Place of Residence, Environmental Characteristics and Child Mortality in the Princess Marie Louise Hospital Catchment Area

Tette, Edem M. A.
1. Department of Community Health, University of Ghana Medical School & Princess Marie Louise Children's Hospital
*Email: edemenator@googlemail.com

Owusu, Alex B.
2. Department of Geography and Resource Development, University of Ghana, Legon; P. O. Box LG 59 Legon, Accra-Ghana
*Email: owusuba@yahoo.com

Abstract
Consistently studies have shown that proximity to health services has a bearing on infant and child mortality. They commonly cite a distance of 4km beyond which the risk of under five death risks increase by four-fold. Princess Marie Louise Children's Hospital is located at the heart of Accra Metropolitan Area serving a catchment area of about 35km^2. Using geographic information system's spatial analytical tools, this study analyzed spatial clustering of under five deaths reported at PML and compared that to distance travel to access service from PML. The study also compared under five deaths in a community to three environmental risk factors including access to improved toilet facility, access to potable water and the use of unimproved cooking methods. The study finds that high under five deaths occurred in communities closer to PML in similar frequency as they occur in distances further away. Similarly communities with high under five deaths are not necessarily the communities with more people with poor environmental characterization such as unimproved toilet facility, no access to potable water and the use of unimproved cooking methods. The study recommends that future studies may look deep into other factors contributing to under five mortality such as availability of intervening health facility, mothers' education, income and distance accessible roads.
Keywords: Child Mortality, Under 5 deaths, spatial pattern

1. Background

In spite of the launch of the Millennium Development Goals with strong emphasis of Goal 4, focusing on reduction in child mortality, progress has been slow and static in some countries. (Black et al, 2003). It is increasingly being recognised that improvements in training and facilities alone may not reduce mortality significantly as child mortality is affected by several other factors. These factors include socio-economic and physical environments, delays in arrival of patients to health posts, available resources and health inequalities (Cambell et al, 2009, Nolan et al, 2001, Victoria et al, 2003). Some of these effects are directly or indirectly related to the town or locality where a child lives (Picket, 2001).

Studies have consistently shown that proximity to health services has a bearing on infant and child mortality (Schoeps et al, 2011, Okwaraji & Edmund, 2012). Children living more than 4km from a health facility had a four-fold risk of death compared to children living within 4km from a health centre in a meta-analysis (Okwaraji & Edmund, 2012). In a review of 25 studies, 23 papers reporting on socio-economic indices and health outcome showed statistically significant associations between at least one's neighbourhood measure of socio economic status and health (Picket, 2001). A study in Mozambique found that higher under fives mortality was associated with the location of mother's residence in some provinces and these were not only related to environmental variables but also to other variables such as income distribution, population density and distribution of basic infrastructure, including health facilities (Macassa et al, 2012).

Using data from the 2000 census of Ghana, (Weeks et al, 2006) showed that spatial variability in child mortality within Accra Metropolitan Area (AMA) is related to the pattern of residential separation of different ethnic groups. For example the mortality rate among the Ga ethnic group living in a community is more related to the spatial separation from other ethnic groups with Ga's having higher levels of child mortality. They demonstrated that clustering of child mortality occurred in the slum areas of Accra (AMA) including Nima, Ussher Town and central Accra. Most of these communities are served by Princess Marie Louise Children's Hospital (PML). With all the efforts being made to achieve MDG 4 and 7 which are related to reducing child mortality and ensuring environmental sustainability, it is not clear whether the situation has changed and there are new residential areas that need to be prioritised.

PML with its location at the centre of Accra sees a diverse mix of patients, most of them coming from impoverished backgrounds and reflecting the banes of urbanization. Being the only children's hospital in the area providing services to some of these communities, a study of the spatial pattern of child mortality within the

catchment area of PML will highlight important factors that need to be addressed when addressing child mortality in this population. The specific questions addressed in this study were stated thus;

- Is there a clustering of under five deaths at PML in particular communities accessing the hospital?
- Do communities (locations) of over 4km from PML experience more deaths than dose below?
- Do environmental characteristics such as access to potable water, improved toilet facilities and the use of unimproved cooking methods correlate with the number of under five deaths in the communities?

