Socio-Demographic Predictors and Distribution of Pulmonary Tuberculosis in Moroto District

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Abstract

Background: Moroto is one of the hard-to-reach districts in Uganda that faces a lot of challenges in effecting the prevention of pulmonary tuberculosis. Despite the high prevalence of PTB in Moroto district, certain areas within the district have a much higher portion of the positive cases recorded when compared to the rest. There is need to identify the distribution pattern of the disease as well as its sociodemographic predictors if elimination of PTB should occur. The geographical information system has become the preferred method and technique for studying the epidemiological characteristics of infectious diseases as it allows for easier and more efficient acquisition, visualization, management, analysis and display of geographic data over other existing methods for disease clusters. Therefore, the aim of this study is to determine the socio- demographic predictors and distribution of pulmonary tuberculosis in Moroto so as to establish information useful a more effective strategy for TB prevention and control in Moroto in the future.

Methodology: A study to determine the distribution of PTB and its socio-demographic predictors was carried out by five second year medical and nursing students under community placement, in conjunction with various health care workers in three sub-counties of Moroto namely; Nadunget, Rupa and Northern division. Face-to-face interviews were done and translators mainly the village health teams were employed. Both gene expert and chest x-ray radiography were employed in attainment of results. For gene Xpert, morning sputum samples were collected in sputum containers, packaged in a cold chain preserved container and sent to Moroto Regional Referral Hospital laboratory for Gene Xpert test. To establish the distribution of PTB, geo-spatial mapping (UTM Geo map) was used to identify PTB hotspots with the aid of GIS technology.

Results: For a period of one month between March and April 2021, 386 individuals aged 5 and above participated in the study21.5% were able to produce sputum for which gene Xpert was carried out and the remaining 78.5% who were unable to produce sputum were examined using a mobile chest x-ray machine that provided instant results. A total of 26 were diagnosed with PTB including one rifampicin resistant case. The positive cases were initiated on treatment, to be followed up by the health workers.

Conclusion: Findings from our study indicate that 6.7% of the 386-sample population were positive giving a prevalence of 6735 per 100,000 of people aged greater or equal to 5 years with highest prevalence of 76.9% and 92.31% among the tobacco and alcohol consumers respectively.

Introduction

Tuberculosis (TB) is an infectious disease caused by mycobacterium tuberculosis bacillus and transmitted through the respiratory route and primarily affects the 15-54 age group. TB remains a global health problem, posing serious social and economic burdens worldwide [1]. According to a recent report of the World Health Organization (WHO), the number of incident TB cases in the world in 2017 was estimated at 10.4 million [2]. However, TB incidence and TB related burden vary from country to country. Among the 22 high TB burden countries and regions, Uganda ranks 16th and there are an estimated 42,000 annual cases of TB giving an incidence of 42,000 per 100,000 population [3]. Moroto, one of the hard to reach districts of Uganda, faces particular challenges in the prevention and control of TB [4]. Being a rural and border district, Moroto has approximately 103,432 permanent residents [5]. They also live in poorly aerated houses "manyattas" and many times share housing with animals. Frequently travelling to different areas to look after their cattle, the men are likely to bring the disease to their families [6].To date, a lot of effort has been directed to the control of TB though they have been confined to the implementation of the WHO recommended DOTS strategy [7]. In circumstances where political and administrative regulations as well as systematic monitoring measures are in place, the identification of TB patients is the first and most important step in the five point strategy [8].

The Geographical Information System (GIS) has become the preferred method and technique for studying the epidemiological characteristics of infectious diseases [9]. Taking advantage of the recent development in computer hardware and software, GIS allows for easier and more efficient acquisition, visualization, management, analysis and display of geographic data over other existing methods for disease clusters [10].The application of GIS technology in the assessment of epidemics [10], and in the predication of disease distribution when baseline data is unavailable or difficult to get has been demonstrated to be cost effective [9]. The use of classical space-time analysis with geostatistical methods is a relatively recent development and is now commonly used in the cluster detection of diseases such as infectious respiratory disorders, cancers, and diabetes [11-13].

