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SPATIO-TEMPORAL TRENDS OF TUBERCULOSIS IN MADOBI LOCAL GOVERNMENT AREA, KANO STATE

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ABSTRACT
This study analyzed the spatial and temporal trends of tuberculosis in Madobi local government area. Tuberculosis cases reported to Akilu Memorial Hospital and Burji Hospital between 2012 – 2015 were used. The data was analyzed using maps, tables, and graphs.Raw data was subjected to Two – way Analysis of Variance (2- Way ANOVA) to determine the significance difference over time and space. Result shows that cases are not equally distributed spatially and temporally. Highest reported incidences were observed in Madobi and Kwankwaso wards with 31 % and 18.3% of the total reported cases. Lowest cases were recorded in Galinja and Kauran Mata wards with 0.7% and 2.1% respectively. The results further show an increasing trend of the reported TB cases from 2012 – 2015. Results of Analysis of Variance (Two – way ANOVA) showed strong statistical main effect for the wards (F=3.21, P=0.001), strong statistical main effect for the years under study (F=1.17, P=0.001) and strong statistical interaction effect for the two variables (F=4.77, P=0.001). In addition, post hoc multiple comparison test using Tukey HSD was performed to further investigate which groups of variables differ significantly. Results showed that only two pairs of wards were found not todiffer significantly. The study recommends that further study should be conducted to explore socio-economic and environmental factors that stimulate the spread of tuberculosis in Madobi local government area.
Key words: Anova, DOT centers, Madobi, Spatial, Temporal, Tuberculosis

INTRODUCTION

Tuberculosis is still considered among the major public health concern world-wide for its high case fatality rate. Although tremendous efforts were exerted to fight the disease in many part of the world, yet it presents a serious health problem in developing countries (Dye *et al*. 2005). World Health Organization estimated that between 8 -10 million people are annually contracted with the disease all over the world, and the disease is responsible for the death of 3 million people annually(WHO, 2008). The above source further predict that if left uncontrolled tuberculosis will kill up to 35 million people in the world by 2025.

Tuberculosis is an infectious disease principally caused by the infection with tubercle bacilli - a generic name that incorporates an expanding list of *Mycobacterium* species collectively called *Mycobacterium tuberculosis Complex*. Members of this group are; *Mycobacterium tuberculosis*, *M. bovis, M.africanum, M. microti, M. canetti, M. caprae, and M. pinnipedi* (Grange, 2008; Boulahbal and Heifets, 2006). They are generally facultative intracellular (phagocytes) pathogens which may be related to their long period of persistence in individuals with latent tuberculosis (Boulahbal and Heifets, 2006). M. *tuberculosis* is a slow replicating bacterium, resistant to most orthodox anti-microbial drugs mainly due to its impermeable cell wall. It may persist in a dormant (latent) condition (Murray, 2000). TB is spread from person to person via the air when infected person cough, sneeze, or release respiratory fluids into the air.

It was estimated that about one-third of the world's population is thought to have been infected with TB bacteria – Tubercle Bacilli (Hudson *et al.*, 2003; WHO, 2014), with new infections forming about 1% of the population yearly (WHO, 2010).In 2007, there were an estimated 13.7 million chronic cases worldwide (WHO, 2009), while in 2013, an estimated 9 million new cases had claimed the lives of 1.5 million people majority of them in developing countries (WHO, 2014). The severity of TB epidemics differs widely among countries.

In 2017, there were an estimated 10 million TB cases, two-third of the cases occurred in eight countries: India (27%), China (9%), Indonesia (8%), the Philippines (6%), Pakistan (5%), Nigeria (4%), Bangladesh (4%) and South Africa (3%) (WHO, 2018).