2. MATERIALS AND METHODS

2.1. Study Area

The study was carried out at the PML, a 62 bed capacity hospital run by the Ghana Health Service (Figure 1). The hospital is located at the commercial centre of Accra. Accra has an estimated total population of roughly 5 million people and a total land area of about 231 sq km. However, the catchment area of PML extends beyond Accra to Kasoa (Awutu-Senya District) in the Central region, (Tema and Dodowa all in the Greater Accra Region (60 km).
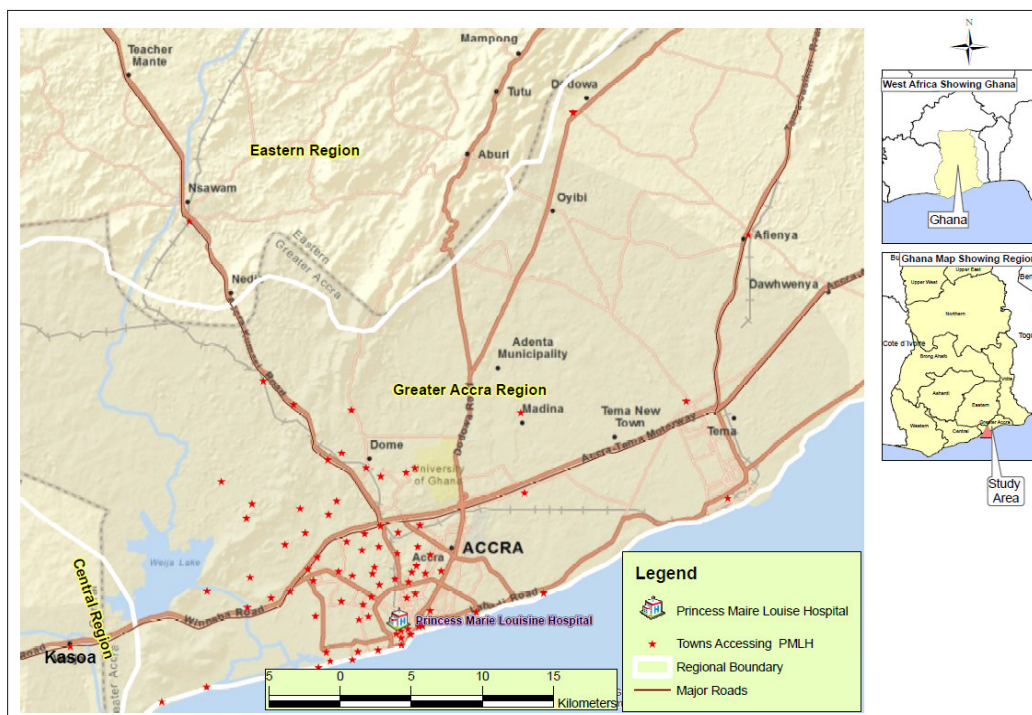

Figure 1: PML and its Catchment Area

The top four farthest distance people travel to access PML include 38.9 km from Dodowa, followed by Tema and Ashale-Botwe 26.5 km each and Kasoa 23.5km.

