes and malnutrition are confined to specific neighborhoods. This analysis uses representative household surveys of Abidjan and Accra to quantify small-area clustering in service provision, demographic characteristics, consumption, and nutrition. Both cities showed significant clustering in housing conditions but not in nutrition, while income was clustered in Abidjan, but less so in Accra. This suggests that neighborhood targeting of poverty-alleviation or nutrition interventions in these and similar cities could lead to undercoverage of the truly needy.

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## **ACKNOWLEDGMENTS**

The authors thank Dr. Guessan Bi Kouassi, Director General of the Institut National de la Statistique, Côte d'Ivoire, for granting access to the Côte d'Ivoire Living Standards Survey, and to Margaret Grosh of the World Bank for comments on an earlier draft.

Saul S. Morris  
Carol Levin  
Marie T. Ruel  
International Food Policy Research Institute

Margaret Armar-Klemesu  
Noguchi Memorial Institute for Medical Research  
University of Ghana, Legon

Daniel Maxwell  
CARE International—Kenya

## 1. INTRODUCTION

Aggregate data on poverty and malnutrition in developing country cities obscure large intra-urban differentials (Ruel et al. 1998). Once these figures are disaggregated, urban slum dwellers may suffer worse conditions than even their rural counterparts (Pryer and Crook 1988, 9). On the other hand, urban élites often enjoy lifestyles that are comparable to rich, industrialized countries. With these inequalities in mind, many intervention programs in the areas of urban food security and nutrition have targeted obvious low-income and marginal neighborhoods for assistance (see, for example, UNICEF 1994) for case studies of Bangladesh, Ecuador, Haiti, and Kenya). A recent analysis by the World Bank has demonstrated that at a national level in Latin America, geographic targeting reduces leakage of program benefits to the nonneedy compared to untargeted programs, although undercoverage of the truly needy increases (Baker and Grosh 1994). The same analysis finds that "fine-tuning" the targeting by basing it on smaller geographic units increases efficiency, but may in some circumstances be costly and politically unacceptable.

The applicability to urban areas of these lessons about the relative efficiency of targeted and untargeted programs will depend critically on the degree to which poverty, food insecurity, or malnutrition are found to *cluster* in particular neighborhoods. While the proliferation of poor quality housing and the irregular coverage of municipal services are clear for all to see in many developing country cities, the degree to which low

incomes and malnutrition (or high incomes and good nutrition) are confined to particular neighborhoods is generally unknown. Therefore, this paper uses two different "representative" surveys of African cities—Abidjan and Accra—to investigate the level of small-area clustering in housing conditions, income, and nutrition, and to assess the likely efficiency of neighborhood targeting of poverty-alleviation or community-based nutrition interventions.

## 2. METHODS

This paper uses data from two different household surveys: the Second Côte d'Ivoire Living Standards Survey (CILSS) 1986, and the Accra Urban Food and Nutrition Study (AUFNS) 1997. The two surveys are broadly comparable in terms of sampling strategy and questionnaire design. Background and design of the two studies are described briefly in the following sections.

### THE CÔTE D'IVOIRE LIVING STANDARDS SURVEY, 1986

The Côte d'Ivoire Living Standards Survey is a multipurpose, multi-round household survey developed jointly by the World Bank and the *Direction de la Statistique* of Côte d'Ivoire. The design and implementation of the survey are described in detail by Ainsworth and Muñoz (1986). A full list of the (many) previous reports and papers that have used CILSS data is available from the Living Standards Measurement Surveys Division of the World Bank.

The second round of the CILSS was conducted in 1986. It was a two-stage random sample with 100 Primary Sampling Units (PSUs), of which 21 were in Abidjan. Only the Abidjan households are used in the current analysis. The Abidjan sampling frame was based on a 1979-80 electoral census, which divided each sector of the city into smaller subsectors. Subsectors with similar types of housing were grouped together to form PSUs, and the required number of PSUs was selected using a systematic sampling procedure. Within each PSU, a pre-survey was conducted to identify households for the 1985 and 1986 surveys, based on a systematic sample of households starting at a random point. Sixteen households were to be selected within each PSU, with replacement of households who could not be contacted or who refused to participate.

