Geographic Aspects of Poverty and Health in Tanzania: Does Living in a Poor Area Matter?

October 2003

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Funded by:
U.S. Agency for International Development

Order No. TE030

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October 2003

Recommended Citation

M. Mahmud Khan, David R. Hotchkiss, Andrés A. Berruti and Paul L. Hutchinson, October 2003. *Geographic Aspects of Poverty and Health in Tanzania: Does Living in a Poor Area matter?* Technical Report No.30. Bethesda, MD: The Partners for Health Reform*plus* Project, Abt Associates Inc.

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Contract/Project No.: HRN-C-00-00-00019-00

Submitted to: Karen Cavanaugh, CTO
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Office of Health, Infectious Disease and Nutrition
Center for Population, Health and Nutrition
Bureau for Global Programs, Field Support and Research
United States Agency for International Development

Abstract

Previous studies have consistently found that that there is an inverse relationship between household-level poverty and health status, and that poor people tend to live in poor communities. However, what is not well understood is whether and how the average economic status at the community level plays a role in the household poverty–health relationship. This study investigates the concentration of poverty at the community level in Tanzania and its association with the availability and quality of primary health care services, the utilization of primary health care services, and health outcomes among both poor and non-poor households. The analysis uses an innovative approach of linking household-level data from 1996 Tanzania Demographic and Health Survey with facility information from the 1996 Tanzania Service Availability Survey. A principle component method is used to rank households separately by urban/rural status according to the reported levels of assets ownership and living conditions, and then classifies communities into three socioeconomic groups based on the proportion of households belonging the poorest wealth tercile. On average, both poor and non-poor households living in low poverty concentration areas were found to have better health outcomes and service utilization rates than their counterparts living in high poverty concentration clusters. Consistent with the finding is that high poverty concentration areas were farther way from facilities offering primary health care than were low poverty concentration areas. Moreover, the facilities closest to the high poverty concentration areas had fewer doctors, medical equipment, and drugs. Among poor communities in rural areas, the ten communities with the best women's body mass index (BMI) measures were found to have access to facilities with a greater availability of equipment and drugs than the ten communities with the worst BMI measures. Although this study does not directly measure quality, the characteristics that differentiate high poverty concentration clusters from low poverty concentration clusters point to quality as more important than physical access among the study population.

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Acronyms

BMI	Body Mass Index
HFA	Height-for-Age
PHR*plus*	Partners for Health Reform*plus*
TDHS	Tanzania Demographic and Health Survey
TSAS	Tanzania Service Availability Survey
USAID	United States Agency for International Development
WFH	Weight-for-Height

Acknowledgments

The authors wish to thank Dr. Sara Bennett of the PHR*plus* project for her insightful comments on a previous version of this paper. A previous version of this paper was presented at the Fourth Conference of the International Health Economics Association in San Francisco, June 2003, and the current report benefited from conferees' comments.

Executive Summary

Previous studies have consistently found that that there is an inverse relationship between household-level poverty and health status, and that poor people tend to live in poor communities. However, what's not well understood is whether and how the average economic status at the community level plays a role in the household poverty–health relationship. The purpose of this study is to investigate the concentration of poverty at the community level in Tanzania and its association with the availability and quality of primary health care services, the utilization of primary health care services, and health outcomes among both poor and non-poor households.

The analysis uses an innovative approach of linking household-level data from 1996 Tanzania Demographic and Health Survey (TDHS) with facility information from the 1996 Tanzania Service Availability Survey (TSAS). The TDHS provides detailed information on household demographics, asset ownership, dwelling conditions, health status of women and children, utilization of maternal–child health and other selected health care services, and knowledge and practices related to health. The TSAS includes detailed information on staff training and the availability of services, infrastructure, equipment, supplies, and medical personnel. The TSAS did not collect information on the distances between the surveyed clusters and the health care facilities, but the geographical coordinates of communities and facilities were collected in the 1991/92 TSAS. We have used the geo-coordinates from the 1991/92 survey to calculate the straight-line distances between the center of each of the clusters and the health facilities of the cluster.

A principle component method is used to rank households separately by urban/rural status according to the reported levels of assets ownership and living conditions. For this analysis, we have classified each cluster into one of three groups based on the proportion of cluster households belonging to the poorest tercile. Clusters were classified as being of "high poverty concentration" if more than 60 percent of households in the cluster were poor, as "medium poverty concentration" if 33 to 60 percent of households were poor, and "low poverty concentration" if fewer than 33 percent households were poor.

We examined the effect of geographic poverty on the health status of the population. The extent of geographic poverty was defined by the concentration of poor households in a locality. A comparison of the health status measures of population, especially the body mass index of women and height-for-age of children, showed that degree of concentration of poverty and health status measures are related. The fact that the differences in health status measures between high and low poverty concentration clusters became greater when we controlled for the socioeconomic status of the households implies that geographic poverty has an independent effect on health. In other words, poor households living in low poverty concentration areas were, on average, better off in terms of a number of health status measures than poor households living in high poverty concentration clusters. Similarly, top tercile households living in low poverty concentration clusters were found to be of better health status than their counterparts living in high poverty concentration clusters.

The analysis of the cluster-level data indicates that the high poverty concentration clusters were located further away from primary health facilities than the low poverty clusters. For Tanzania, we expected a relatively egalitarian geographic distribution of primary health care facilities because of its socialistic past. The presence of unequal geographic distribution in Tanzania probably implies that the situation is even worse in other developing countries of the world.

Distance is only one aspect of unequal access to care for the poverty clusters; another important aspect is the availability of health care providers and drugs in the facilities. Households from the poorest clusters not only have to travel longer distances to reach primary health centers or other health facilities, but these facilities also had fewer health care providers, medical equipment, and drugs. Utilization of selected primary care services was also found to be lower in high poverty concentration areas than in low poverty concentration. Although we cannot derive a definitive conclusion from the tabulations, it appears that quality of services delivered from the health facilities is an important factor in explaining utilization differences.

We compared the physical availability to and quality of primary health care service for the ten best and ten worst health status clusters among the poorest clusters of the sample. The results indicate that the average distances to health facilities of these two sets of poor clusters were almost identical, but the two groups differ significantly in terms of the quality of services delivered from the health facilities. Therefore, one possible way to improve the health status of the population in poor clusters is to provide better quality services from the existing health facilities; distance to the health center does not appear to be the critical factor. The two groups also differ significantly in terms of educational status of women and their husbands, knowledge about family planning and other medical care services, and the percent of women widowed or divorced.