PML serves as a primary referral centre for an estimated population of 38,290 people and though it is principally a children's hospital, it also renders a few other services such as family planning services to the adult population. Most of its patients are brought in by their parents, self-referred, the rest are referred from health facilities around and beyond Accra. Since it has the largest nutritional rehabilitation unit in the country, it also receives referrals for malnourished children from all over Accra including the Korle Bu Teaching Hospital, the largest tertiary referral unit which is 10 – 20 minutes drive from the PML. Figure 2 compares the number of deaths in year 2003 and year 2012 to the top four farthest distances which people travel to access PML. Year-2003 and Year-2012 represents under five deaths for the 2003 and 2012 respectively.
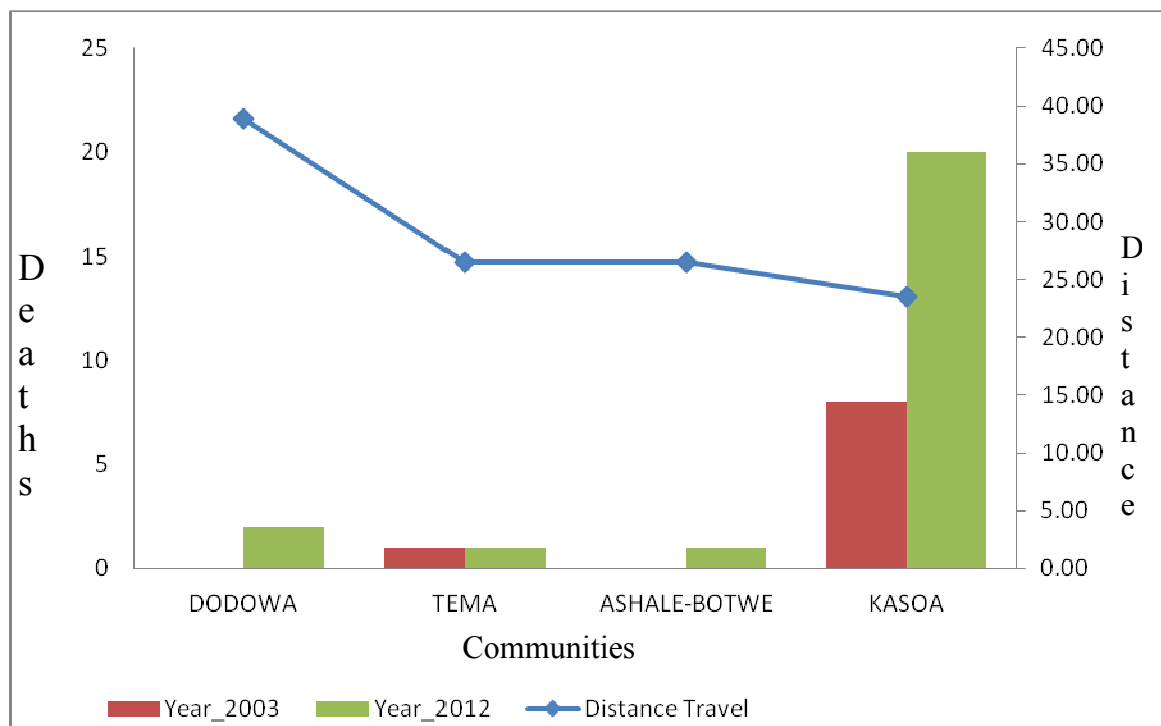
Figure 2: Mortality of the top four farthest distance people travel to access service from PML

2.2. Study Design

The study was a retrospective cross sectional data review of child deaths occurring at the PML. In this study, the places of residence of the children under the age of five years who died in 2003 and 2012 were obtained and plotted on a Geographic Information Systems (GIS). It is part of a three-part Child mortality study. The first part examined the mortality trend in consecutive deaths in children occurring at the hospital from January 2003 to December 2012. The second part, a case-control study examined under-fives who were admitted and died in the hospital in 2011 and their age and sex and matched with the controls that survived. These two of the three studies will be presented elsewhere**.** This third study explores the correlation between place of residence, child mortality and environmental characteristics using place aggregation. The study aggregated each community as a place and linked that to place characterization such as distance to PML, environmental characteristics and the number of under five deaths.

Specifically the residences of children under the age of five years who died at PML in 2003 and 2012 were examined. There were 69,400 out-patient attendances in 2003 and 75,900 attendances in 2012 at PML. There were 1757 admissions in 2003 and 5201 admissions in 2012, with 108 deaths in 2003 and 158 deaths in 2012. Of these, 96 and 141 of the deaths occurred in children under 5 years respectively. These deaths were mapped to their respective places of residence.

2.3. Data Collection Methods and Instruments

Computerised and hand written records on the age, sex, cause of death, residence, date and time of admission, date of discharge and status of registration with the National Insurance Scheme were obtained from the records department of PML. This was entered into a computerised record form. Data on place of residence was extracted from the database and summarised for children under the age of five years who died in the hospital in 2003, and 2012. The individual distances from the place of residence to the hospital were determined using point-distance analysis and the results were plotted on a GIS map.

Information from the 2010 Census on the population and environmental characteristics of the various sub-metropolitan areas of Accra and surrounding districts were obtained from the Ghana Statistical Service. These included data on the total population, under five mortality, population density, sources of drinking water, type of toilet facilities and source of household fuel. These were summarised and joined using spatial join tool in the ArcGIS software and was subsequently used to construct GIS maps.

2.4. Ethical clearance

Ethical Clearance was obtained from the Ghana Health Service Ethical Review Committee. Permission to use the census data was obtained from the Government Statistician, in-charge of the Ghana Statistical Service.

