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Mapping Unhealthy Behavior Among Economically Active Men Using GIS in Suburban and Rural Areas of Sri Lanka

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Abstract

The burden of noncommunicable diseases (NCDs) and certain behavioral risk factors related to NCDs (unhealthy behaviors) are becoming more common. This survey aims to map out such common unhealthy behaviors among all men 35 to 50 years old in a Medical Officer of Health area in the Western Province of Sri Lanka using a geographical information system (GIS) and an interviewer administered questionnaire by visiting all households in the study area. Data were analyzed with ARC GIS and SPSS software. Geographical areas where men with unhealthy behaviors cluster together (clusters) were identified and visually and statistically related to locations of schools, places of religious worship, and factories in the area. It was revealed that clusters of unhealthy behaviors are mostly seen in areas with less population density. Smoking and alcohol are clustering in estate areas occupied by Tamils. This way GIS mapping could be used to identify and reduce the burden of NCDs by visualizing clusters and how certain locations affect their spread.

Keywords

behavioral risk factors; geographical information system; noncommunicable diseases; sociobehavioral mapping; unhealthy behaviors

Introduction

Unhealthy behaviors such as smoking, excessive consumption of alcohol, unhealthy dietary practices, and inadequate physical exertion which are more common among men¹ lead to many diseases, including noncommunicable diseases (NCDs). Of the world's 56 million deaths in 2012, 38 million (68%) deaths were attributed to NCDs.² Almost 4 out of 5 NCD-based deaths happen in low- and middle-income countries.³ More than 9 million deaths

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attributed to NCDs occur before the age of 60 years; 90% of these premature deaths occurred in low- and middle-income countries.⁴ In 2001, chronic NCDs accounted for 71% of all deaths in Sri Lanka, and trend analysis suggests that NCD mortality rates have been rapidly increasing during the past decade.⁵ NCDs have massive social and economic implications for individuals, families, communities, and countries.⁶

The geographic areas where most men with certain unhealthy behaviors could be located (clusters) are not known. If clusters do exist, they could be visualized with other geographically likely associated factors for such unhealthy behaviors and could be used to implement cost-effective targeted preventive measures of NCDs, including World Health Organization's (WHO) best buys interventions.

The study aimed to map out areas where certain risk behaviors related to NCDs (unhealthy behaviors) cluster together (clusters) using a geographical information system (GIS) and how such clusters could be geographically related to important locations such as places of religious worship, schools, and factories. Visualizing such clusters and important locations could be used to implement preventive measures.

Methods

Study Setting

A household survey was conducted in a single Medical Officer of Health (MOH) area (Ingiriya) in the Western Province of Sri Lanka. This is a suburban and rural area having a population of approximately 50 000.

Data Collection

GIS data and data related to unhealthy behaviors were collected by visiting almost all the houses in the study area where there was a male who was between 35 and 50 years old. It was possible to collect data from 5402 men 35 to 50 years old, who were permanently residing in the area (ie, those who had lived in the residence for more than 6 months). Because there was more than 1 eligible male person in a few households, the number of households included was less than 5402.

GIS data related to a few important locations such as schools, places of religious worship (ie, temples, *kovils*, and churches), and a few factories were obtained from the Survey Department of Sri Lanka. Almost all the households in all 31 smaller administrative areas in Ingiriya MOH area were covered during a period of 3 months.

Development of the Interviewer-Administered Questionnaire

GIS recordings and unhealthy behaviors were marked on an interviewer administered questionnaire. Face, content, and consensual validity of the questionnaire was developed.

Training of Data Collectors

Five undergraduates were trained in distinguishing accurately the unhealthy behavior patterns from normal sudden change in behaviors. They were also trained on how to operate

GIS machines by a person professionally qualified in GIS mapping in the WHO office in Colombo. Because this research project involved administration of a questionnaire to a population of economically active men, it was necessary to train data collectors in such a way that they developed a mechanism to meet and interview those men who were away from home during the daytime. In estate areas, men were interviewed in the evening once they finished their work and returned home. Those men who were away from home were revisited by data collectors, and those who were unwilling to participate (nonrespondents) were excluded from the study.