Nigeriais one of the countries that have high burden of TB cases. According to Federal Ministry of Health (2014) an estimated 460,000 new cases of TB are occurring every year, and the country is classified among the five leading countries of TB cases. The World Health Organization in its 2010 report gave an estimate incidence of 210,000 new cases for all forms of TB in Nigeria, equivalent to 133 per 100,000 populations, and an estimated 320,000 prevalent cases, equals to 133 per 100,000 populations (WHO, 2010).

Kano state is the most populated state in Nigeria where TB is increasingly becoming trouble to the healthcare communityover the last two decades (Imam and Oyeyi, 2008). This is mainly due to the increasing incidence following the advent of HIV infection and the emergence of resistant strains besides unusual presentation of the disease in other system such as kidney, heart, etc. Kano state was at the end of last century included among the vulnerable HIV/TB regions in Africa (Raviglion *et al.* 1997), and in the beginning of this century registered 12.4% TB-positive cases (Ekanem *et al*. 2004). Several studies (Imam and Oyeyi, 2008; Abubakar, 2015; Nasir, 2015) have been conducted in the state to examine the distributional patterns of TB cases. However, these studies concentrate on cases reported to Infectious Disease Hospital (IDH) Kano, a comprehensive analysis of TB cases reported to other DOT centers in the state is therefore required.

This study therefore, aims at geographical analyses of TB reported cases in Madobi local government area, Kano state. The specific objectives were to: develop distributional map of reported cases and statistically analyze spatio-temporal variations of the reported cases.

METHODS OF THE STUDY

Study area

The study was carried out in Madobi local government, Kano state. The area is located between latitudes 11^0 42′N to11^0 54′N and longitudes $8^0$15′E to 8^0 33′ E. It is bounded on the North by TofaL GA, North-west by Rimin Gado LGA, Kabo LGA by the west, Kiru LGA by the South-west. Bebeji and Garun Malam LGAs bordered the area by the South; to the East are Kura and Dawakin Kudu LGAs, and Kumbotso LGAby the North-east (Figure 1). The climate of the area is tropical wet and dry type coded as Aw in Koppens climatic classification. The mean annual temperature is about 26°c, but means monthly values range between 21°c in the coolest months December/January and 31°c in the hottest months April/May. (Olofin, 2008). The annual mean rainfall in the area is between 800 mm and 900 mm, which concentrate between 4-5 months (May to September). The area experience four distinct seasons: the dry and cool, dry and hot, wet and warm and dry and warm seasons (Olofin, 2008).The 2006 population census puts the population of the area at 136,623 with an estimated land mass of 273km^2 giving an average population density of 500 persons/km^2.

Data Sources

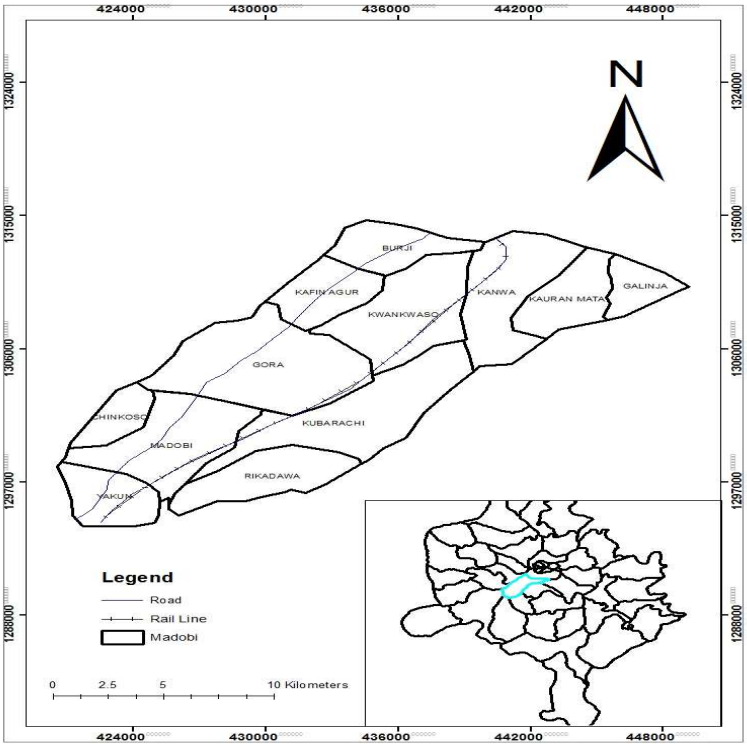
Data used for the study were obtained from two DOT centers purposively selected for the study. The centers are the Akilu Memorial Hospital, and Birji Hospital all in Madobi local Figure 1: Madobi Local Government Area