Since the completion of the survey, a number of potential biases in both the selection of PSUs and the selection of households within PSUs have been suggested. These include underrepresentation of Yopougon, a relatively new residential area to the west of the city center, and a general over-enumeration of large households (Coulombe and Demery 1993). Corrective weights have been developed to compensate for these errors (see CILSS documentation, available from the World Bank). However, as with any post hoc corrective weights, there is always a danger that their use might result in other, unpredictable biases. Therefore the current analysis is based on the original unweighted sample, with major findings tested for robustness to reweighting.

## THE ACCRA URBAN FOOD AND NUTRITION STUDY, 1997

The Accra Urban Food and Nutrition Study was a single-round household survey with a focus on income, expenditure, consumption, and nutrition, conducted by the Noguchi Memorial Institute for Medical Research (University of Ghana, Legon) and the International Food Policy Research Institute.

The sample design was a two-stage random sample. Primary Sampling Units were Enumeration Areas (EAs) identified by the Ghana Statistical Service in 1984. The sampling frame consisted of 880 EAs in Accra, Tema, and surrounding peri-urban areas. Thirty-two additional EAs were excluded from the sampling frame because they were military/police areas (24), a university campus (1), or predominantly inhabited by expatriates (7). Current (1997) population size in each EA was estimated by assuming 3 percent annual growth since 1984 in the urban areas of Accra and Tema, and 8.9 percent annual growth in the remainder of the study area since the 1984 census, as indicated by the best city planning figures available at the time. The full list of EAs was then sorted geographically, and 16 EAs were selected using a systematic selection procedure with probability proportional to estimated population size. Within each selected PSU, a pre-survey was undertaken to identify households with children under three years of age. Forty households were to be picked at random from this list, with no replacement of households who could not be contacted or refused to participate, as recommended by Kish (1965, 558-559). Achieved sample size per EA therefore varied slightly.

The AUFNS is not representative of all households in Accra; it was designed to be representative of all households with children 0-36 months of age (termed *index children*). In the case of households with more than one child 0-36 months of age, a randomly chosen individual was designated the "index" child. Preliminary data analysis suggested an underenumeration of children aged 0-3 months, probably resulting from the 1.5-3 month interval between the pre-survey and the bulk of the data collection, but the sample is fully representative of households with children aged 3-36 months. Anthropometry estimates are therefore confined to this range.

#### CONSTRUCTION OF DERIVED VARIABLES

In both surveys, total household expenditure (used as a proxy for income) was determined by summing the following items: household food expenditure, consumption of home-produced food and nonfood products, all other expenditures, remittances, and wage income in kind. The proportion of all household expenditure devoted to food (the *food share*) is the sum of the first two elements, divided by the total. All expenditures were annualized, and expressed in local currency at current (survey-year) values. Total household expenditure was expressed on a per capita basis, by dividing the total by the number of household residents.

Nutritional status was assessed as height-for-age, weight-for-height, and weight-for-age of infants and young children, and body mass index (weight in kilograms divided by the square of height in meters) of adults over 18 years of age. Child anthropometry

was standardized using the reference population of the National Center for Health Statistics (Hamill et al. 1977). In the case of the CILSS, 20 percent of all anthropometry measurements were repeated, but these could not be treated as duplicate measures because of an interval of (on average) two weeks that elapsed between the pairs of measurements. Therefore, for each individual, the first available set of anthropometry measures was used for the current analysis. Forty-four out of 363 (12 percent) of children under five years of age in the Abidjan household roster did not have any anthropometry measurements, and a further 91 children have unknown month of birth, making it impossible to calculate standardized height-for-age or weight-for-age. A small number of gross outliers were removed from the Abidjan data set, and standardized measures were censored at  $\pm 5$  standard deviations of the reference median, resulting in the loss of a further 13 observations for height-for-age CILSS, 6 for weight-for-age CILSS, 4 for weight-for-height CILSS, and 1 for height-for-age AUFNS.