Data Entry and Analysis

All 5402 filled questionnaires were fed into a database using SPSS version 16 by a trained data entry operator under the direct supervision of the Principal investigator (PI). These data were copied to ARC GIS software to make shape files and, thereby, draw maps that show the spatial distribution of unhealthy behaviors in Ingiriya MOH area. GIS data were analyzed using ARC GIS software. Geographical locations of clusters of unhealthy behaviors and certain possible associated factors (ie, schools, places of religious worship and a few factories) were visualized using geographical maps. Clusters of unhealthy behaviors were visualized using Kernel density mapping technique in ARC GIS software. Schools, places of religious worship, and a few factories were marked on Kernel density maps to visually relate the possible associations between clusters of unhealthy behaviors and above-mentioned important locations.

Measures Taken to Ensure the Validity and Reliability of Data

Measures were taken to minimize nonresponse by visiting each household and briefing them of the study, including the confidentiality of the information to be obtained. Carrying out data collection during the afternoon hours of the day helped minimize nonresponse in estate areas. Measures were also taken to minimize measurement errors through training of data collectors, validation of the questionnaire, cross-checking of the GIS recordings in about 5% of participants, and by conducting a pilot study.

Ethical Considerations

Ethical approval for the above research was obtained from the ethics review committee of the Colombo Medical Faculty (Reference EC 12-061) on August 16, 2012. Consent to participate in the study was obtained from the eligible men after explaining the nature of the study. Participants were allowed to withdraw from the study at any time. Confidentiality of information was maintained. Respondents were assured of their anonymity by introducing a numerical coding system for the questionnaire identification.

Results

Kalutara district is located in the Western Province in Sri Lanka. Ingiriya MOH area is located within the district of Kalutara. According to population census conducted in Sri Lanka in 2012, the study area has a total population of 53 645.⁷ The highest population density in Ingiriya MOH area could be seen in Poruwadanda west, followed by Ingiriya north and Pelpitiya areas.

Alcohol and Smoking

As revealed by the survey, the prevalence of alcohol consumption among men aged 35 to 50 years in Ingiriya MOH area was 52%, and of those who consume alcohol, 290 (1.4%) consumed more than half a bottle at a session. Among alcohol consumers 975 (34.6%) consumed illicit liquor, and 2588 (92%) had consumed alcohol for more than 1 year. The prevalence of smoking was 28.2%. Among smokers, 650 (42.6%) smoked daily, and 64 (4.2%) smoked more than 5 per day, with 1399 (92%) having smoked for more than 1 year. On binary logistic regression analysis, there was no statistically significant association between distance to alcohol (and smoking) clusters from certain important places (schools and religious places) and density of alcohol (and smoking) clusters; $P < .05$.

Educational Profile

Among the 5402 participants, 124 (2.3%) had an education up to grade 5, and only 216 (4%) had a diploma/degree.

Places of Religious Worship, Schools, and Factories in Ingiriya

The maps in Figures 1 and 2 depict places of religious worship, schools, and factories in Ingiriya. In each map, the geographical locations of 28 places of religious worship (23 Buddhist places of worship, 3 Hindu *kovils*, and 2 Christian churches), 23 schools, and 3 factories have been marked. By looking at the Kernel density map, it was possible to visually relate the proximity of the above-mentioned places to the areas where certain unhealthy behaviors were clustered.

Clusters of Unhealthy Behaviors

As seen in the maps, current alcohol consumers have clustered in Handapangoda, Eduragala, Nimalagama, Rathmalgoda, Imagira, and a few other smaller administrative areas. Nimalagama, Imagira, and Maha Ingiriya have estate areas with a majority Tamil population. One school each could be seen in Imagira and Eduragala areas, but no places of religious worship could be found in both areas. In Nimalagama, neither a school nor a place of religious worship could be found (Figure 1). The population density in Handapangoda south GN division was found to be relatively less (between 500/km² and 1000/km²).

Therefore, it could be hypothesized that clustering of current alcohol consumers in Handapangoda south is unlikely to be a result of higher population density.