3. Analysis And Results

The study employed spatial analytical technique of point distance analysis and buffer to determine whether

distance is principal determinant of under five mortality at PML. The study also calculated the number of deaths per community and related that to their distance to PML. A buffer distance of 4km, 8km and 12km were demarcated and the results are shown on Figure 3. This is to assess distance decay as a major cause of under five deaths as postulated by other studies.
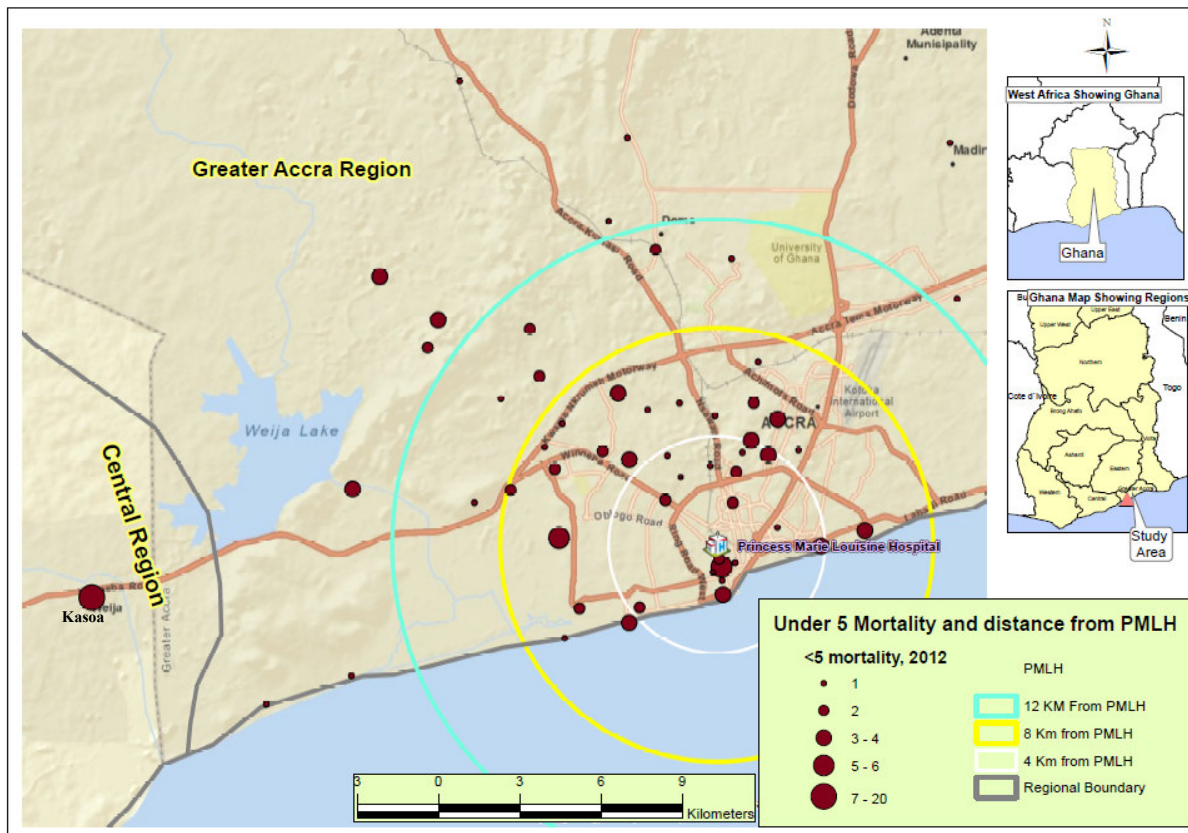

Figure 3: PML and recorded under five mortality from communities accessing the hospital

Kasoa has the highest recorded number of deaths of 20 children in 2012, although it is not the farthest distance from the hospital (See figure 2). Among the top 7 communities with highest recorded number of deaths, one community is found within four (4) kilometres, three communities are between four (4) and eight (8) kilometres whilst the last three are more than 12 kilometres from PML (see figure 3).

Table 1: Top seven (7) communities with the highest number of deaths and their distance to PML

TOWN_NAME	Distance to PML	Deaths_2003	Deaths_2012
KASOA	23.50	8	20
ABLEKUMA	14.50	0	4
WEIJA	15.20	2	4
NIMA	6.50	4	4
CHORKOR	5.10	1	4
AGBOGBLOSHIE	2.10	3	5
DANSOMAN	4.60	4	6

The top three farthest communities, Dodowa, Ashale-Botwe and Tema (shown in figure 2) are not among the top seven (7) communities with the highest mortality in the catchment area. This finding is at variance with other studies that found that children living more than 4km from a health facility had a four-fold risk of death compared to children living within 4km from a health centre in a meta-analysis (Okwaraji et al 2012). In fact the study finds no relationship between under five deaths and distance to PML.