## STATISTICAL METHODS

Characteristics of the two samples were summarized using proportions (dichotomous variables), means (symmetrically distributed continuous variables), and medians (asymmetrically distributed continuous variables). Geographical clusters (PSUs in Abidjan and EAs in Accra) were ranked from worst to best on each variable, and the same summary statistics are presented for the most disadvantaged and most favored clusters, to illustrate the limits of between-cluster variation. Clustering was formally

assessed using the *intraclass correlation coefficient* ( $\rho$ ) (Snedecor and Cochran 1980, 243-244), which may be interpreted as the proportion of the total variance of an observation that is associated with the cluster to which it belongs. For normally distributed variables, this parameter was calculated using a standard random effects analysis of variance model (Snedecor and Cochran 1980, Chapter 13), as were also the estimates of the between- and within-cluster standard deviations (StataCorp 1977, G-O, 381). In order to approximate normality, per capita household expenditures were log-transformed prior to calculation of the intraclass correlation coefficient, and the reciprocal was taken of adult body mass index. For dichotomous variables, the intraclass correlation was estimated using the Generalized Estimating Equation approach, assuming a logit link, binomial error structure, and exchangeable correlation among observations from the same cluster (Liang, Zeger, and Qaqish 1992). Since  $\rho$  may take any value from 1 to 0 (and even just below zero in stratified samples), any attempt to define "high," "low," and "moderate" levels of clustering is necessarily arbitrary. However, Deaton (1997) has noted that "for quantities like income and consumption in rural areas of developing countries,  $\rho$  is often substantially larger than zero and values of 0.3 to 0.4 are frequently encountered." On the other hand, Bennett et al. (1991) note that "in practice, values above 0.4 are uncommon, except for variables which are specific to the locality rather than the household, and hence clustered by definition." We therefore adopted the following classification:

$\rho \geq 0.3$	"high intracluster correlation,"
$0.2 \leq \rho < 0.3$	"moderately high intracluster correlation,"
$0.1 \leq \rho < 0.2$	"moderately low intracluster correlation,"
$\rho < 0.1$	"low intracluster correlation."

A simulation exercise (Monte Carlo, 500 replicates) was carried out to determine the *ex-post* power of each of the two studies to detect intracluster correlation, assuming a classic random effects model and normally distributed outcome variables. With 21 clusters and 16 observations per cluster, the study would have 100 percent power to detect as significantly different from zero at the 5 percent significance level an intraclass correlation coefficient of 0.15, and >99 percent power to detect as significant an intraclass correlation coefficient of 0.10. With 16 clusters and 35 observations per cluster, the study would have near 100 percent power to detect as significant an intraclass correlation coefficient of 0.10.

All analyses were conducted using STATA, version 5.0 (StataCorp., College Station, Texas).

### 3. RESULTS

In the Abidjan 1986 data, 337 households were interviewed in 21 different clusters (mean 16.0 households per cluster, range 16-17). In the Accra 1997 data, 559 households

were interviewed in 16 clusters (mean 34.9 households per cluster, range 32-38). Results are presented for the two studies separately in the following sections.

## ABIDJAN

Approximately one-half of all households interviewed in the Abidjan survey had exclusive use of a toilet and obtained their drinking water from an inside tap, while the vast majority of households (>80 percent) had electric lighting and had their garbage collected in a truck (Table 1). These services, however, were unevenly distributed between neighborhoods, with the result that there were clusters where no survey households (or virtually none) accessed these services, and other clusters where all households interviewed benefitted. Intraclass correlation coefficients ( $\rho$ ) exceeded 0.5 for all four variables.

The great majority of households in Abidjan had at least one member with some schooling, and households without any schooling were spread across the city, so that no cluster had more than 50 percent households without schooling. Migrant status also showed very little geographic clustering in this survey ( $\rho = 0.05$ ), with a remarkable 73 percent of household members 15 years old or older born somewhere other than Abidjan. Income, proxied by per capita total household expenditure, did, however, show a high degree of geographical clustering ( $\rho = 0.39$ , or  $\rho_w = 0.33$  using the corrective weights described in the Methods section). The median per capita expenditure in the best-off cluster in the survey was nearly six times the median in the worst-off cluster. By contrast,

**Table 1—Geographic heterogeneity and clustering of selected household characteristics and nutritional status of children and adults in Abidjan**