Although Guma et al investigated the prevalence of TB in Moroto in 2019, this information was from only one sub county, Nadunget [14]. Moreover, there is dearth of information about previous studies on TB distribution and population characteristics that have employed geospatial mapping techniques in Moroto. Therefore, the aim of this study is to attempt to gain information useful for establishing a more effective strategy for TB prevention and control in Moroto in the future.

Methods and Materials

Study design

Descriptive Cross sectional study will be used.

Study area

The study will be carried out in Moroto district, one of the 7 districts in Karamoja region of mid- eastern Uganda which shoulders the highest TB burden.

Moroto district houses 6 sub-counties, 30 parishes and 186 villages. The sub-counties include; Katikekile, Nadunget, Rupa, Tapac, North division and South division [15]. The study will be carried out at sub-county level in Moroto district.

Sample size determination

Sampling Strategy: Multi-stage sampling which involves staging cluster samples and getting stratified samples until the target population is obtained. Of the 6 sub-counties, we choose 3 that is; Katikekile, Rupa and Tapac (Table 1).

Table 1. Sampling strategy.

Sub-county	Number of parishes	Number of villages	Population
Katikekile	2	14	11,700
Rupa	7	30	44,600
Tapac	3	15	26,700
*With a total household population of 22,066; **22,066/6= 3,677.66 approximately 3,678*3=11,034 households			

The sample size of the study will be based on the prevalence of PTB in Karamoja region and determined using Kish Leslie's formulae

$N=Z^2Pq/e^2$ Where;

N is the sample size

Z= 1.96 at a 95% confidence interval P is the prevalence estimated at 0.5 Q=1-p=0.5

e is the degree of accuracy=0.05 $N= (1.96^2*0.5*0.5)/0.05^2=384.16$

N is approximately 384

Study population

All residents within the community at sub-county level that meet the inclusion criteria are a target; hence data will be stratified by sub-county.

Inclusion criteria

The following are people at a higher risk of acquiring active PTB or reactivation of PTB;

- Adults
- Children>5 years of age

People with weakened immune systems, for example; HIV/AIDS, chemotherapy, diabetes or medicines that weaken immune system

PTB can be notified using signs and symptoms and observing any resident with these qualifies the individual for participation in the study. These include:

- Breathing difficulty
- Chest pain
- Cough(usually with mucus) for >2weeks
- Excessive sweating, particularly at night
- Fatigue
- Fever
- Weight loss >10 kilograms
    a) Informed consent, given by participants for screening tests for sputum
    b) Area being cited by Google maps

Exclusion criteria

- Individuals that are sick at the time of the study and are unable to participate.
- Individuals that can't participate due to unavoidable circumstances.

Data collection methods and tools

Sample selection will be based on multi-stage sampling. To determine the socio-demographic predictors of PTB, we will have face-to-face interviews involving a piloted questionnaire with open and close ended questions [16]. The questionnaire will comprise demographic, lifestyle and medical data to assess predisposing factors to PTB. Additionally, to establish the distribution of PTB, geo-spatial mapping will be used to identify PTB hotspots with the aid of GIS technology [17]. This involves use of a Geomap application (Arc GIS) to enter spatial data for analysis. Furthermore, GPS will be used to cite the different areas visited to ease laying out of the map. To ascertain the prevalence of PTB, an intensive case finding form will be employed to attain the number of presumptive PTB cases [18]. The participants will be assigned identification numbers and preferably, morning sputum samples will be collected in sputum containers. The samples will be packaged in a cold chained preserved container and sent to the nearest health facility for Gene Xpert application [19].

Laboratory procedure

This involves application of the Gene Xpert mechanism to detect Acid Fast Bacilli in the patients' sputum and can yield positive or negative results [20]. This technique tests for DNA sequences specific for Mycobacterium Tuberculosis and is rapid, simple for nucleic acid amplification. The results will be noted and assessed accordingly [21].

Data processing, analysis and interpretation

Software and devices use: Geographic Information System (GIS) is a computerized system where data linked to geographical location can be entered, managed, manipulated, analyzed and displayed [22]. Global Positioning System (GPS) will be used to collect exact geographic coordinates and generate non-spatial data identifying individual house addresses. The corresponding coordinates will be uploaded in Google Earth to identify the locations [23]. The residences of participants will be marked in various colors on the map obtained. The Moroto base map will be linked to software ArcView 9.3 which consists of three basic versions (Arc Catalog, Arc Map and Arc Tool box). The variables will be linked to ArcGIS version of ArcMap for creating geospatial maps.