A number of other social conditions were also found to be associated with poorer health status among the poverty clusters. As mentioned above, differences in educational status of women and their husbands were found to be important between these two sets of clusters selected from high poverty concentration clusters. Therefore, improvements in general education of the population should improve the health status of the population. Even short-term health education delivered through informal mechanisms or through health facilities may improve the health of the households in poor clusters. In our analysis, knowledge about diarrhea and family planning methods were important factors that distinguished between these two sets of poor clusters.

The analysis of this paper suggests that appropriate design and delivery of health services can effectively work against inequities that currently disadvantage the poor. That the high poverty concentration areas were further away from primary health care facilities and were served by facilities with lower levels of medical personnel, drugs, and equipment, indicates that there are considerable gains to be realized from improved targeting of public health sector resources. Even among the poorest communities, the finding that the ten clusters with the best health outcomes had better availability of drugs and equipment than the ten clusters with the worst health outcomes is likely to reflect the crucial importance of quality of services for the poor areas in developing countries of the world.

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1. Introduction

In both developed and developing countries, poverty is an important determinant of health status of the population (Backlund et al.,1996, Marmot 1999, Polednak 1997, Shaw 1999). In fact, poverty and poor health status appear to reinforce each other, making it difficult for individuals with poor health to break out of a poverty–health trap (Whitehead et al. 2001). Thus, a lower socioeconomic situation leads to poorer health status, which, in turn, exacerbates the incidence and intensity of poverty.

A number of studies have also found quite a strong geographic concentration of poverty, i.e., poor households tend to live in areas where most of the people are poor (Polednak 1997, Minot and Baulch 2002). The geographic concentration of poverty is not surprising. The economic status of households, to some extent, determines the infrastructural development of the locality and the availability of amenities of life. The non-poor are likely to be both able and willing to pay for better and more available services. The presence of these improved facilities, infrastructure, and quality services increases the cost of living, thereby pushing poor households out of the area. Despite these underlying dynamics, geographic units are rarely exclusively poor or non-poor, especially in the developing countries of the world. This is because economic and social mobility affects poverty of households in the short-run but changing residential location is a longer-run decision. Moreover, non-poor households often need the poor households in the locality as a source of labor.

In a private market-oriented system, purchasing power affects service availability and its quality. However, it is not clear if the average economic status of geographic regions also affect the spatial distribution of primary health care services, especially when health services are organized and delivered predominantly by the public sector or not-for-profit agencies. The purpose of this study is to provide insights into the complex relationship between household-level poverty and health by investigating the special distribution of poverty and its association with health outcomes on both the poor and the non-poor, primary health care utilization, and the availability and quality of health care services in small geographic areas. The main questions addressed in the study are: Is the degree of poverty concentration at the community level associated with health status after controlling for household wealth? Is there any evidence of systematic bias against poor areas in terms of the availability and quality of primary health care facilities? How does the availability of services affect utilization patterns? Will an improvement in the supply of health care services improve the health status of the population in poor areas?

We address these questions using data from Tanzania, an East African country with high levels of poverty but with a history of experimentation with socialism and egalitarian efforts at wealth redistribution. The Tanzanian government's 1967 Arusha Declaration proposed a decentralized system of government and a rural development plan based on cooperative farm villages. Heavy emphasis was also placed on the development of primary education and primary health care (Ofcansky 1997).

The effectiveness of these reforms was limited, and Tanzania remains one of the world's poorest countries (World Bank 2001). Access to quality health services varies geographically, but on average rural populations tend to be closer to health facilities than rural populations in neighboring countries (Beegle 1995). Even so, the availability of key supplies, equipment, and services at those clinics varies considerably (Turner 1994, World Bank 1999, Chen and Guilkey 2002). Efforts over the past decade have sought to improve public sector administration and health system responsiveness by devolving key responsibilities for health system management to local governments (Mills, 1994, Hutchinson 2002)

2. Methodology of Analysis

2.1 Survey Design and Sample Size

The data used in the study have been obtained from two surveys done conjointly – household information was obtained from 1996 Tanzania Demographic and Health Survey (TDHS), while information on the health care supply environment comes from the 1996 Tanzania Service Availability Survey (TSAS) (Bureau of Statistics of Tanzania and Macro International 1997). The TDHS provides detailed information on household demographics, asset ownership, dwelling conditions, health status of women and children, utilization of maternal–child health and other selected health care services, and knowledge and practices related to health.

The TDHS is based on a three-stage sampling design and consists of 357 sample enumeration areas, the same clusters used by the Demographic and Health Survey carried out in 1991/92. Ninety-five of the clusters were located in urban areas, and the remaining 262 were rural. The selection of these enumeration areas or sample clusters was made in two stages. At the first stage, small administrative units called "wards" were selected randomly, and, at the second stage, clusters were randomly selected within the selected wards. A list of households residing in those clusters was prepared, and, at the third stage, households were randomly selected from each of the clusters in proportion to the number of households in the clusters. In total, the TDHS selected 8,900 households for the survey and out of this sample a total of 8,120 women age 15 to 49 years (2,088 urban and 6,032 rural) were successfully interviewed. Therefore, the average number of households surveyed in a cluster was about 23.

In addition, information on the availability and quality of health care facilities was obtained from the 1996 TSAS, which was implemented in conjunction with the TDHS. For each sample cluster, the closest of each type of facility (hospital, health center, and dispensary) was visited and information on the facilities and their service delivery operations was obtained. The TSAS includes detailed information on staff training and the availability of services, infrastructure, equipment, supplies, and medical personnel. The TSAS did not collect information on the distances between the surveyed clusters and the health care facilities, but the geographical coordinates of communities and facilities were collected in a previous survey, the 1991/92 Tanzania Service Availability Survey. This study used the geo-coordinates from the 1991/92 TSAS to calculate the straight-line distances between the center of each of the clusters and the health facilities of the cluster. Unfortunately, neither the 1991/92 TSAS nor the 1996 TSAS was carried out in the island of Zanzibar. As a result, this study excludes households in Zanzibar from the parts of the analysis that are based on linked household and facility information and brings the number of clusters studied to 327.

2.2 Method of Data Analysis

2.2.1 Household Asset Scores and Poverty

In this study, socioeconomic status of households has been defined by using information on asset ownership and dwelling conditions. Because the TDHS did not collect information on household income or consumption, we used alternative measures of economic status based on asset or wealth indicators.[1] Since the TDHS questionnaire collected information on both the dwelling conditions (i.e., type of toilet, floor construction, availability of electricity, source of water) and asset ownership (i.e., radio, refrigerator, bicycle, motorcycle, and car), all these variables were used to construct a composite measure of economic wellbeing or wealth ownership by applying principal component analysis. These indices are often referred to as household wealth scores. Details on the construction of the wealth scores are summarized in the annex.