	Entire sample	Least privileged cluster	Best-off cluster	Intracluster correlation coefficient
Electric lighting	82% (278/337)	0% (0/16)	100% <sub>a</sub>	0.52
Private toilet	52% (170/325)	6% (1/16)	100% <sub>a</sub>	0.53
Garbage collected by truck	87% (293/337)	0% (0/16)	100% <sub>a</sub>	0.54
Drinking water from inside tap	48% (162/337)	0% <sub>a</sub>	100% <sub>a</sub>	0.68
Any member of household completed first-grade education	86% (291/337)	50% (8/16)	100% <sub>a</sub>	0.13
Born in Abidjan (all household members 15 years or older)	27% (353/1308)	12% (7/57)	46% (33/72)	0.05
Household total expenditures (median, per capita annualized, CFA Francs)	327,735 ( <i>n</i> =337)	194,252 ( <i>n</i> =16)	1,131,192 ( <i>n</i> =16)	0.39 <sup>b</sup>
Food share (mean)	39% ( <i>n</i> =337)	51% ( <i>n</i> =16)	22% ( <i>n</i> =16)	0.25
Height-for-age Z-score (under-fives, mean)	-0.22 ( <i>n</i> =225)	-1.25 ( <i>n</i> =8)	1.47 ( <i>n</i> =6)	0.04
Weight-for-height Z-score (under-fives, mean)	-0.58 ( <i>n</i> =298)	-1.49 ( <i>n</i> =16)	0.29 ( <i>n</i> =7)	<0.001
Weight-for-age Z-score (under-fives, mean)	-0.58 ( <i>n</i> =228)	-1.33 ( <i>n</i> =10)	0.14 ( <i>n</i> =9)	0.03
Body mass index (males, 18 years and over, median)	21.8 ( <i>n</i> =524)	20.4 ( <i>n</i> =22)	23.9 ( <i>n</i> =19)	0.04 <sup>c</sup>
Body mass index (females, 18 years and over, median)	23.4 ( <i>n</i> =388)	20.7 ( <i>n</i> =15)	26.1 ( <i>n</i> =13)	0.05 <sup>c</sup>

Source: Côte d'Ivoire Living Standards Survey, 1986.

<sup>a</sup> More than one cluster with this value.

<sup>b</sup> Calculation based on log-transformed value.

<sup>c</sup> Calculation based on reciprocal.

within clusters, the ratio of the 75<sup>th</sup> percentile of per capita household expenditures to the 25<sup>th</sup> percentile varied from 1.8 to 3.3 (data not shown). The poorest five of 21 survey clusters (24 percent) accounted for only 12 percent of all expenditures. There was also a moderately high level of intracluster correlation in the food share (the percentage of all household expenditure devoted to food;  $\rho = 0.25$ , or  $\rho_w = 0.20$  using corrective weights).

Anthropometric variables—height-for-age, weight-for-height, and weight-for-age of children under five, and body mass index of men and women 18 years and older—showed low intracluster correlations ( $\rho \leq 0.06$  in all cases;  $\rho_w \leq 0.09$  using corrective weights). In the case of children's anthropometric status, there was substantial between-cluster variability for the two age-based measures, with estimated between-cluster standard deviations of 0.26 Z-scores for weight-for-age and 0.36 Z-scores for height-for-age. However, these apparently large between-cluster differentials were totally overshadowed by the enormous within-cluster variability (estimated within-cluster standard deviations of 1.72 Z-scores for height-for-age and 1.42 for weight-for-age). Nineteen of 21 clusters had at least one child in the lower tercile of the height-for-age distribution, and 20 clusters had at least one child in the upper tercile (data not shown). There was no between-cluster variation in weight-for-height (estimated between-cluster standard deviation  $< 0.01$  Z-scores). Using dichotomous instead of continuous variables resulted in intraclass correlation coefficients of -0.01 for stunting (height-for-age Z-score  $< -2$ ), 0.02 for wasting (weight-for-height Z-score  $< -2$ ), and 0.05 for underweight (weight-for-age Z-score  $< -2$ ).

## ACCRA

In general, the Accra 1997 survey showed poorer housing conditions than those documented in Abidjan in 1986: 38 percent of households had use of a private toilet, 45 percent obtained their drinking water from a piped source, be it inside or outside, and just 12 percent had their garbage collected. With respect to housing type, nearly one-half of households interviewed lived in houses with tile or slate roofs, as opposed to (the much cheaper) corrugated metal. The degree of geographical clustering in these variables was considerably less than that identified in Abidjan, with intraclass correlation coefficients ranging from 0.17-0.40 (Table 2).