Data analysis: Computations using Microsoft Office Excel, as well as, an added spatial pattern and cluster analysis for PTB prevalence using Geographical Information System (GIS) Technology will be used to improve understanding of geographical variation of PTB occurrence in Moroto and predictors [24]. This will involve application of ex/inclusion criteria during data cross-checking, validation and clearing. Data will be entered in Spatial Statistical Package (SPSS, PASW® Statistics 18) database. Furthermore, transferred to Microsoft Excel 2007and joined with version of ArcMap for map creation and spatial autocorrelation [25]. The questionnaire data will be tallied against the various determinants that will be obtained and the results thereafter tabulated.

Spatial analysis: A thematic map, that is, map or chart especially designed to show a particular theme connected with a specific geographic area, will be used over PTB case locations and an overlaid base map of Moroto identifying PTB hotspots and relationships to socio-demographic predictors of PTB [26]. Hotspot analysis reveals intensified clustering of socio-demographic predictors of PTB.

- Hot-spots are high values of clustering due to positive sputum screening test scores.
- Cold-spots are low values of clustering due to negative sputum screening test scores.

Visualizing spatial characteristics of data will enable appreciation of patterns of distribution of PTB and highlight errors, factors which might influence the

observed pattern [27]. The pattern will be shown to the target audience using a map of disease distribution [28].

Presentation

Statistical frequency distribution tables, graphs, charts and maps to be used for data presentation with independent variables of proportions, percentages, ratios and absolute values. The findings presented are to be both univariate and bivariate [29].

Ethical consideration

Ethical approval obtained from Busitema University Faculty of Health Sciences Research Board Committee. In addition, all adult participants in the study will provide written informed consent and participants younger than 18 years will assent through written consent provided by a parent or guardian [30].

Results

- Tb screening indicators (Figures 1-5).
- Sign and symptom used to screen patients among positive cases (Tables 2-9).

Sociodemographic predicators

Table 2. House status

sign and symptom	present	absent
cough	25	1
bloody cough	12	14
fever	24	2
weight loss	23	3
night sweats	22	4
chest pain	24	2
house	ventilation present	no ventilation
semi permanent	1	5
manyattas	2	16
permanent	2	0

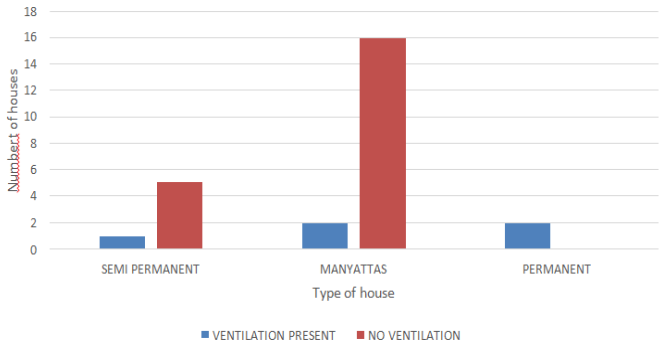

Figure 1. Column graph for house status.

Table 3. Occupation.

Occupation	Number
Level	Total
None	10
Primary	15
O level	1
A level	0
Tertiary education	0
Unemployed	24
Informal	2
Formal	0

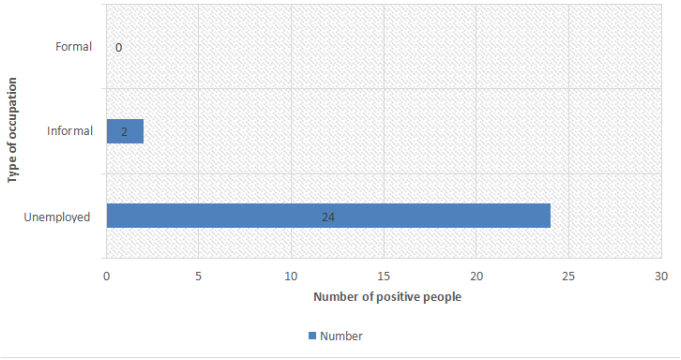

Figure 2. Bar graph for occupation categories.