2.2.2 Cluster-level Poverty

Since the wealth scores are based on pattern of asset ownership among households rather than the monetary value of assets owned, the scores can be used to define relative socioeconomic position of households and relative poverty. In order to define the poor households in the sample, we have ranked households in terms of their wealth scores (described in the annex). Most previous studies that used this type of approach divided the sample into wealth quintiles (Filmer and Pritchett 1999, Filmer and Pritchett 2001, Montgomery et al. 2000). In this analysis, an attempt was made to define five socioeconomic groups as well, but the ranking of households in terms of wealth scores revealed that dividing the sample into quintiles (or quartiles) would require arbitrary allocation of significant number of households into two lowest quintiles due to lumping of wealth scores into few values. In order to avoid this problem, we opted to divide the sample into wealth terciles. The lowest tercile defines the "poor group" for this analysis.

In constructing the wealth scores, we also examined the effect of excluding the variables related to dwelling condition. This exclusion did not affect the relative scores of households significantly, and it was decided to use both the asset and dwelling condition related variables in the analysis. In addition, we calculated the wealth tercile groups separately for rural and urban areas to examine the potential effect of rural–urban differences in asset ownership on the ranking of households. Separating the sample into rural and urban categories appears to provide more realistic levels of poverty across geographic regions. This will be discussed in some detail in the results section of the paper.

Our principal interest in this study is to distinguish between poor and non-poor clusters in order to examine the degree of poverty concentration and its association with access to and quality of health care services, health care utilization, and health outcomes. For this analysis, we have classified each cluster into one of three groups based on the proportion of cluster households belonging to the poorest tercile. Clusters were classified as being of "high poverty concentration" if more than 60 percent of households in the cluster were poor, as "medium poverty concentration" if 33 to 60 percent of households were poor, and "low poverty concentration" if fewer than 33 percent households were poor. Although the cut-off points chosen are quite arbitrary, two practical concerns were balanced to identify the cut-off levels. To define the high poverty concentration areas, we started with 75 percent as the cut-off. The number of

[1] A number of studies have demonstrated the validity of using wealth-based indicators for categorizing households (Filmer and Pritchett 1999, Filmer and Pritchett 2001, Montgomery et al. 2000).

clusters above this level was so low that we decided to use a lower cut-off level to increase the sample size for empirical analysis. The choice of 60 percent as the cut-off yielded 48 clusters in rural areas and 20 clusters in urban areas in the high poverty concentration category. The lower cut-off point used here (33 percent) to distinguish between low and medium poverty concentration is quite widely applied in defining relative poverty. At the cluster-level analysis, we have dropped those clusters in which fewer than ten households were sampled. The exclusion of the small clusters reduced the number of clusters in the sample from 327 to 298. However, exclusion of the clusters did not affect the results of the analysis.

2.2.3 Availability and Quality of Health Care Services

The health facility surveys associated with the TDHS collected information on facilities located in or near each of the survey clusters. Access to health facilities was defined by the facility's distance from the center of the cluster. However, the presence of a facility, by itself, does not indicate access or delivery of quality services. A number of additional variables were used to indicate the degree of access and the quality of services delivered through the facilities. Following the literature on quality indicators (Akin et al. 1998, Mwabu, Ainsworth, and Nyamete 1994, Alderman and Lavy 1996), we measured facility quality by the number of health care providers in the facility, the availability of essential medical equipment and supplies, and the availability of essential drugs.

The facility surveys collected information on the availability of a large number of essential medical equipment and drugs. In order to represent the average quality of the facilities, it was important to summarize the information in an index. For this purpose, we have used the principal component approach again. Alternative measures of equipment availability were also defined by adding the type of different drugs and equipment available in the health facility. For drugs, we have considered not only their availability but also the information on their regular availability. For example, if the facility did not have a specific drug from the list during the survey, the value assigned to that facility for that drug was zero. Drug availability index is assumed to be 0.5 if the facility had the drug at the time of the survey but reported a stock out during the past six months, and 1.0 if the facility had the drug without any stock out. After assigning the values to each of the drugs in the list, an overall facility-specific drug availability index was constructed by computing a simple summation of the values for all drugs. The first principal component scores were also used to construct an alternative index of drug availability for a health center.

In summary, the information on equipment and drug availability was used to construct five indices of service quality: *i*) number of 11 most important pieces of equipment available in the facilities of a cluster,[2] *ii*) first principal component scores for each of the clusters using the information on availability of all 71 pieces of equipment listed in the facility surveys; *iii*) number of equipment available in a cluster out of the 71; *iv*) simple summation of drug availability indices per cluster; and *v*) first principal component of drug availability indices per cluster.

[2] The 11 most important pieces are: sterilizer, microscope, ultrasound, laparoscope, suction equipment, cautery, refrigerator, bag and mask for neonatal resuscitation, vehicle, maternal waiting room, hemoglobinometer for diagnosis of anemia.)

3. Wealth Scores and Poverty in Tanzania

3.1 Asset Scores, Poverty, and Health Status

Table 1 lists all the variables on assets and living conditions used for constructing the wealth score, and the percent of households owning these items by the three socioeconomic categories defined. It is clear from the results in Table 1 that the household categorization based on dwelling condition and asset scores does reflect underlying poverty and wellbeing of the groups in both rural and urban areas. For example, as expected, no households in the poorest and middle terciles reports owned a car or a motorcycle. Regarding source of potable water, rivers and springs were more frequently mentioned as the primary sources by the poorest tercile than by the other two groups.

Table 1 also indicates the differences in asset ownership patterns between rural and urban areas. For example, 3.5 percent of rural households mentioned having piped water inside their house; among urban households, the proportion was 36.9 percent. Ownership of bikes was higher in rural areas than in urban areas, possibly due to the lack of alternative transportation systems.

Clearly, the distribution of assets between rural and urban areas varies quite significantly. Ownership of specific types of assets is affected not only by the economic status of the households but also by differential monetary values and utility of the assets in rural and urban areas. If we estimate wealth scores without distinguishing between rural and urban areas, only a very small proportion of households (about 6 percent) are categorized as poor in urban areas. Such a low level of relative poverty in urban Tanzania compared to rural areas appears quite unrealistic. For this reason, we decided to calculate the wealth scores for rural and urban areas separately. Separate scoring for rural and urban areas implicitly assumes that the same assets or dwelling conditions have different values in the two areas and therefore, a standard set of assets can only define relative poverty within a given geographic region.

