Area-based sampling for an epidemiological study on injury patterns and risk factors in a low-income urban setting in sub Saharan Africa

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Abstract

The following paper is intended to document an area-based sampling method designed to facilitate an epidemiological study to examine injury patterns among children and adolescents in Dar es Salaam, Tanzania. We used official census data and geographic information system software to create a series of area maps for Dar es Salaam city. Then, based on these maps, we identified population clusters for sampling based on area population density.
Background

Unintentional injuries represent an important health threat to the lives of children and adolescents world-wide. The epidemic of injury and resulting harm such as disability or death, are likely to be the most severe in the low- and middle-income countries of the African continent. In 2001, approximately 20% of all recorded deaths on the African continent were among children under the age of 5, and over 40% of these deaths occurred in Sub-Saharan Africa (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Among all age groups in Sub Saharan Africa, injuries are the third leading cause of death (C Moshiro, Mswia, Alberti, Whiting, & Unwin, 2001).

In Tanzania prevalence patterns has been a subject of investigation in recent years. The overall incidence of injuries in Tanzania is estimated at 32.7 per 1000 per year of which 96% are unintentional (WHO, 2005). A recent study compared injury patterns for all age groups in Dar es Salaam (DES) city (urban), Hai (rural), and Morogoro (rural) districts of Tanzania between 1992 to 1998. In urban DES, transport injuries n=68 (206 total injury cases) were the leading cause of nonfatal injury with males and females being roughly equally represented in the numbers of those injured. The balance of these injuries (n=138) were categorized as falls n=56; cuts/stabs n=38; struck by object n=12; animal bites n=4; assault n=7; and other n=9 (Candida Moshiro et al., 2005). The Moshiro (2005) study analyzed injury records of 8,188 surveyed individuals in DES the study had a response rate of 89%. The findings from this study indicated that burns were the most common injuries among younger children in urban settings ages 0-5 (35%). Falls were reported for the age groups 0-4 (30%) and 5-14 (40%) respectively, as being more likely to occur in and around homes in urban areas.

Children between the ages of 5 and 14 were less likely to sustain traffic related injuries when compared to those between the ages of 15 and 44. Other studies document the high injury risks experienced by children in Tanzania generally. Dental trauma (Kahabuka & Mugonzibwa, 2009) and eye injuries
(Mselle, 1998) are known to be contributors to the overall injury burden in children ages 0-15. Children aged 0-15 represented 44% (n=114) of all eye injury patients (n=257) admitted for treatment at the Muhimbili Medical Centre between January 1993 and January 1994. The literature shows that most injuries occurring among Tanzania's children are unintentional and preventable. The evidence from these studies indicate a need for investigations centered around children's environments, to better understand injury risks to Tanzanians from infancy through age 18 years.

In 2009 a cross-sectional epidemiological study designed to investigate injury patterns among children and adolescents in DES was carried out. As DES did not have a well-developed system for systematically demarcating populations, such as a postal code system, we devised an alternative system using census data and geographic information tools. The aim of the present paper was to describe the method and procedures employed in reaching a representative population sample using an area-based sampling method.

**Method**

**Setting**

The procedures carried out in this paper were based on information obtained from official sources in the United Republic of Tanzania. The country has a population of approximately 34.4 million people with approximately 77% residing in rural areas. DES is a major commercial city the former capitol of the East African nation. It is a coastal city having a total area of 1,393 km2 which is divided into three districts (Ilala, Temeke and Kinondoni). These districts are further subdivided into 72 wards.

As of the latest census report, the city had a population of approximately 3.5 million people with roughly 33% being under the age of 14 years (Kamala, Wilson, & Hasselberg, 2011).
Sample size calculation

Using Stata 10, a power of 80% was selected to detect as significantly different from the null hypothesis (1.0), an adjusted odds ratio of 2.5 for the association between injury risk and the demographic and socio-economic exposures. Assuming a 5% incidence of all cause childhood injury (ages 0-18) (Candida Moshiro et al., 2005), the unit sample size with 80% power of the two-tailed test at 0.05 level of significance was calculated to be 1,968 households. Thus approximately 2,000 households were needed to fulfill the sample size requirements for the overall study.

Ward selection and sampling procedure

We utilized a stratified random cluster sampling method to identify seven contiguous zones within the greater DES region. The sample units used for all calculations were households having at least one child aged 0-18 years. Demographic data on ward population densities and sizes were obtained from the 2002 Tanzanian Census (CENSUS, 2006). This information was used to facilitate the development of maps characterizing each ward within the Dar es Salaam region. The general procedures are described elsewhere (Kamala et al., 2011). Briefly, one map with all wards was created using the geographic information system package ArcGIS 9.2. From this map, DES was divided into six contiguous zones based on incremental distances from the city's central business district.