Table 4. Alcohol use and tobacco use.

Practices	Yes	No
Alcohol	24	2
Tobacco	20	6

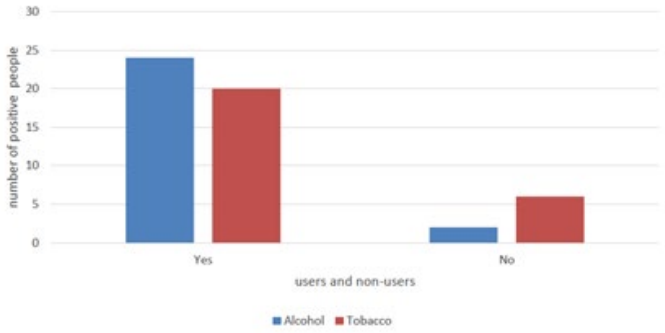

Figure 3. Column graph for alcohola and tobacco use

Table 5. Tobacco use.

Mode of use	Number
Sniffing	18
Smoking	6
Sniff/Smoke	4

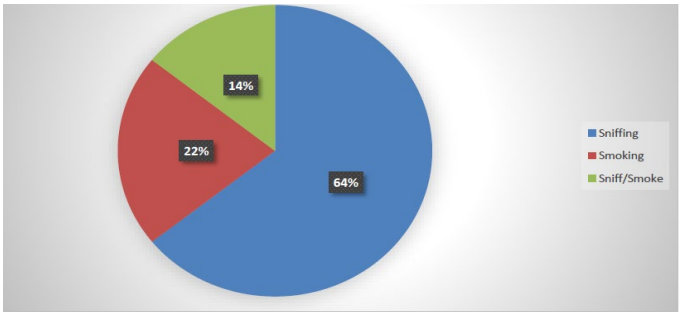

Figure 4. Pie Chart forms for tobacco use.

Table 6. Sex.

Gender	Positive
Male	16
Female	10

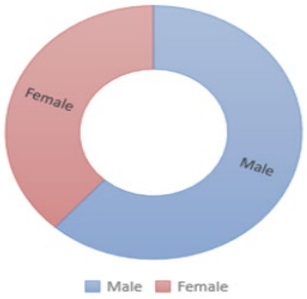

Figure 5. Sunburst showing gender distribution of positive cases.

Table 7.Age

Groups	Positive
5-19 years	4
20-49 years	15
>50 years	7

Figure 6. Age group distribution of positive cases.

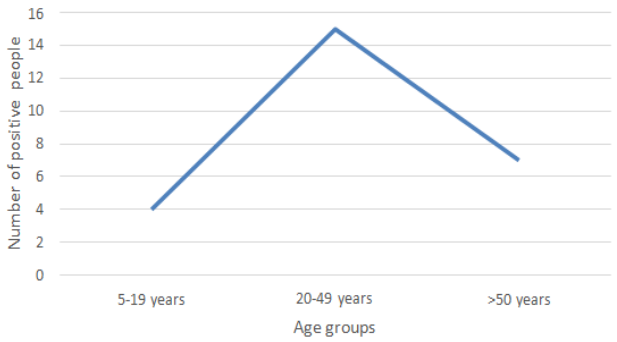

Figure 7. Line graph of positive cases among age groups.

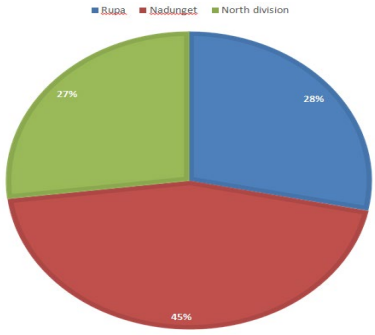

Figure 8. Subcountry gene Xpert results.

Table 8. Distribution.

Sub county	Total	Negative	Positive
Rupa	109	98	11
Nadunget	173	162	11
North division	104	100	4

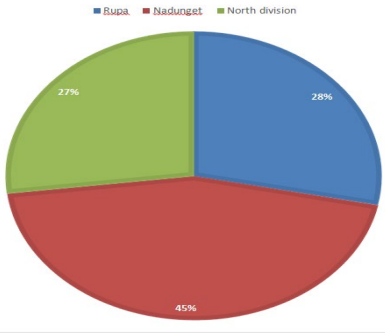

Figure 9. Subcountry population sampled.