Table 1: Percent of Households Who Report Owning Various Assets, by Wealth Terciles and by Urban/Rural Residences

Dwelling Condition/Asset	Rural				Urban			
	Poorest	Middle	Top	Total	Poorest	Middle	Top	Total
	n=2413	*n*=2446	*n*=854	*n*=5713	*n*=130	*n*=399	*n*=1467	*n*=1996
Has flush toilet	0.000	0.000	0.071	0.011	0.000	0.000	0.097	0.072
Has pit toilet	0.772	0.911	0.828	0.840	0.900	0.985	0.843	0.875
Has other type of latrine	0.000	0.000	0.050	0.008	0.000	0.000	0.050	0.037
Has no toilet facilities, bush	0.226	0.086	0.042	0.139	0.100	0.013	0.007	0.015
Has piped drinking water into the residence	0.000	0.000	0.233	0.035	0.000	0.000	0.502	0.369
Major source of drinking water: public tap	0.034	0.492	0.240	0.261	0.069	0.732	0.380	0.430
Major source of drinking water: well in residence	0.002	0.011	0.070	0.016	0.000	0.005	0.010	0.009
Major source of drinking water: public/private well	0.446	0.251	0.220	0.329	0.592	0.125	0.078	0.121
Major source of drinking water: spring	0.189	0.096	0.136	0.142	0.108	0.030	0.003	0.015
Major source of drinking water: river, stream	0.267	0.105	0.071	0.168	0.169	0.090	0.015	0.040
Major source of drinking water: pond, lake or dam	0.059	0.041	0.021	0.046	0.062	0.015	0.003	0.009
Major source of drinking water: rainwater or other	0.000	0.000	0.008	0.001	0.000	0.003	0.010	0.008
Has cement floor	0.000	0.000	0.794	0.119	0.000	0.000	0.928	0.682
Has parquet, tiled floor	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002
Has wood, plank floor	0.000	0.001	0.009	0.002	0.000	0.000	0.000	0.000
Has earth/sand floor	1.000	0.999	0.173	0.876	1.000	1.000	0.067	0.315
Has electricity	0.000	0.000	0.191	0.029	0.000	0.000	0.536	0.394
Has radio	0.008	0.694	0.788	0.418	0.000	0.664	0.813	0.730
Has fridge	0.000	0.000	0.049	0.007	0.000	0.000	0.171	0.126
Has a bike	0.290	0.457	0.478	0.390	0.238	0.381	0.292	0.307
Has a motorcycle	0.000	0.000	0.062	0.009	0.000	0.000	0.032	0.024
Has a car	0.000	0.000	0.049	0.007	0.000	0.000	0.089	0.065

Note: Poorest: bottom 34%; Middle: next 33%; Richest: top 33%

Table 2 shows the distribution of households among the three socioeconomic categories with and without separate rural–urban calculations. If scores are calculated for the whole sample using the wealth and dwelling condition variables, almost all poor households (94.9 percent) belong to rural areas and almost two-thirds of the top tercile (63.2 percent) were urban households. Derivation of separate wealth scores for rural and urban areas implies that relative poverty must be defined separately for the geographic regions. In this analysis, we define the households belonging to the lowest terciles of rural and urban wealth score distributions as the poverty group. Table 3 shows the weights for different assets with and without rural–urban separation of samples. Note that the weights change significantly due to rural–urban disaggregation.

Table 2: Distribution of Households Across Asset Groups with and without Separate Wealth Scoring for Rural and Urban Areas

Wealth Categories	Rural and urban combined			Separate calculations for rural and urban		
	Rural	Urban	Total	Rural	Urban	Total
Poorest tercile	2413	130	2543	2309	623	2932
	94.9%	5.1%	100.0%	78.8%	21.2%	100.0%
Middle tercile	2446	399	2845	1503	724	2227
	86.0%	14.0%	100.0%	67.5%	32.5%	100.0%
Top tercile	854	1467	2321	1901	654	2555
	36.8%	63.2%	100.0%	74.4%	25.6%	100.0%
Total	5713	1996	7709	5713	2001	7714
	74.1%	25.9%	100.0%	74.1%	25.9%	100.0%

Note: Poorest: bottom 34 percent; Middle: next 33 percent; Richest: top 33 percent

Table 3: Component Scores for Dwelling Conditions/Assets with and without Separation of the Sample by Rural and Urban Residences

Dwelling Condition/Asset	Sample's Weights		
	Whole	Rural	Urban
Has flush toilet	0.2483	0.2399	0.2877
Has pit toilet	-0.0563	-0.0080	-0.2981
Has other type of latrine	0.1384	0.1616	0.1479
Has no toilet facilities, bush	-0.1099	-0.0964	-0.0352
Has piped drinking water into the residence	0.3551	0.3037	0.5096
Major source of drinking water: public tap	0.0093	-0.0045	0.0000
Major source of drinking water: well in residence	0.0196	0.0862	0.0162
Major source of drinking water: public/private well	-0.1237	-0.0555	-0.0231
Major source of drinking water: spring	-0.0658	-0.0031	-0.0275
Major source of drinking water: river, stream	-0.1108	-0.0851	-0.0287
Major source of drinking water: pond, lake or dam	-0.0436	-0.0216	-0.0172
Major source of drinking water: rainwater or other	0.0228	0.0314	0.0251
Has cement floor	0.4101	0.4434	0.3401
Has parquet, tiled floor	0.0761		0.0913
Has wood, plank floor	-0.0024	0.0128	
Has earth/sand floor	-0.4140	-0.4433	-0.3534
Has electricity	0.3993	0.3861	0.3775
Has radio	0.2477	0.2295	0.2250
Has fridge	0.3179	0.3122	0.3231
Has a bike	0.0056	0.0827	-0.0141
Has a motorcycle	0.1132	0.1901	0.0827
Has a car	0.2510	0.2450	0.2644

Given our definition of poverty, we can now examine the relationship between poverty and health status of the population. The survey collected information on a number of health status indicators. The indicators of health status used here are the body mass index (BMI) of women, weight-for-height and height-for-age of children, and prevalence of common childhood illnesses.

Table 4 shows the mean values of BMI by socioeconomic category of households and by rural and urban residence. In developing countries of the world, lower socioeconomic status should be associated with lower BMI values. The table indicates that for both rural and urban areas, the average BMI value increases with improved socioeconomic status. Table 4 also shows the distribution of women by three BMI categories: low BMI (less than 21.0), medium BMI (21 to less than 27) and high BMI (27 or greater). In rural areas, only about 3 percent of women from poor families had high BMI compared to 7 percent among women in the top socioeconomic category, and over 44 percent of poor women had low BMI levels compared to 39 percent among women in richer households. In urban areas, 38 percent and 27 percent of women from respectively, the lowest and highest terciles had low BMI. Therefore, in terms of women's BMI, poverty appears to be related to health status. One-tail significance tests imply that the average BMI of poverty groups was significantly lower than the average BMI of the highest tercile.