A computer-assisted random sampling of 17 wards was obtained to be used in the study. A proportional sample of households were chosen from each ward. This was equal to 1.1% of the total number of households in each of the selected wards. This yielded a total of 2,131 households. Two wards were removed due to demographic and structural similarities with other wards, this resulted in a final sample of 2,007 households selected for visitation.
Results

Table 1 provides information on all of the wards which were included in the original selection. The wards which were removed have been identified with NS. The results of the sampling process are illustrated in Figures 1-12.

Table 1: Selected wards during the initial ward selection procedure

<table>
<thead>
<tr>
<th>Ward name</th>
<th>Ward type</th>
<th>Number of households per ward</th>
<th>Number of households selected*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kigamboni</td>
<td>Urban</td>
<td>8 858</td>
<td>97</td>
</tr>
<tr>
<td>Ukonga</td>
<td>Urban</td>
<td>16 752</td>
<td>184</td>
</tr>
<tr>
<td>Vijibweni^NS</td>
<td>Rural</td>
<td>1 287</td>
<td>14</td>
</tr>
<tr>
<td>Ndugumbi</td>
<td>Urban</td>
<td>9 351</td>
<td>103</td>
</tr>
<tr>
<td>Somangira</td>
<td>Rural</td>
<td>2 725</td>
<td>30</td>
</tr>
<tr>
<td>Charambe</td>
<td>Urban</td>
<td>19 849</td>
<td>218</td>
</tr>
<tr>
<td>Manzese</td>
<td>Urban</td>
<td>17 685</td>
<td>195</td>
</tr>
<tr>
<td>Kave</td>
<td>Urban</td>
<td>21 478</td>
<td>236</td>
</tr>
<tr>
<td>Kunduchi</td>
<td>Mixed</td>
<td>16 885</td>
<td>186</td>
</tr>
<tr>
<td>Kurasini</td>
<td>Urban</td>
<td>8 331</td>
<td>92</td>
</tr>
<tr>
<td>Azimio</td>
<td>Urban</td>
<td>15 692</td>
<td>172</td>
</tr>
<tr>
<td>Sandali^NS</td>
<td>Urban</td>
<td>9 885</td>
<td>109</td>
</tr>
<tr>
<td>Segerea</td>
<td>Urban</td>
<td>16 130</td>
<td>177</td>
</tr>
<tr>
<td>Chanika</td>
<td>Mixed</td>
<td>6 004</td>
<td>66</td>
</tr>
<tr>
<td>Pemba Mnazi</td>
<td>Rural</td>
<td>1 199</td>
<td>13</td>
</tr>
<tr>
<td>Kimara</td>
<td>Urban</td>
<td>14 328</td>
<td>158</td>
</tr>
<tr>
<td>Mbezi</td>
<td>Mixed</td>
<td>7 290</td>
<td>80</td>
</tr>
</tbody>
</table>

* = 1.1% of the total number of households per ward.
NS = Wards which were not included in the final sample

Discussion

The sampling method described may prove useful in the design and implementation of future population-based studies where the identification of households by addresses or other criteria is difficult.

References
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setting: a cross-sectional study in Dar es Salaam. *International Journal of Injury Control and

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70*(2), 185–192.
Figure 1 Dar es Salaam population density per square kilometer
Figure 2 Dar es Salaam Districts
Figure 3 Dar es Salaam wards
Figure 4 Dar es Salaam wards (inner city)
Figure 5 Dar es Salaam total population count by ward
Figure 6 Dar es Salaam population density by ward
Figure 7 Dar es Salaam average household size by ward
Figure 8 Dar es Salaam actual household counts
Figure 9 Dar es Salaam female population actual count
Figure 10 Dar es Salaam male population actual count

<table>
<thead>
<tr>
<th>Male_Count</th>
<th>1597 - 3418</th>
<th>3419 - 5599</th>
<th>5600 - 9164</th>
<th>9165 - 11634</th>
<th>11635 - 14040</th>
<th>14041 - 19282</th>
<th>19283 - 23588</th>
<th>23589 - 28269</th>
<th>28270 - 35455</th>
<th>35456 - 48058</th>
</tr>
</thead>
</table>

Kilometers

1:350,000
Figure 11 Initial selection of wards in Dar es Salaam
Figure 12 Dar es Salaam zone and ward selection