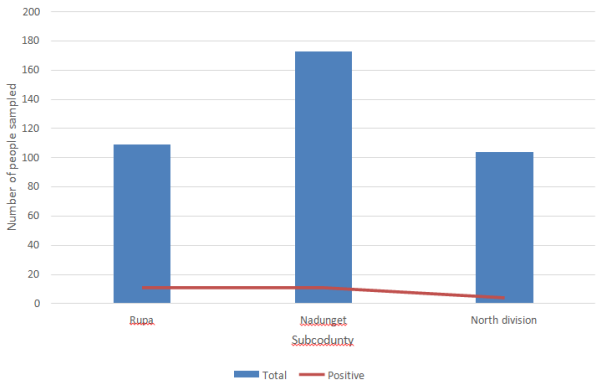

Figure 10. Subcountry positive cases compared with the population sampled

Table 9. Manyatta house occupants.

Occupants	Number
=<4 members	11
5-6 members	5
=>7 members	10

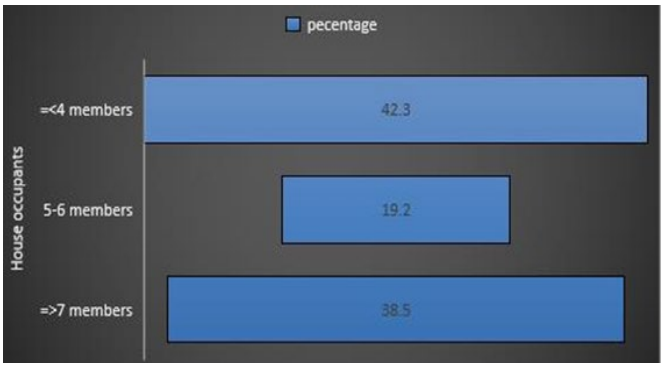

Figure 11. Percentage of house occupants.

Sociodemographic characteristics

A total of 386 participants from 3 sub-counties, Nadunget, Rupa and Northern division, were involved in the study (Figure 6). An intensive case finding tool incorporated into a stratified questionnaire was used to come up with results on the sociodemographic predictors of PTB among the population [31]. 193 males (50%) and an equal number of females participated with the most common age group being those between 20 years and 49 years (Figure 7).The percentage of participants that attained education at tertiary level was 8%, and these were mainly the health care workers (Figure 8). Participants with A level education were0.26% and those with O level education 4.4%, while 23.3% of the participants had primary as their highest level of education and had not attained education at all [32]. 28.2% of the total participants lived in permanent houses, 9.8% in semi-permanent and 61.9% lived in manyattas (Figure 9).

Of the 386 presumptive cases, 26 were diagnosed with PTB and of these, 61.54% were males and 38.46% females [33].of the positive cases, 65.38% resided in grass-thatched houses (manyattas), 23.08% in semi- permanent houses and the remaining 7.69% lived in permanent houses [34]. From the study, an average of five (5) people shared a single room. 55.2% had between 4 and 7 room occupants, 22.3% had more than 7 room occupants and those that had less than 4 room occupants were 22.3%. For all the positive cases, 88.46% had no ventilation to their houses while only 7.69% had good house ventilation (Figures 10-12).

Prevalence of pulmonary tuberculosis

Of the 386 participants, 26 (6.74%) were found to be positive for PTB and these were initiated on PTB first line treatment [35]. Average age of the positive cases was 39 years and this was lower than the average age of the total respondents.