Sample clusters were similar with regard to schooling of the household head, so that the proportion of households with a totally uneducated household head was never greater than 21 percent. On the other hand, the proportion of households where the head was born in Accra did show some geographical clustering, ranging from 19 percent to 89 percent of all households in a cluster ( $\rho = 0.18$ ). Income, proxied by per capita total household expenditure, showed much less geographical clustering than in Abidjan: the ratio of median per capita expenditure in the best-off cluster to the worst-off cluster was 2.8:1, while within clusters, the ratio of the 75<sup>th</sup> percentile of per capita household expenditures to the 25<sup>th</sup> percentile varied from 1.7 to 3.0. The intraclass correlation coefficient for per capita total household expenditures was 0.14 (0.11 when eight outlying values were removed from the analysis), and the poorest four of 16 clusters (25 percent)

**Table 2—Geographic heterogeneity and clustering of selected household characteristics and nutritional status of children and adults in Accra**

	Entire sample	Least privileged cluster	Best-off cluster	Intra-cluster correlation coefficient
Private toilet	38% (212/558)	0% <sup>a</sup>	97% (31/32)	0.38
Garbage collected	12% (65/558)	0% <sup>a</sup>	71% (24/34)	0.40
Drinking water from piped supply (inside or outside)	45% (249/558)	3% (1/38)	91% (29/32)	0.17
Roof made of tiles or slates	48% (267/558)	0% (0/36)	88% (28/32)	0.29
Household head completed first grade education	90% (501/557)	79% (26/33)	100% (32/32)	0.03
Household head born in Accra	46% (300/559)	19% (6/32)	89% (34/38)	0.18
Household total expenditures (median, per capita, annualized)	764,871 (n=557)	544,903 (n=38)	1,513,478 (n=32)	0.14 <sup>b</sup>
Food share (mean)	54% (n=557)	61% (n=38)	38% (n=32)	0.09
Height-for-age Z-score (3-36 months, mean)	-0.93 (n=560)	-1.28 (n=35)	-0.07 (n=31)	0.03
Weight-for-height Z-score (3-36 months, mean)	-0.57 (n=561)	-1.03 (n=34)	-0.29 (n=31)	<0.01
Weight-for-age Z-score (3-36 months, mean)	-1.05 (n=561)	-1.49 (n=34)	-0.32 (n=31)	0.04
Body mass index (principal caregiver of index child, median)	23.3 (n=555)	22.1 (n=34)	26.5 (n=34)	0.04 <sup>c</sup>

Source: Accra Urban Food and Nutrition 1997.

<sup>a</sup> More than one cluster with this value.

<sup>b</sup> Calculation based on log-transformed value.

<sup>c</sup> Calculation based on reciprocal.

accounted for 19 percent of all expenditures. There was low intracluster correlation in the proportion of household budgets allocated to food ( $\rho = 0.09$ ).

As in Abidjan, there was virtually no geographic clustering in measures of nutritional status (height-for-age, weight-for-height, and weight-for-age of children aged 3-36 months, and body mass index of the "index children's principal caregivers"<sup>1</sup>;  $\rho \leq 0.04$  in all cases). Estimated between-cluster standard deviations were 0.19 Z-scores for height-for-age, 0.20 for weight-for-age, and 0.09 for weight-for-height. Estimated within-cluster standard deviations were 1.16 for height-for-age, 1.05 for weight-for-age, and 0.93 for weight-for-height. Using dichotomous instead of continuous variables resulted in intraclass correlation coefficients of 0.01 for stunting and wasting, and  $\rho < 0.00$  for underweight. Children in the lowest quintile of the height-for-age distribution, and in the highest quintile, were found in all 16 clusters.