Government area. These healthcare facilities are the only ones handling and keeping records of tuberculosis in the area. Records of TB cases from 2012 – 2015 were retrieved and used for the study. Case file of TB patients were reviewed and vital information such as age of patients, sex of patients, location of the patients, and year of diagnosis and status of the patient on discharge were recorded.

Data Analysis

Mapping of the case events for the period under investigation was done using Arc GIS. Political map of the local government was scanned, geo-referenced and digitized using Arc GIS 10.3 vision. The annual incidence of the disease from 2012 to 2015 as well as the total incidence was added to the attribute table on the GIS environment and a chloropleth map was produced to display the spatial distribution of the disease over the study.

Descriptive statistics was used to analyze demographic characteristics of the patients including sex structure and age structure. Disease type, treatment type and treatment outcome of the disease were also analyzed descriptively. Two-way analysis of variance (Two-way ANOVA) on the other hand was applied on the raw data to reveal the statistical difference between wards, months and years in the reported incidences of the disease. Multiple comparison tests using Tukey HSD was also applied to further investigate which groups of variables differ significantly.



Source: GIS Lab KUST Wudil

RESULTS AND DISCUSSION

Demographic characteristics of TB patients

The distribution of gender and age group of TB patients is presented in table 1. The table reveals that male gender has higher incidence rate (53%) compared to their counterpart female (47%). This analysis shows that case notification rate is slightly higher among male than female. The result of this study is consistent withthefindings of other studies indicating slightly higher notification rates among males than females (Nwachukwu *et al.* 2009; Roza *et al.* 2012; Dandisso *et al.* 2015; Effiong and Nwakaego 2015; Ogbudebe *et al.* 2015; Ojiezeh *et al.* 2015). Some other studies (Aliyu, 2015; Tabatabaee *et al.* 2015; Brahmapurker *et al.* 2016; Audu *et al.* 2017;Huang *et al.* 2017; Omote *et al.* 2018) had much higher rate of notified cases among males ranging from 60.3% - 79.5%. The possible reason for the higher notification rates among males in this study are partly due to the fact that majority of the people in the area are Hausa/Fulani who are predominantly Muslims. In this community male interact more frequently with different people for example, in the market place, social events, religious gatherings among others. As such this group is expected to be exposed to TB infection than females who most of the time are at home. Effiong and Nwakaego (2015) relate higher case notification rates among males due to the stigma attached to the disease which seems to have more impact on the females than males. Another possible reason for a lower case notification rate among females is associated with their lower economic status, unemployment, lower access to health care and poor health seeking behavior (Nigeria National HIV Sero-prevalence Survey, 2010 cited in Effiong and Nwakaego, 2015).

Contrary findings were however noted by other researchers (Codlin *et al.* 2011; Sato *et al.* 2012; Gyar *et al.* 2014; Iroezindu *et al.* 2016) who showed higher rate of notification cases among females compared with males. Most of these studies relate high incidence of TB among females due to the co-infection with HIV which was higher in females than males.