Table 4: Mean Levels of Body Mass Index (BMI) of Women by Wealth Terciles and by Urban/Rural Status

Wealth score-based categories	BMI of women: Rural areas				BMI of women: Urban areas			
	Average	Percent of women in			Average	Percent of women in		
	BMI	Low	Medium	High	BMI	Low	Medium	High
Poor tercile	21.46*	44.4	52.3	3.4	22.08+	38.0	53.7	8.3
Middle tercile	21.59	42.2	53.3	4.5	23.09	30.8	49.1	20.1
Top tercile	22.33*	39.3	53.8	6.9	24.60+	26.5	48.5	25.0

Low BMI: BMI<21, Medium BMI: 21 to <27, High BMI: 27 or more

* Means are statistically significant different from each other with a significance level of less than 0.01

+ Means are statistically significant different from each other with a significance level less of than 0.01

Two indicators of children's nutritional status were calculated from height, weight, and age information. The average weight-for-height (WFH) and height-for-age (HFA) z-scores are reported in Table 5. Notice that, in both rural and urban areas, the average scores tend to improve with better socioeconomic status of households. In addition, in both rural and urban areas, average HFA z-score among children in the top tercile was significantly higher than children in the poorest tercile. The difference of WFH scores between the poverty group and top tercile was statistically significant for children in rural areas but was not found to be significant for urban children.

Table 5 also reports the prevalence of common childhood illnesses by socioeconomic categories. Among children in urban areas, the reported prevalence of diarrhea or fever declines with higher household wealth, and this result is statistically significant. No such pattern was found among the children in rural areas.

Reported prevalence of illnesses is often quite unreliable. Perceptions of illness vary significantly among socioeconomic groups due to the differences in educational status of household members and the extent of knowledge about health and disease (Sen 2000). Poor households are less likely to seek medical care for childhood illnesses, and when medical care has not been sought, households may not consider the episode as an illness. Since the type of health indicators that are not subject to reporting bias (BMI and

child anthropometry) show a clear relationship with socioeconomic status, we can conclude that household poverty adversely affects the health status of household members.

Table 5: Mean Levels of Child Anthropometric Z-Scores and Percent of Children with Acute Health Problems, by Household Wealth Terciles and by Urban/Rural Status

Child health status	Household categories: Rural				Household categories: Urban			
Indicators	Poor	Middle	Top	P*	Poor	Middle	Top	P*
Weight-for-height average z-scores	-0.452	-0.415	-0.311	0.001	-0.296	-0.146	-0.198	0.161
Height-for-age average z-scores	-1.812	-1.673	-1.552	0.000	-1.507	-1.330	-0.990	0.000
Prevalence of								
Diarrhea (%)	14.4	14.0	14.7	0.599	13.3	12.1	12.6	0.388
Fever (%)	31.2	29.1	33.6	0.926	36.5	29.8	28.8	0.014
Diarrhea/fever (%)	36.8	34.1	38.2	0.790	40.8	36.5	33.2	0.018

* Testing the hypothesis that the average health status indicator in high poverty concentration areas is worse than the health status indicator in low poverty concentration areas based on a one-tail t-test

3.2 Cluster-level Poverty and Health

The negative relationship between economic status and health is well known and widely reported. However, the purpose of this paper is to go beyond the household-level poverty and health relationship, to investigate the effect of concentration of poverty within a geographic area on the health status of the population living in that area. As mentioned earlier, the concentration of poverty is defined by using household wealth scores. The three geographic clusters defined are high concentration, medium concentration, and low concentration of poverty.

Table 6 reports the health status of the population by cluster categories. Again, we have used anthropometric measures of women and children and prevalence of childhood illnesses to define the average health status of the population in a geographic area. Note that, with the exception of weight-for-height in urban areas, the mean anthropometric z-scores of children was found to be significantly lower in the high and medium poverty concentration areas than in the lowest poverty concentration areas. The analysis of the incidence of childhood illnesses and women's BMI reveals a similar pattern. For example, in urban areas, households report a significantly lower prevalence of diarrhea and fever in the low poverty concentration areas than in the high poverty concentration areas.

However, it is not surprising to see a correlation between the degree of concentration of poverty and the health status of the population. We saw earlier that health status measures are related to household poverty levels. A higher proportion of poor households in an area should imply lower health status in the area. However, lower average health status of high poverty concentration areas may not necessarily imply an independent effect of geographic poverty concentration on health.

Table 6: Mean Levels of Women's BMI and Child Anthropometric Z-Scores, by Degree of Poverty Concentration and by Urban/Rural Area

Health status measures	Poverty concentration: Rural				Poverty concentration: Urban			
	High	Medium	Low	P*	High	Medium	Low	P*
BMI of women	21.43	21.64	22.11	0.000	22.16	22.67	23.71	0.000
Weight-for-height average z-scores	-0.432	-0.438	-0.344	0.039	-0.262	-0.148	-0.232	0.371
Height-for-age average z-scores	-1.791	-1.789	-1.504	0.000	-1.557	-1.360	-1.180	0.000
Prevalence of								
Diarrhea (%)	14.6	14.9	13.7	0.262	16.0	11.6	11.8	0.042
Fever (%)	34.0	30.4	31.2	0.075	40.2	29.8	29.4	0.001
Diarrhea/Fever (%)	38.7	35.6	36.7	0.165	46.1	35.3	34.2	0.000

* Testing the hypothesis that the average level of indicator in high poverty concentration areas is worse than the level of indicator in low poverty concentration areas based on a one-tail t-test

To test the hypothesis that poverty concentration at the community level influences health status of the population after controlling for household wealth, we compared the health status measures of poor and non-poor households across the three poverty concentration categories. Table 7 reports the average levels of each of the health status indicators by cluster and household poverty categories. While these results are somewhat mixed, they generally support the premise that differences in health status among the population are not due solely to the poverty of households, but that the concentration of poverty at the community level appears to play a role in determining the health status of the population. For example, consider the results on height-for-age. Among the children in the poorest and highest household wealth terciles, those living in the low poverty concentration areas were found to be significantly better off than those living in the high poverty concentration areas. No such relationship was detected among children living in middle tercile. In addition, for the indicator weight-for-height, children of households in the middle household wealth tercile living in the low poverty concentration areas were better off than comparable children in the high poverty concentration areas. This finding does not hold for children in the poorest and top wealth tercile.