#### 4. DISCUSSION AND CONCLUSIONS

This paper uses household survey data to assess small-area geographic clustering of housing conditions, income (proxied by total expenditure), and nutrition in two West African capital cities, Abidjan (1986) and Accra (1997). Neither city showed any sign of geographic clustering of nutritional status. On the other hand, both cities exhibited significant clustering in housing conditions, measured by toilet type, garbage collection,

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<sup>1</sup> The principal caregiver was the child's biological mother in 80 percent of cases.

drinking water source, electricity supply (Abidjan), and type of roofing (Accra). For all of these variables, geographic clustering was more marked in Abidjan—which was, on aggregate, the better-off of the two cities—than in Accra. Income, which was proxied in this analysis by total household expenditures, was markedly clustered in Abidjan, much less so in Accra. Thus, in Abidjan, the poorest five of 21 survey clusters (24 percent) accounted for just 12 percent of all expenditure, while in Accra, the poorest four of 16 clusters (25 percent) accounted for 19 percent of all expenditure. Interestingly, in Abidjan, neither schooling nor migration status, both variables that might be thought to influence earning capacity, showed much evidence of clustering by geographic area, at least when defined as in this analysis. The share of household expenditure devoted to food, often taken as an important indicator of household food security, showed moderately high levels of geographic clustering in Abidjan and little clustering in Accra. We are unaware of previous published reports of clustering of income in developing country cities, although Deaton (1984) has reported strong evidence of intra-cluster correlation in the food share in urban areas of Sri Lanka, based on a survey conducted in 1969-70.

We found it surprising that there was not more clustering of total household expenditures (income) in Accra. One possible explanation is that the relatively small sample size in each of the two studies may have affected the precision of our estimates. We conducted simulation exercises and found that the estimated intraclass correlation coefficient was not significantly biased downwards at the sample sizes observed in the

Abidjan and Accra data sets. However, precision of the estimate is substantially reduced with small numbers of clusters and/or small numbers of observations per cluster. Using bootstrap methods (Efron and Tibshirani 1986) with 5,000 replicates to derive 95 percent confidence limits for the point estimate for income clustering in the Accra study ( $\rho = 0.14$ ), we determined that the upper confidence interval would not exceed 0.235 under any assumptions. Even this higher level would seem to indicate a surprising level of mixing in Accra neighborhoods. Vandell (1995) has developed a general model showing how market forces (demand, supply, and equilibrium price adjustment), as well as institutional factors, can create between-neighborhood heterogeneity in income, ethnicity, and housing characteristics. For example, differences in income and wealth could create spatial concentration by dint of higher-income households outbidding lower-income households for (1) housing units in neighborhoods where residents exhibit "desirable" qualities such as wealth, education, or stability, (2) housing units with desirable structural characteristics such as size, age, and style, or (3) housing units in neighborhoods with specific site characteristics, neighborhood amenities, or accessibility characteristics. Asabere (1981) has shown that in the 1970s, land values in Accra were strongly related to location, government zoning, aspects of land tenure, ethnic clustering, and site services. Further research should address why, at the end of the 1990s, Accra neighborhoods do not show more sharply differentiated consumption profiles.

The most striking finding of our analysis was the very low level of geographic clustering in all of the nutritional variables examined, both in Abidjan and in Accra

( $\rho \leq 0.06$  in all cases). This appeared not to be due to a lack of differences in mean anthropometric status between clusters, but rather to the very large variability *within* clusters. In Accra, children in the lowest quintile of the height-for-age distribution were found in all 16 clusters, as were children in the highest quintile of height-for-age. We were only able to locate one other report of geographic clustering of nutritional status in an urban area of a developing country: in a series of six consecutive surveys of children aged 6-59 months in Kinshasa, Zaire (Arbyn et al. 1995), the design effect for wasting ranged from 0.75 to 4.69, which, with 30 clusters and 61-62 children sampled per cluster, would imply intraclass correlations of  $<0.00$  to 0.061 (Bennett et al. 1993). With the exception of the last survey round ( $\rho = 0.061$ ), these surveys indicate negligible geographic clustering of wasting in Kinshasa, just as our findings showed negligible clustering of wasting in Abidjan and Accra. Katz (1995) has published design effects for four large nutritional surveys in *rural* areas of Malawi, Zambia, Indonesia, and Nepal. Again, these design effects can readily be converted into intraclass correlation coefficients: for stunting,  $\rho \leq 0.00$  in the two African countries and 0.01-0.04 in the two Asian countries; for wasting,  $\rho = 0.01$  in Malawi,  $< 0.01$  in Indonesia, and 0.03 in Nepal; for underweight,  $\rho = 0.00$  in Malawi, 0.01 in Indonesia, and 0.02 in Nepal. These levels are little different from the those that we identified in Abidjan and Accra, although underweight appeared to be somewhat more clustered in Abidjan ( $\rho = 0.05$ ).