Finding answers to the variations in under five mortality records after rejecting distance decay hypothesis, the study related mortality to three key variables known to have direct contribution to child mortality. These include the use of improved toilet facilities, access to potable water and access to improved cooking facilities. Below is Figure 4 showing district level under five mortality recorded at PML as a percentage of the districts population in comparison to the proportion of the district's population with no access to potable water, using unimproved toilet facility and using unsafe cooking facilities.
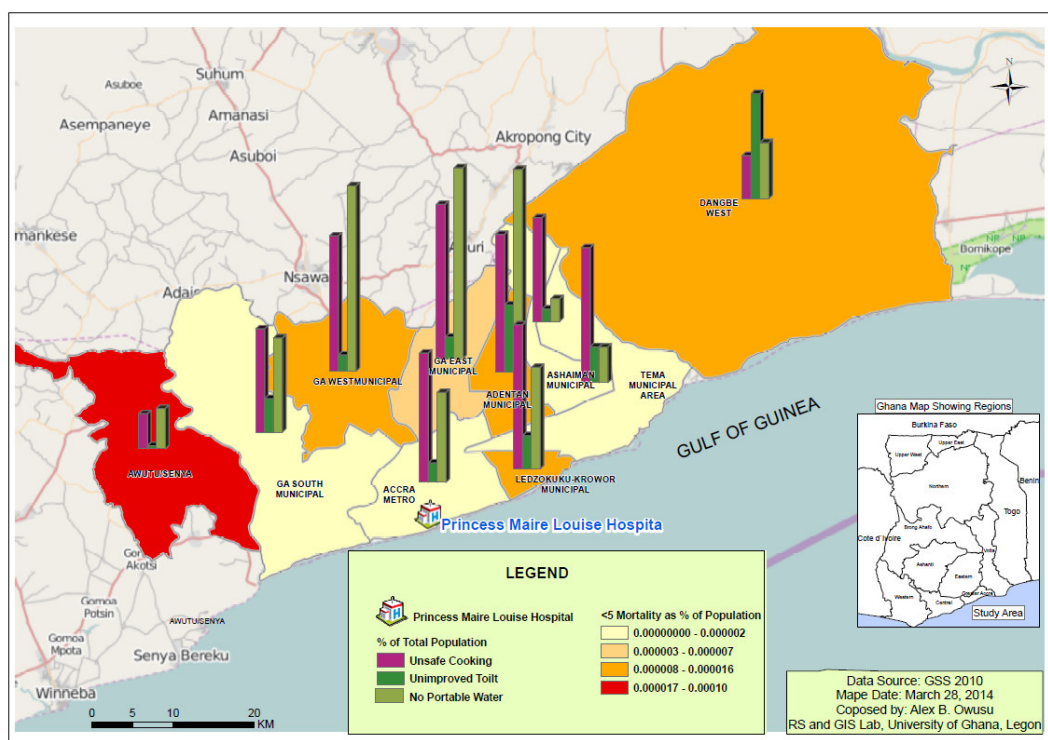
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Figure 4: Districts level normalize <5 mortality population with no potable water, unsafe cooking and unimproved toilet facility

In figure 4, under five mortality at district level reported at PML hospital was calculated and normalized with the total district population from 2010 population Census. The results show that Awutu-Senya District has the worst under five mortality to total population ratio with as much as 0.00010%, followed by Dangbe West, Ledzokuku-Krowor, Ga West and Adenta Municipalities. Awutu-senya district although has the highest total under five mortality, has the lowest total population with no potable water, using unsafe cooking and unimproved toilet facility. Weeks et al, 2006 found that AMA has the largest under five death records, however, if one analyze under five mortality as normalized ratio of total population, AMA is one of the least. It is therefore important to compare under five deaths in relation with the population since it is not farfetched to expect, the likelihood of a high number of deaths in a big town, such as AMA, with three (3) to five (5) million people, as compared that of a small town (Kasoa) with approximately 60, 000 residents.

Similarly comparison of population with no access to potable water, using unsafe cooking and no access to improve toilet with under five deaths, there seem to be no correlation for most of the districts except for Adenta and Ga West Municipalities. For example the two districts with the highest under five deaths relative to their total population have the lowest ratio of population with no access to potable water, and use unsafe cooking method (figure 4).