Among women in each of the three household wealth terciles, the percent of women with low BMI levels (below 21 percent) was found to be higher in the low poverty concentration areas than in the highest poverty concentration areas. The results were found to be statistically significant for women in the poorest and richest terciles, but not in the middle tercile.

Table 7: Mean Levels of Women's BMI and Child Anthropometric Z-Scores, by Household Wealth Terciles and by Degree of Poverty Concentration

Household categories/ Health status measure	Poverty concentration of geographic clusters			
	High	Medium	Low	P*
Mean Weight-for-height z-scores				
Poorest tercile	-0.354	-0.498	-0.469	0.902
Middle tercile	-0.413	-0.471	-0.291	0.051
Top tercile	-0.243	-0.362	-0.220	0.444
Mean Height-for-age z-scores				
Poorest tercile	-1.834	-1.725	-1.674	0.054
Middle tercile	-1.635	-1.661	-1.747	0.912
Top tercile	-1.540	-1.482	-1.199	0.035
Mean BMI values for women				
Poorest tercile	21.54	21.5	21.24	0.890
Middle tercile	21.71	21.5	22.02	0.095
Top tercile	22.3	21.98	23.48	0.021
Percent of Women with BMI <21				
Poorest tercile	46.4	43.6	35.7	0.017
Middle tercile	39.5	44.5	38.9	0.448
Top tercile	43.8	50.4	30.5	0.088

* Testing the hypothesis that the average health status indicator in high poverty concentration areas is worse than the health status indicator in low poverty concentration areas based on a one-tail t-test

4. Concentration of Poverty, Access to Care, and Quality of Medical Services

One of the key questions addressed in the analysis is whether access to and quality of health care services is different between clusters with low and high poverty concentrations. If the health care supply environment is worse in poorer clusters (high poverty concentration clusters), then this might be an important factor in explaining why the concentration of poverty is associated with poorer health outcomes. Using a number of measures of both physical access to services and the readiness of health care facilities to provide services, we find evidence that high poverty concentration areas are indeed at a disadvantage.

Consider Table 8, which compares the physical availability of services for households living in the highest poverty concentration clusters with that for households in the lowest poverty concentration areas. In rural areas, the high poverty concentration areas were found to be more than 50 percent further away from the closest health care facility of any type than the lowest poverty concentration areas (5.3 km vs. 3.5 km). The types of facilities considered in the analysis were hospitals, health centers, and dispensaries, which are administered by the Ministry of Health, and UMATI *(Chama cha Uzazi na Malezi Bora Tanzania)* clinics, which are administered by the Family Planning Association of Tanzania. High poverty concentration clusters in rural areas were also found to be further away from the closest hospital, health center, and UMATI clinic. For dispensaries, no systematic relationship was found between the degree of poverty concentration of an area and the distance.

Within urban areas, the results are somewhat mixed. Households in poorer clusters were found to have significantly less-favorable physical access to dispensaries, health centers, and hospitals than households in better-off clusters. However, unlike rural areas, there does not appear be a difference between high and low poverty concentration areas in the distance to the closest facility of any type. In addition, physical access to UMATI clinics was found to be more favorable for the poorest group of clusters than for better-off clusters.

Table 8: Mean Distances between Closest Health Facilities and Clusters, by Type of Facility and by Degree of Poverty Concentration

Distance in kilometers from cluster center to:	Poverty concentration: Rural				Poverty concentration: Urban			
	High	Medium	Low	P*	High	Medium	Low [a]	P*
	n=48	*n*=103	*n*=71		*n*=20	*n*=16	*n*=40	
Distance to the nearest Facility (481)	5.3	4.3	3.5	0.017	0.7	0.9	1.0	0.803
Distance to the nearest Hospital (90)	25.4	22.4	18.4	0.007	11.3	6.3	3.6	0.000
Distance to the nearest Health Center (123)	18.7	15.9	15.3	0.113	10.2	12.9	7.5	0.220
Distance to the nearest Dispensary (253)	6.0	6.8	5.3	0.288	5.5	4.6	3.6	0.114
Distance to the nearest UMATI (10)	25.0	18.9	15.8	0.090	2.0	6.6	4.4	0.893

Note: Number of facilities is presented in parenthesis

* Testing the hypothesis that average distance to facility in high poverty concentration areas is worse than in low poverty concentration areas based on a one-tail t-test

If we consider the number of health care personnel available in all facilities nearest to the sample clusters (excluding hospitals) as another proxy for access to care, the high poverty concentration clusters were found to be worse off than the medium and low poverty concentration clusters. Consider Table 9, which compares clusters with respect to the mean number of doctors, medical assistants, medical aides, and trained midwives working in the nearest primary health care facilities. Note that hospitals, which may not be as important in determining the geographic equity to access as the availability of primary care health facilities, are excluded from the analysis. The indicators in Table 9 were generated by summing the number of each type of health care personnel across the closest health care facilities. The results indicate that as the concentration of poverty declines, the average number of each type of personnel increases. The differences in the number of personnel across the poverty concentration areas are statistically significant.

Table 9: Mean Numbers of Doctors, Nurses, and Other Medical Staff, by Degree of Poverty Concentration and by Urban/Rural Status (only primary health care facilities)

Average Health Personnel Per Cluster	Poverty concentration: Rural				Poverty concentration: Urban			
	High	Medium	Low	P*	High	Medium	Low	P*
	n=48	*n*=103	*n*=71		*n*=20	*n*=16	*n*=40	
Doctors	0.1	0.2	0.3	0.039	0.2	0.7	3.2	0.000
Medical aides and assistants	4.7	6.5	7.6	0.000	8.6	9.3	20.2	0.000
Public health nurses	0.6	1.0	2.2	0.044	3.7	3.1	24.3	0.000
Trained midwives	1.7	2.0	2.5	0.078	3.1	3.4	11.8	0.000

Note: As many as four types of facilities serve a cluster

* Testing the hypothesis that average personnel in high poverty concentration areas is lower than average personnel in low poverty concentration areas based on a one-tail t-test

In addition to having less physical access to services, households in high poverty concentration clusters may also face lower quality of care at health care facilities than households in low poverty concentration clusters. We explore this issue by comparing the availability of equipment and drugs in health care facilities in high and low poverty concentration areas (Table 10). The results indicate that, in both rural and urban areas, facilities nearest to the poorest group of clusters were found to have significantly lower levels of supplies of equipment and drugs than facilities nearest to the least poor clusters.