Although there was one school, no places of religious worship were found in Handapangoda south GN division. By looking at Figure 1, it is difficult to predict whether factories could be geographically related to areas where alcohol consumers clustered, because there are no factories close to clusters of alcohol consumers.

Current smokers clustered in Rathmalgoda (Imagira), Wagawatta, Nimalagama, Eduragala, Ingiriya north, and Kurana smaller administrative areas (Figure 2). Although the smaller administrative divisions of Imagira and Eduragala have clusters of smokers (Figure 2), their population density was found to be relatively less. There were no places of religious worship nor schools in Imagira GN division, where a cluster of current smokers was found.

In Handapangoda east, Rathmalgoda west, and Kotigala areas, schools could not be identified. Although there is one factory close to the cluster of smokers in Nambapana area, other clusters of current smokers are located away from the factories shown in Figure 2.

Discussion

In this study, 5402 men between 35 and 50 years old, living in the entire Ingiriya MOH area were enrolled for mapping to visualize geographically the patterns of distribution of unhealthy behaviors among them. The exact location of the household was recorded using GIS equipment. Where there were 2 men between 35 and 50 years of age in the same household, GIS location was recorded twice to ensure that the number of GIS locations (coordinates) was the same as the number of men enrolled. Because a perceived clustering of health events is usually associated with a great deal of anxiety and stress from involved communities, these investigations continue to be a very important and necessary public health responsibility.⁸

As revealed in the survey, the prevalence of alcohol consumption among men aged 35 to 50 years in Ingiriya MOH area was 52%. Consumption of alcohol among adults 15 years and older in Sri Lanka is around 30%.⁹ Globally, an estimated 2.5 million deaths occur as a result of harmful use of alcohol every year, of which a significant proportion is among the young. It is the third leading risk factor for poor health globally. The diversity of alcohol-related problems and measures necessary to reduce alcohol-related harm point to the need for comprehensive action across numerous sectors.¹⁰

The prevalence of smoking among men aged 35 to 50 years old in Ingiriya MOH area was 28.2%. The current smoking prevalence in Sri Lanka is 39% among men and 2.6% among women.¹¹ Per WHO's Global Health Observatory, in 2012, 21% of the global population 15 years and older smoked tobacco. The prevalence of smoking among men was 5 times that in women.¹²

Through identification of clusters closer to schools and places of religious worship, low-cost awareness programs aimed at reducing unhealthy behaviors and, thereby, NCDs could be implemented with intersectoral coordination. Whereas many interventions targeted against NCDs may be cost-effective, some are considered "WHO best buys"—actions that should be undertaken as soon as possible to produce accelerated results in terms of lives saved, diseases prevented, and heavy costs avoided.¹³

Conclusions and Recommendations

Maps could be a useful tool to identify geographical regions where unhealthy behaviors cluster. Maps could also be used to visualize how facilities such as schools and places of religious worship have affected the spread of unhealthy behaviors and, thereby, to implement preventive measures with intersectoral coordination. Based on the above findings, it is possible to make recommendations to policy makers with a view to reducing the burden of unhealthy behaviors and, thereby, NCDs. Further research involving GIS mapping will help identify relations with institutions such as marketplaces and supply chains of food and

beverages with easy accessibility in certain geographical areas where unhealthy food-related behaviors are clustered.

Clustering of unhealthy behaviors among economically active men could be seen mostly in areas where the population density is relatively low. Smoking was clustered in estate areas where the majority are estate Tamils. Alcohol consumption was also clustered in Imagira GN division where the majority of the men are estate Tamils. Their level of education is low, and the majority work as laborers. Most of them practice Hinduism. In the sociobehavioral mapping survey in Ingiriya MOH area, it was revealed that there was only 1 school; also, no places of religious worship were found in both Eduragala and Imagira estate areas. Therefore, it is recommended that more educational facilities and places where spiritual guidance could be provided be established in such areas. This may help reduce the burden of NCDs.

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Figure 1.
Kernel density of current alcohol use and some important places in Ingiriya.

Figure 2.
Kernel density of current smoking and some important places in Ingiriya.