Table 1: Demographic Characteristics of TB Patients

Variables	Frequency	percentage
Gender:		
Male	75	53
Female	67	47
Age group:		
< 20 years	11	7.75
20-39 years	64	45.05
40-60 years	50	35.21
>60 years	17	11.97

Source: Burji and Akilu memorial Hospitals, (2016)

Table 1 further displays the incidence of TB according to age group. The table reveals that infection of TB is highest (45%) among patients belonging to 20-39 years and lowest among patients who are less than 20 years of age. This result shows that prevalence of TB is highest among youths who are the most active part ofthe population. The possible reason for this is that they participate in various economic activities and therefore are exposed to numerous health risks. This finding is in line with the results of studies obtained by Gyar *et al.* (2014); Audu *et al.* (2017); Omete *et al.* (2018); who reported high incidence among 31-40 years, 27-39 years and 21-40 years respectively. Studies conducted by Aliyu (2015); Ogbudebe *et al.* (2015);Tabatabaee *et al.* (2015); and Huang *et al.* (2017); found that prevalence of TB was highest in age group15-24 and 25-34 years, 25-34 and 35-44 years, 25-34 and 35-44 years, 15-30 and 30-45 years respectively. The least prevalence of TB infection seen in age group less than 20 years could be due to their less participation in economic and other social gatherings.

Figure 2 presents the overall results of treatment outcome of TB for the period under investigation. From the result, successful treatment outcome was found to be 80%. Although high treatment success rate was achieved in the area of this study, the rate is lower than the national success rate of 85% (FMoH, 2009). The low success rate of treatment outcome as compared to national target in this area is serious setback to the goal of TB control programme. This result agrees with findings of previous studies conducted in Enugu by Dim and Dim (2013) and in Kano and Cross Rivers(Kingsley,2014) where reported success rates are lower than the national target. The result further indicates variation in the treatment outcome between genders with male having a lower success rate of 77% and female with slightly higher rate (82%). In this study, the variation in the treatment success rate between sexes is not exactly known. However, it could be a result of high compliance in taking drugs by the female gender compared to their counterpart male gender.

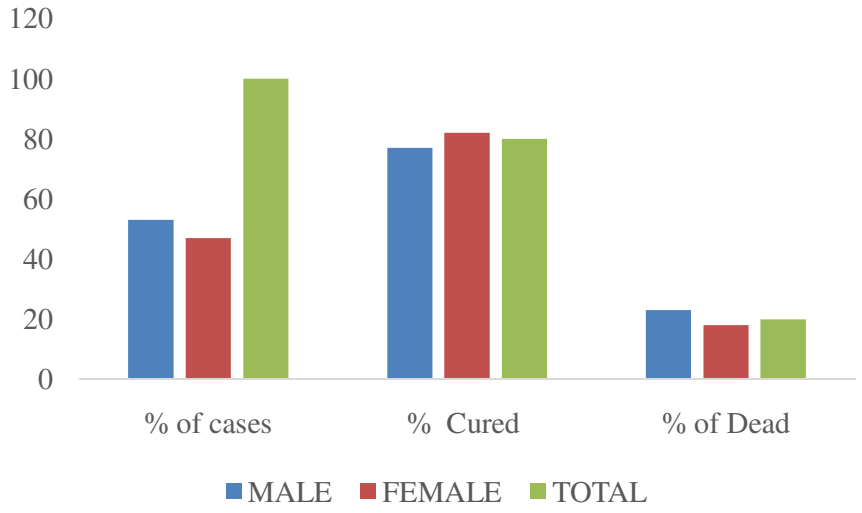


Fig. 2: Distribution of treatment outcome by gender

Spatial Distribution of Tuberculosis patients inMadobi LGA

The spatial distribution of TB cases in Madobi local government area from 2012 to 2015 is shown in Figures 3a-3e. The figures illustrate spatial variation in the occurrence of the disease for the period under investigation. In 2012 and 2014 Madobi ward was the only area with high reported cases while Galinja, Kubarachi,Yakun and Chinkoso are among the wardswith lowest reported incidence. The pattern of the distribution in 2013 and 2015 is somehow different from 2012 and 2014. Although Madobi ward still remained in high incidence region, Burji, Kwankwaso, Rikadawa and Kubarachi also emerged as high risk cells. Galinja, Kafin Agur and Yakun wards maintained their status of being in low incidence region.