Table 10: Mean Levels of Equipment and Drug Availability Indices of Health Facilities Located Nearest the Clusters, by Degree of Poverty Concentration and by Urban/Rural Status

Index	Poverty concentration: Rural				Poverty concentration: Urban			
	High	Medium	Low	P*	High	Medium	Low	P*
	n=48	*n*=103	*n*=71		*n*=20	*n*=16	*n*=40	
Availability of 11 basic types of equipment								
Average number per cluster	4.375	5.369	4.901	0.109	5.600	5.875	6.650	0.056
Average standard score	-0.245	0.168	-0.026	0.109	-0.292	-0.180	0.135	0.056
Availability of all equipment								
Principal component scores	-0.973	0.648	0.448	0.040	-1.009	-1.219	0.801	0.026
Availability of drugs[a]								
Number of essential drugs	23.792	24.553	26.141	0.107	25.700	23.688	37.563	0.000
Average standard scores	-0.097	-0.024	0.126	0.107	-0.621	-0.786	0.356	0.000
Principal component scores	-0.304	-0.106	0.434	0.099	-2.058	-2.573	1.181	0.000

* Testing the hypothesis that the average level of indicator in high poverty concentration areas is worse than the level of indicator in low poverty concentration areas based on a one-tail t-test

[a] Each medication equals 0 if the facility does not have it; 0.5 if the facility has it and 1 if the facility has it without a stock-out of 6 month

5. Does Geographic Access Affect Utilization Services?

We have seen that the poorest clusters have lower physical access to care compared to the least poor clusters. In addition, the health care facilities that are nearest to these poorest clusters are characterized by lower levels of equipment and drugs than those nearest the least poor clusters. This raises the possibility that lower access and inferior quality may adversely affect health outcomes among households living in poorer cluster via the utilization of health care services. To examine utilization patterns by the poverty concentration of clusters, we calculated the proportion of respondents using three types of primary health care services – prenatal care, deliveries, and immunizations

For prenatal care and deliveries, utilization rates in both rural and urban areas were found to be significantly lower in the poorest group of clusters than in the better-off group. In rural areas, for example, the percent of women delivering in a health care facility was reported to be 33.9 percent in the high poverty concentration clusters compared to 47.0 percent in the low poverty concentration areas. In addition, women in poorer clusters were less likely to have their births attended by a trained provider than women in the least poor clusters (43.7 percent vs. 55.8 percent), and utilization rates for tetanus toxoid injections and child vaccinations were found to be significantly lower in the poorest areas than in the least poor clusters. (These last findings do not hold among individuals residing in urban areas). Unfortunately, it was not possible to investigate the utilization rates of curative health care services, as the TDHS does not include this type of information.

Table 11: Percent of Women Using Basic Medical Care Services, by Degree of Poverty Concentration and by Urban/Rural Status

Selected primary care service used for the last child	Poverty concentration: Rural				Poverty concentration: Urban			
	High	Medium	Low	P*	High	Medium	Low	P*
	n=48	*n*=103	*n*=71		*n*=20	*n*=16	*n*=40	
Prenatal care provided by trained personnel	88.7	91.5	91.4	0.114	95.6	96.4	98.8	0.005
Average prenatal visits per pregnancy	447.1	489.4	484.4	0.021	510.1	511.6	600.1	0.002
Had at least one tetanus toxoid injection	91.4	91.6	94.5	0.042	96.4	98.0	95.5	0.658
Delivered at health facility	33.9	38.9	47.0	0.005	75.3	77.4	84.6	0.036
Delivered with assistance of trained personnel	43.7	49.5	55.8	0.006	77.1	80.6	88.8	0.007
Had vaccination card	80.0	84.6	86.8	0.002	85.6	92.6	87.4	0.261
Vaccinated child	81.3	86.1	89.5	0.000	90.3	94.4	92.3	0.206

* Testing the hypothesis that average level of indicator in high poverty concentration areas is worse than the level of indicator in low poverty concentration areas base on a one-tail t-test

6. Variability within Cluster Categories

It is interesting to note that some of the high poverty concentration clusters fared quite well in terms of BMI of mothers and anthropometry of children. Are these poor clusters different from others in the same category in terms of access to medical care, educational status, or knowledge of household members on health and diseases? To examine the differences between the two sub-groups of clusters within the poor clusters in rural areas, we identified the ten worst and the ten best clusters using BMI of women as the basis for selection. Because the access indicators for urban clusters were skewed due to the presence of a large tertiary hospital, the analysis is limited to the high poverty concentration clusters in rural areas.

Table 12 shows the characteristics of these two sub-groups within the high poverty concentration areas. Note that the women and their husbands in the best clusters are better educated than their counterparts in the worst clusters. Moreover, the percentage of women having knowledge on diarrhea and family planning methods was also significantly higher in the best ten poor clusters.

In terms of the structural factors thought to influence the quality of health care services, the ten worst clusters were found to have lower levels of equipment and drugs in the closest health care facilities compared to the ten best clusters. For example, the principal component scores for medical equipment were -4.804 and -0.267 for best and worst poor clusters respectively while the principal components for drugs were -1.018 and -0.504. However, these differences were not statistically significant. Not reported in Table 12 is that the differences between the two groups of clusters in the physical distance to the closest health care facilities were also statistically insignificant.

In summary, the comparison between these two sub-groups of poor clusters probably implies that health status in poor areas is affected by a host of social and economic factors. Educational status of women and men, knowledge about medical services, and percent of women divorced or widowed appear to be associated with the health status of the population in poor areas.

Table 12: Mean Characteristics of Women for the Ten Best and Ten Worst Clusters within the High Poverty Concentration Clusters in Rural Areas

Characteristics of Woman	Worst and Best Clusters (BMI based) among the High Poverty Clusters		
	Worst 10 clusters	Best 10 clusters	P*
	n=10	*n*=10	
Education			
Average years of respondent's education	3.2	4.2	0.110
Average years of husband's education	3.9	4.9	0.093
Household characteristics			
Average number of children in the household	1.7	1.4	0.096
Average number of adult female in the household	1.8	1.7	0.215
Percentage of widowed/divorced women	13.3	8.4	0.077
Nutrition status			
Average respondent's height	156.7	156.8	0.455
Average WHZ score	-1.141	-1.144	0.506
Knowledge of illness			
Proportion knowledgeable about diarrhea via drinking patterns	0.424	0.631	0.012
Proportion knowledgeable of diarrhea via eating patterns	0.613	0.704	0.058
Average knowledge of the signs of illness w/ diarrhea that needs professional treatment	0.907	0.892	0.685
Average knowledge of the signs of illness w/ cough that needs professional treatment	0.934	0.872	0.950
Knowledge of modern family planning methods and usage			
Percent knowledgeable about AIDS	87.6	93.8	0.164
Average knowledge of modern family planning methods	0.619	0.833	0.050
Proportion using condom	0.055	0.065	0.380
Proportion knowledgeable about condoms	0.298	0.333	0.346
Availability of equipment and drugs			
Principal component scores of all equipment	-4.804	-0.267	0.129
Principal component scores of drugs[a]	-1.018	-0.504	0.379