4. Discussion

The results showed clustering of under five deaths around the central Accra similar to the findings by (Weeks et al, 2006). However if the total under five deaths are normalized with the total population of the area, AMA is not the worse due to its high residential population. It also showed clustering of deaths at Awutu-Senya District (Kasoa) in the Central region which was not captured by the data from Weeks et al used in their study. The clustering of deaths occurred at distant sites like Kasoa and in areas close to the hospital which implies that there are other determinants of mortality than distant. In fact the three most distant locations are Dodowa, Tema and Ashale-Botwe yet they are not the highest cluster of under five deaths as would be expected from the results of previous studies (Schoeps et al and Okwaraji et al, 2012). Suffice to say that this study does not take into account the presence of intervening opportunities, which is the existence of non-specialist health facilities that attend to the health needs of children under the age of 5 years.

The relationship between the environment characteristics and child mortality was less clearly demonstrated in this study since the two districts with the highest mortality did not show a clear correlation between lack of potable water and improved toilet facilities. However, two out of the three municipalities which had the highest level of reduced access to potable water and the two communities with the unimproved toilet facilities had relatively high child mortality to population ratios. This finding is similar to that of Weeks et al who found that,

out of the five areas with at least two thirds of houses being connected to piped water only three had low levels of mortality (Weeks et al, 2006). They also found a general lack of influence of water and sanitation on health levels. The finding is also similar to the study in Mozambique in which house-hold environmental variables of mothers only slightly reduced child mortality although an earlier study had shown a clearly positive association (Macassa et al, 2012; Macassa et al, 2006).

In spite of the methodological differences, the finding suggests that other factors such poverty, socio-cultural practices among others may be related to child mortality as has been reported elsewhere (Macassa et al, 2006). The observation requires further study since modifying the environment through improved sanitation and water sources is at the heart of interventions such as the Global Action Plan to reduce Pneumonia and Diarrhoea, in addition to vaccine initiatives. It is likely that these interventions may not impact child mortality in this population significantly unless they are tackled together with the other determinants of child mortality. Thus it is important to identify these determinants, their distribution across the various municipalities in Accra and the weight they exert on child mortality. This can be done by comparing children who die with those who survived using data collected prospectively.

There were some limitations to this study. The study was unable to determine whether there are spatial differences in the distribution residences of children dying at the PML between 2003 and 2012 as Weeks did because data on ethnicity was not available (Weeks et al, 2006). Attempts to obtain data on the pattern of poverty in the various suburbs were unsuccessful. These would have provided useful information. Another major limitation was that the study did not have data on the attendants to the hospital from the various suburbs and since this was not the only hospital attended by the children from the various residences, it only reflects a portion of deaths occurring in the various areas. In addition, even though the study determined the distances between the hospital and places of residence, it did not take into account the actual time taken to travel which may be influenced by the traffic on the road.

5. Conclusion

In conclusion this study draws inspiration from Weeks et al who used data from the 2000 Housing and Population Census, for Accra and the Ghana Demographic and Health Survey in 1998 and 2003 to examine spatial variability in under five deaths. The study concluded that there is spatial variability in levels of under five deaths within Accra and this variability is not spatially random, but rather clustered in specific parts of the city near the coast. They also demonstrated that the hot spots of child mortality were in the older central parts of the town near Ussher town and Central Accra and also around Nima which are regarded as urban slums. This study on the other hand related place of residence to child mortality using hospital data recorded at PML, Accra. This study confirms high clustering of under five deaths in and around Accra. Although the observed pattern from this study is similar to the findings of Weeks et al, it further observed a rather disturbingly high clustering in Kasoa which is part of the Central Region, a situation which be best accounted for by the pattern of utilization of health services in Accra. Thus community based interventions to reduce child mortality in Accra must go beyond administrative barriers to include functional or urban sphere of influence, that is other districts which may come under the sphere of influence of Accra such as Kasoa who utilise health facilities in Accra.

Some studies focusing on under five deaths have accounted for mortality cluster based on distance to health facility with identified minimum distance of four (4) miles. In this study, however, distance from the PML facility did not seem to play a significant role in accounting for under five deaths. The three most distant locations are not among the highest cluster. The only distant location with a high cluster of under five deaths is Kasoa. Similarly, the study finds no clear relationship between environmental factors, including access to portable water, use of unsafe cooking and use of unimproved toilet facility in municipalities accessing PML and child mortality records at PML. The study recommends further studies that will assess the existence of intervening opportunities (other health facilities) and also explore the possible relationship between other determinants of child mortality such as mother's education, poverty and also relate environmental factors to diseases such as pneumonia and diarrhoea.

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