Distribution of pulmonary distribution

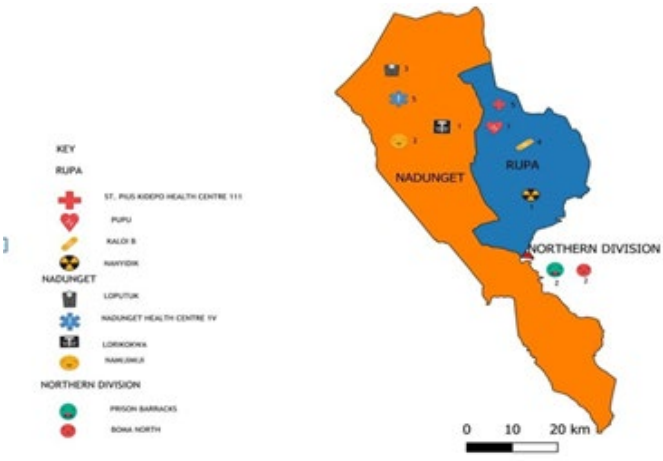

Figure 12. Distribution of PTB in Sub-counties of moroto district.

Discussion

Out of 386 participants screened for PTB using gene x-pert test, 26 (6.7%) were positive giving a prevalence of 6735 per 100,000 people aged greater or equal to 5 years, with a higher prevalence in males (61.5%) than females (38.46%). higher prevalence in males is attributed to poor health seeking behaviors in males [36]. Among these participants, the most affected age group was that between 20 years and 49 years (57.69%) followed by those older than 50 years (26.9%) with the least affected being those aged between 5 years and 19 years (15.38%). This is because the middle-aged group are exposed to a lot of PTB contacts since they can move from one community to another grazing their cattle [37]. This study is in line with another carried out in Nigeria where high PTB prevalence was detected in middle aged groups [38].

The greatest percentage 69.2% of the positive cases resided in manyattas. These are tiny grass thatched houses with a radius of about 1 meter that have just a single 50 cm-high portable door with neither windows nor ventilators [39]. A study on the relationship between physical condition of a house environment and incidence of PTB in Indonesia showed that there is a correlation between poor house ventilation and pulmonary tuberculosis [16,40]. Good ventilation plays a function of keeping fresh air flow and freeing air from bacteria thus decreasing risk of airborne spread [41-43]. Poor ventilation however provides a humid environment which is conducive for growth and proliferation of mtb.[4]

The occupancy density in the households was also found to be a high-risk factor for PTB [44-46]. Given that the number of room occupants is high, with an average of five people sharing a room at night, transmission of mycobacterium tuberculosis is simplified as the bacterium is airborne [1]. A study in Kapuas district showed that a dense house occupancy eased and made transfer of PTB through the air much easier in case one of the family members infected with the disease accidentally coughed [47-49]. High prevalence of PTB was also noticed among prisoners (11.5%) due to overcrowding in prisons and this is in line with a study carried out in one of the largest prisons of Eastern Nepal which found prevalence of PTB in prisons to be higher than the general population [50,51].

PTB prevalence was also very high among tobacco (76.9%) and alcohol consumers (92.31%) thus indicating alcohol and tobacco use as major predisposing factors to PTB [52, 53]. This is because alcohol and tobacco are used for daily living as a source of money and food shortage in Moroto district. Tobacco use though snuffing, smoking or chewing is a very common practice among both males and females in Moroto district as the locals share it amongst themselves as a sign of good relation. One study in India showed a strong association between tobacco smoking and development of pulmonary tuberculosis with another study carried out in South Africa showing a greater increase in odds of current tuberculosis with snuff use [54, 55].

PTB prevalence was also high among unemployed (76.9%) and 100% of the positive cases had a low monthly income of less than UGX130000 thus indicating poverty as one of the risk factors of PTB [56]. Due to high poverty rate, the community members cannot afford seeking health care, good housing, balanced diet hence increasing PTB spread [57].

Conclusions & Recommendations

- Continuous PTB intensive case finding/ screening at all contact points in the health facilities and carry out community contact tracing activities.
- Training of health workers, VHTs and important stake holders about PTB relation to tobacco and alcohol use as well as PTB prevention.
- Continuous health education of community about PTB relation to tobacco and alcohol use, its prevention at health facilities, church, schools, by posters, radios, VHTs, health workers and other stake holders (LCs, head teachers, church leaders).
- Empowerment of the community of Moroto district with income generating activities like skills-based activities by the government of Uganda together with supporting partners.

- Provision of more scholarships by partners like NGOs and the ministry of Education, for the children who cannot afford fees payment.
- Other studies should be carried out on relationship between health workers and PTB prevalence.

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