* Testing the hypothesis that indicator in the worst 10 clusters is worse than indicator in the 10 best ones based on a one-tail t-test

[a] Each medication equals 0 if the facility does not have it; 0.5 if the facility has it and 1 if the facility has it without a stock out of 6 month

7. Conclusions and Policy Implications

Using an index of asset ownership for categorizing households into three socioeconomic groups, this paper shows that the poorest tercile of households in Tanzania had worse health status indicators compared to those in the top tercile. This is consistent with the findings in the literature that indicate an inverse relationship between the degree of poverty and health status.

We also examined the effect of geographic poverty on the health status of the population. The extent of geographic poverty was defined by the concentration of poor households in a locality. A comparison of the health status measures of population, especially the BMI of women and height-for-age of children, showed that degree of concentration of poverty and health status measures are related. The fact that the differences in health status measures between high and low poverty concentration clusters became greater when we controlled for the socioeconomic status of the households implies that geographic poverty has an independent effect on health. In other words, poor households living in low poverty concentration areas were, on average, better off in terms of a number of health status measures than poor households living in high poverty concentration clusters. Similarly, top tercile households living in low poverty concentration clusters had better health status than their counterparts living in high poverty concentration clusters.

The analysis of the cluster-level data also indicates that the health facilities were located farther away from the high poverty concentration clusters than the low poverty clusters. For Tanzania, we expected a relatively egalitarian geographic distribution of primary health care facilities because of its socialistic past. The presence of unequal geographic distribution in Tanzania probably implies that the situation will be even worse in other developing countries of the world.

Distance is only one aspect of unequal access to care for the poverty clusters; another important aspect is the availability of health care providers and drugs in the facilities. Households from the poorest clusters not only have to travel longer distances to reach primary health centers or other health facilities, but these facilities also had fewer health care providers, medical equipment, and drugs. Utilization of selected primary care services was also found to be lower in high poverty concentration areas than in low poverty concentration. Although we cannot derive a definitive conclusion from the tabulations, it appears that quality of services delivered by the health facilities is an important factor in explaining utilization differences.

We compared the physical availability to and quality of primary health care service for the ten best and ten worst health status clusters among the poorest clusters of the sample. The results indicate that the average distances to health facilities between these two sets of poor clusters were almost identical, but the two groups differ significantly in terms of the quality of services delivered from the health facilities. Therefore, one possible way to improve the health status of the population in poor clusters is to provide better quality services from the existing health facilities; distance of the health center does not appear to be the critical factor here. The two groups also differ significantly in terms of educational status of women and their husbands, knowledge about family planning and other medical care services, and the percent of women widowed or divorced.

A number of other social conditions were also found to be associated with poorer health status among the poverty clusters. As mentioned above, differences in educational status of women and their husbands were found to be important between these two sets of clusters selected from high poverty concentration clusters. Therefore, improvements in general education of the population should improve the health status of the population. Even short-term health education delivered through informal mechanisms or through health facilities may improve the health of the households in poor clusters. In our analysis, knowledge about diarrhea and family planning methods were important factors that distinguished between these two sets of poor clusters.

This analysis suggests that appropriate design and delivery of health services can effectively work against inequities that currently disadvantage the poor. That the high poverty concentration areas were farther away from primary health care facilities and were served by facilities with lower levels of medical personnel, drugs, and equipment indicates that there is considerable gains to be realized from improved targeting of public health sector resources. Even among the poorest communities, the finding that the ten clusters with the best health outcomes had better availability of drugs and equipment than the ten clusters with the worst health outcomes is likely to reflect the crucial importance of quality of services for the poor areas in developing countries of the world. In order to reach poor households – and poor communities – health system strengthening initiatives should include provisions for greater and more equitable investments in quality improvements in the short run. In the medium run, the question of physical distance can be addressed, but policymakers should focus on quality improvements, especially provisions that ensure the availability of personnel, medical equipment, and drugs in primary care facilities. Such investments in the quality of health care services in poor regions should be able to reduce socioeconomic-related inequities in access to care, utilization, and health status.

Annex: Information on Dwelling Conditions

Following Filmer and Pritchett (2001), the information on dwelling conditions (i.e., source of water, sanitation facilities, type of floor, availability of electricity) and asset ownership (i.e., radio, refrigerator, bicycle, car) were used to construct a wealth score by applying the principal component approach. The purpose of this technique is to discover or to reduce the dimensionality of the data set to identify new meaningful underlying variables. This procedure transforms a number of potentially correlated variables into a smaller number of uncorrelated variables called principal components. The idea is to establish factors or principal components to explain as much of the total variation in the data as possible with few components. At the first stage, the approach identifies the weighted linear combination of living conditions and ownership variables to explain the largest amount of total variation in the data (first principal component). A second linear combination of the variables, perpendicular to the first one, tries to explain the maximum of the remaining variance, and so on. In order to calculate the principal components, we first compute the eigenvectors of the correlation matrix of the household ownership item variables. The first eigenvector is the vector corresponding to the largest characteristic root of the correlation matrix. There are as many eigenvectors as there are items, say *n*. Let $\boldsymbol{\Sigma} \in \Re^{n \times n}$ be the correlation matrix, then $\mathbf{v}$ is called an eigenvector of $\boldsymbol{\Sigma}$ corresponding to the eigenvalue τ if:

$$(\boldsymbol{\Sigma} - \tau \mathbf{I}_n)\mathbf{v} = \mathbf{0},$$

where $\mathbf{I}_n$ is the identity matrix (*n*x*n*) and the elements of $\mathbf{v}$ are the factor loadings. Thus the first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.

In this paper, we have used only the first principal component. The categorical responses were converted into dichotomous variables and standardized values were estimated for each of the dichotomous variables defined. The wealth score was defined as:

$$W_s = \sum_{i=1}^{n} v_i S_i$$

where *Ws* is the wealth index for a household, *vi* is the loading for asset or dwelling category *i*, *Si* is the standardized value of that variable and *n* is the number of assets or dwelling conditions considered in calculating the wealth scores

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