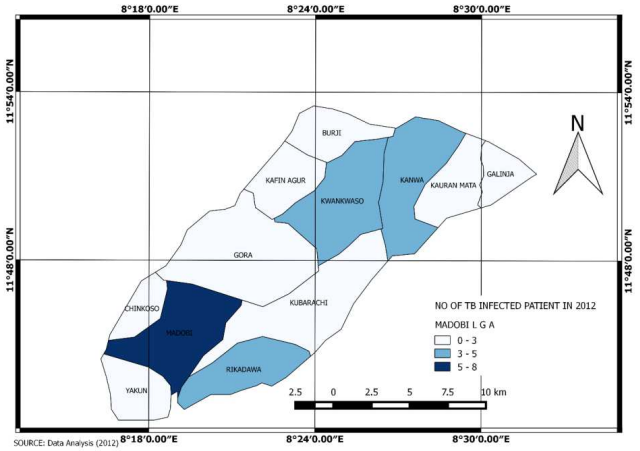


Figure 3a: Distribution of TB reported cases in Madobi LGA (2012)

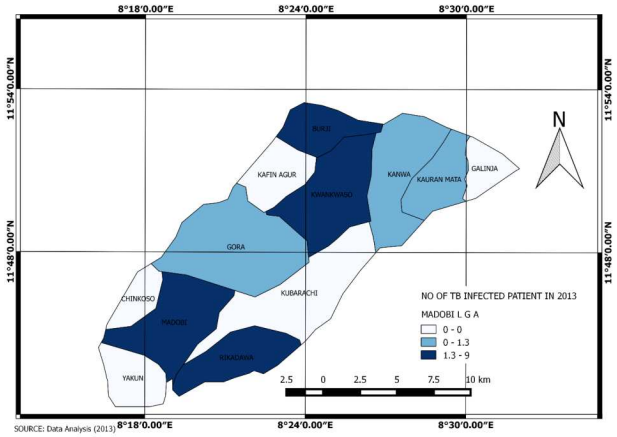


Fig 3b: Distribution of TB reported cases inMadobi LGA (2013)

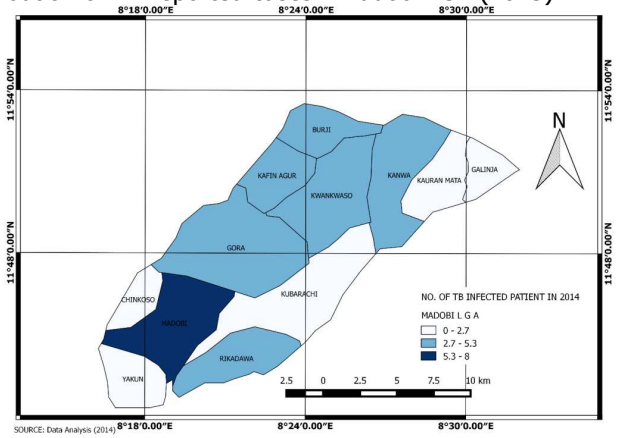


Figure 3c: Distribution of TB reported cases in Madobi LGA (2014)