The reasons for the lack of clustering in nutritional status, in either city, are intriguing. One possibility is that the clusters were too large to exhibit truly homogenous

conditions. Yet, in Accra, the total study area was divided into no less than 880 clusters before selection of the 16 clusters surveyed—if these units were still too large, one must question how fine spatial disaggregation needs to be before homogeneity is finally achieved? Another possibility is that sampling procedures in both studies resulted in underrepresentation of neighborhoods with more extreme profiles. Indeed, previous investigators have raised doubts about the representativeness of the Abidjan data (Coulombe and Demery 1993), and corrective weights have been developed in an attempt to answer some of these criticisms, as described in the Methods section above.

Application of these weights resulted in a slight increase in the estimated clustering of nutritional status of children and adult females ( $\rho_w = 0.08$  for height-for-age and weight-for-height,  $\rho_w = 0.06$  for weight-for-age,  $\rho_w = 0.09$  for body mass index, females), but even these higher levels still point to fundamentally heterogeneous clusters. Furthermore, it is unclear that these "corrected" estimates are more free of bias than the uncorrected alternatives. In Accra, the seven wealthiest EAs in the city were excluded from the sampling frame because of a high proportion of expatriate residents, and the investigators also felt that the very poorest of the poor neighborhoods had—by chance alone—failed to be included in the systematic sample of PSUs. Such chance occurrences are unavoidable with random samples, unless the PSUs can be ordered by socioeconomic status when drawing a systematic sample, which data limitations prevented in the case of the Accra study. Nonetheless, it seems unlikely that such effects could account in isolation for the almost total lack of geographic clustering observed.

In fact, the low levels of geographic clustering of nutritional outcomes in both Accra and Abidjan appear to be due not to any lack of variation *between* clusters, but from a surprisingly large degree of variation *within* clusters. This may suggest that unfavorable environmental conditions, which our own analysis as well as previous studies (Benneh et al. 1993; Atelier d'Architecture d'Urbanisme et de Topographie 1993) have shown to cluster in particular neighborhoods, may be overcome by favorable practices in the home. This phenomenon, referred to as "positive deviance," is familiar in the nutrition literature: Zeitlin (1991) has suggested that it may be related to known correlates of malnutrition (e.g., maternal education, family size and birth spacing, knowledge of modern nutrition, birth weight, maternal height and weight, parity, morbidity, weaning practices, and dietary intake of nutrients), to a number of different poorly understood metabolic mechanisms, and also to behavioral, social, and cultural aspects of child care. It is not clear how widespread such cases are, but it has previously been shown that in urban Côte d'Ivoire, maternal and paternal stature are important determinants of height-for-age Z-scores of under-fives (Sahn 1990), and that in Accra, good care practices mitigate the effects of poverty on children's nutritional status (Ruel et al. 1998). It is also possible that in some circumstances, relatively favorable environmental conditions in the absence of other health- and care-promoting factors may not be sufficient to ensure good nutrition (it has been noted, for example, that community water supplies are often recontaminated while stored in the home [Mintz, Reiff, and

Tauxe 1995]). If this is the case, then interventions focusing purely on neighborhood infrastructure and sanitary environment may have little impact on nutritional status.

The scant available literature on interventions to improve household food security and nutrition in urban areas of developing countries (UNICEF 1994; Atkinson 1992) indicates that geographically focused projects and programs have often been seen as the natural choice. Neighborhood upgrading programs, which aim to remove the worst environmental hazards from the urban landscape and often include a health or nutrition component, are by definition geographically focused. The current analysis suggests that in cities such as Abidjan and Accra, such approaches would lead to dramatic undercoverage of the truly needy, and—unless accompanied by additional screening mechanisms—would suffer from significant leakage also. Even (relative) poverty and wealth seem to be far more geographically dispersed in these cities, (especially Accra) than a cursory evaluation guided by housing type, housing quality, and infrastructure, would suggest. More data on the homogeneity, or otherwise, of neighborhoods in other developing country cities are urgently needed to assess the generalizability of these findings; meanwhile, the potential for self-targeting of household food security and nutrition programs, or targeting based on characteristics other than neighborhood of residence, requires examination.

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