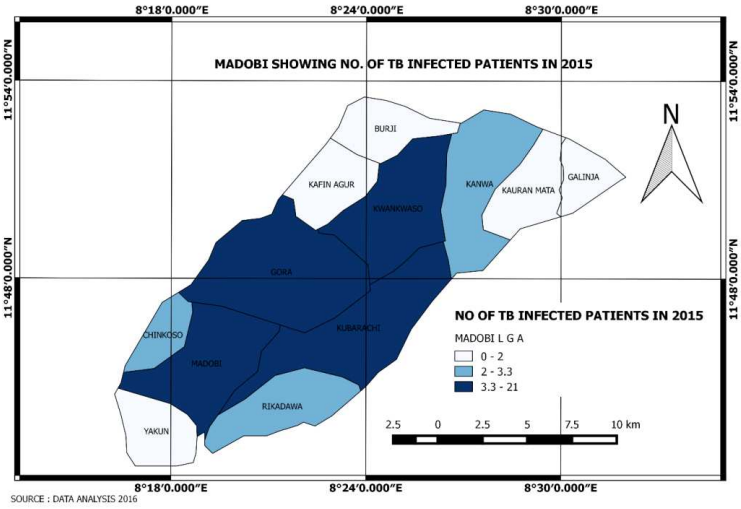


Fig 3d: Distribution of TB reported cases in Madobi LGA (2015)

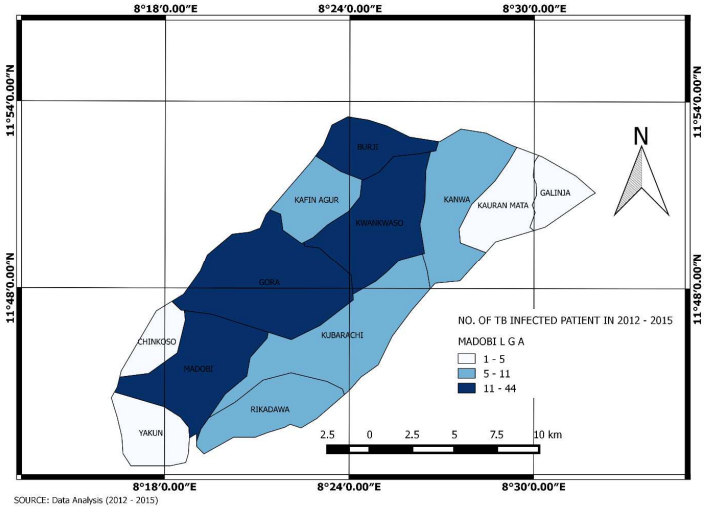


Fig 3e: Cumulative TB reported cases in Madobi LGA (2012-2015)

Cumulative incidence of tuberculosis reported cases in the area for the years under study is contained in figure 3e. The figure defined Madobi, Gora, Kwankwaso and Burji wards as the high incidence reporting regions. Chinkoso, Yakun, Kauran Mata and Galinja wards on the other handare considered as low incidence zones. The possible explanation for the high reported cases in Madobi, Gora, Kwankwaso and Burji wards could be due to the proximity to TB DOT centers. People in these wards can easily get access and present their cases to the facilities. In addition, these wards have high level of urbanization compared to others. Their inhabitants are likely to have high level of education which made them to be more aware about the disease,hence, report their cases to the nearby hospital. However, the low recorded cases in Chinkoso, Yakun, Kauran Mata and Galinja do not mean absence of the disease in the wards.This can be related to location of the wards on the border to other local government areas. Thus, patients may decide to consult other nearest DOTS center in neighboring local governments. Secondly, most rural dwellers due to their limited knowledge on diseases and their cultural believes prefer to use traditional medicine than the conventional drugs.

Annual Distribution of TB Reported Cases

A total of 142 tuberculosis cases were reported to the two DOTS centers between 2012 and 2015. The distribution as illustrated in figure 6 shows progressive increase in the reported cases. The year 2015 recorded the highest number of incidences (54 cases or 38%) while the year 2012 has the least reported cases (26 cases or 18.3%).

The increasing trendin the reported cases in the area can be attributed to increased awareness campaign in the area and also presence of another TB DOTS centre in Madobi and Burji wards.

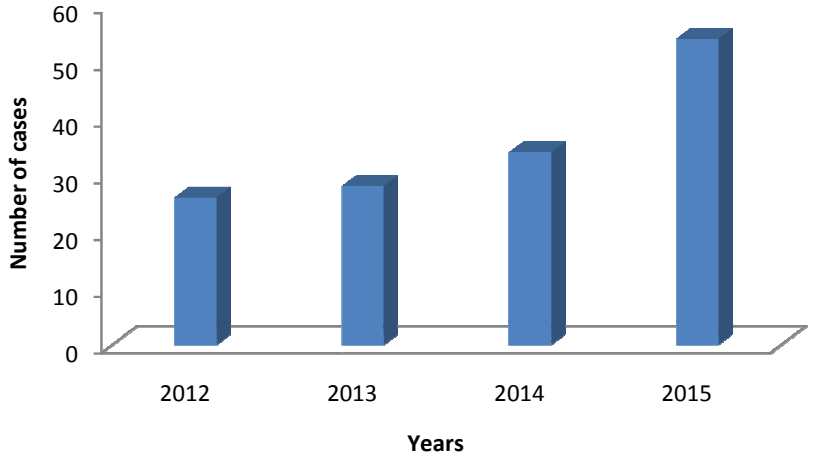


Fig 6: Annual reported TB cases in Madobi LGA

Mean Differences of TB Reported Cases using 2-way ANOVA

A two-way ANOVA between group analysis was conducted to explore the mean differences between dependent variable (TB reported cases) and independent variables (wards and years). The following Hypotheses were tested.

H_{o1}: There is no significance difference in the reported cases of TB between wards of investigation

H_{o2}: There is no significance mean difference in the reported TB cases between the studied years

H_{o3}: There is no interaction effect between wards and years

Table 2: Univariant Analysis of Variance between wards and years

Tests of Between-Subjects Effects

Dependent Variable: Incidenceoftuberculosi

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1271.833[a]	47	27.060	1.162E+31	.000
Intercept	840.167	1	840.167	3.607E+32	.000
Ward	822.833	11	74.803	3.211E+31	.000
Year	81.833	3	27.278	1.171E+31	.000
Ward * Year	367.167	33	11.126	4.776E+30	.000
Error	1.000E-013	48	1.000E-013		
Total	2112.000	96			
Corrected Total	1271.833	95			

a. R Squared = 1.000 (Adjusted R Squared = 1.000)

The result obtained as depicted by table 2 shows a strong statistical significance difference in the number of tuberculosis cases for wards (F = 3.21, P = 0.001). In addition, the result observed a strong significant statistical difference in the prevalence of the disease over the years (F = 1.17, P =0. 001).Furthermore, the interaction effect of two variables (wards and years) indicated a strong statistical difference (F = 4.77, P = 0.001). Therefore, the study rejects the stated null hypotheses.

Post Hoc multiple comparison tests using Tukey HSD was performed to further identify the level of significant difference between groups under study. Results verified that the only pairs of wards that did not differ significantly are: Chinkoso and Yakun as well as Kanwa and Rikadawa. However, the means of the remaining wards under study are significantly different. For the case of years, the mean differences were statistically significantly different.

CONCLUSION AND RECOMMENDATIONS

The study analyzed spatio-temporal distribution of TB reported cases in Madobi LGA. The paper concluded that TB cases are not equally distributed in both space and time. It was observed that high cases of TB concentrated in Madobi, Gora, Kwankwaso and Burji wards. The temporal analysis indicated a progressive increase of case notification rates of the disease from 2012 to 2015. Result from the Two – way analysis of variance (Two way-ANOVA) showed that, there is a significant statistical main effect in the reported cases of tuberculosis infection between wards and between years. Result of multiple comparison tests using Tukey HSD indicates that onlyKauran Mata and Chinkoso as well as Kubarachi and Rikadawa showed no significant difference in their cases. Moreover, the annual reported cases showed significant difference between years. The study recommends an urgent need for more campaign and awareness about the disease especially in the remote areas of the local government. This is to encourage people to report their health problems to the health care facilities as quickly as possible for proper treatment. Additional studies on other aspect of Tuberculosis, including behavioral, cultural practice and environmental factors that encourage the spread of the disease should be carried out.

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