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Application of GIS and Spatial Analysis to Investigate Factors Influencing Health Status of People in Mubi Metropolis

Nicolaus Y. Wamangra
Surveying and Geo- informatics,
Federal Polytechnic Mubi
Mubi, Nigeria

Babangida Baiya
Surveying and Geo-informatics,
Federal Polytechnic Mubi
Mubi, Nigeria

Salkushu Wapaburda
Surveying and Geoinformatics
Federal Polytechnic Mubi
Mubi Nigeria

***Abstract*: The factors influencing health status of people in Mubi metropolis wards was examined, where the suitability of Geographical Information Systems as a research tool was explored. Socioeconomic factors like employment and education were analyzed in order to measure the health status of people. These explanatory variables were analyzed by spatial analysis techniques. Reported ill-health cases as the dependent variable, was used in measuring the health of people. The result from the Global Moran's I was significant because it indicates the pattern of the dependent variable was clustered. The research shows how GIS spatial analysis in conjunction with socioeconomic data can be applied to examine the factors influencing the health status of people. The result can be used to inform the local planning process and the GIS method can be expanded into another local authority domains. The method presented in this research provide a generic approach for measuring the difference in the provision (for instance education and employment) for the various wards in Mubi metropolis.**

Keywards: Education; Employment; Health status; Ill-heath; GIS.

I. INTRODUCTION

New opportunities for public health administrators to enhance planning, analysis, monitoring and management of health systems have been created in the recent advances in geographical information and mapping technologies. Health mapping has evolved since mapping of cholera death by Dr. John Snow in mid-nineteenth century. [4]. Health is regarded as a resource not just a reason for living. The World health organization (WHO) defines health as a state of complete physical, mental and social wellbeing and merely the absence of disease or infirmity. When these conditions are not met, it is referred to as ill health [2]. Researches describe health as being physically fit, resulting to a healthy lifestyle as a resource and psychological stability. Ill health or ailment however, is a state of poor health [1].

Evaluating people's health status is a common phenomenon in many disciplines like psychology, epidemiology and demography. Previous research has shown that the way people perceive and evaluate their health gives additional information to that obtained from other measures [1]. Also evaluation of health is considered as a legitimate indicator of overall health status which provides valid, reliable and cost effective measures of health assessment, especially in studies where other forms of health information areas are lacking [13].

Socioeconomic factors such as educational qualification among others, influences people's health status. [10]. describe a relationship between socioeconomic measures and health, as wealthy people are healthy whereas low income, low education and less prestigious jobs, suffer poor health condition. Similarly, epidemiological research by [1]. shows that impact of socioeconomic measures on health seems to be facilitated due to psychological and social factors, such as one has perceived social class in the society relative to others. [1,16]. suggested that individual's perception on social status influence ill health significantly than equal socioeconomic factors. Hypothesis of psychological health disparities suggests that individual social status is principally linked with perception of relative class [11]. This is the main reason why health of the less privileged people suffers.

The term ill health is strongly correlated to social measures. In fact, [17]. states that highly learned people tends to consider their health in an optimistic way even if they have other similar features like languages, ethnic and religion back ground. Also, according to [9]. Population Health Promotion Programs and policies can support the development of healthy environment, because healthy environment is essential to human health. Thus the study tends to understand ill health and analyze the influence of educational qualification and employment on ill health.

II. AIM

The aim of this project is to examine the effect of socio-economic factors with emphasis on educational qualification and employment on ill health of people in Mubi metropolis, as well as to explore the suitability of geographical information system as a research tool in the analysis of data.

III. OBJECTIVES

To achieve the above goal, the following objectives will be conducted:

i. To determine the correlation between the dependent variable and the explanatory variable
ii. To examine the influence of level of education and employment on people's health in Mubi metropolis
iii. Determine the areas (Wards) whose health is mostly influenced by level of education and employment.

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IV. 1.2 JUSTIFICATION WHY THE TOPIC IS WORTHY OF INVESTIGATION

The issue of ill health is a global concern. This is because ill health greatly affects individual's characteristics like education and wealth. [8]. state that ill health is a factor influencing child's enrolment in school and socioeconomic factors like livelihood and kinship. In addition, improved health leads to child's better physical, cognitive and psychological development. However, ill health has adverse economic impacts on individuals. It is one of the major causes of low investments in household. In recent study by [14]. it is argued that ill health is closely related to poverty through it savings and portfolio decisions. Many days of works could be lost due to ill health and consequently reduced individual's earnings or even lead to work dismissal. Likewise, [12]. describe that healthy people have advantages over ill health people although the level of disadvantage varies from one individual to another. This topic was therefore worthy of investigation because ill health has severe effects on entire human socioeconomic indicators. [20]. describes the relationship between ill health and unemployment as existence of one will lead to the occurrence of the other. Unemployment itself might be the basis for poor health while ill health is determinant of unemployment .Subsequently, this topic was important to investigate because it focuses on understanding ill health and factors influencing it in Mubi metropolis. Consequently, this research topic is significant to investigate since it is aim at identifying the factors influencing ill health and it is essential for public health planning strategies

V. 3.0. METHODOGY

VI. 3.1 STUDY AREA

Mubi is one of the oldest towns in Adamawa State of Nigeria, located on geographical coordinate $10^0\ 16'\ 18''$ North, $13^0\ 16'\ 14''$ East and situated Northeast of Nigeria (figure1). Mubi metropolis consists of seven (7) geopolitical wards, namely: Lokuwa, Sabon layi, Kolere, Gude, Lamurde and Yelwa wards shown in fig.1. [6]. provides that Mubi metropolis has a total population of 128,900. Mubi shares boundary with Michika on the Northeast, Hong on the West, Maiha on the South and Cameroun on the East.

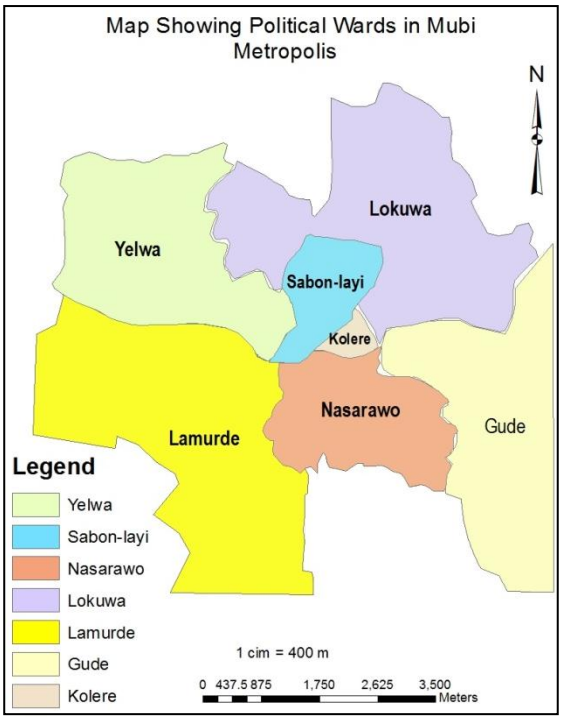

Fig.1 Political wards in Mubi metropolis

VII. 3.2 DATA COLLECTION

The data used in this analysis were acquired through primary and secondary sources, from various organizations. There are two explanatory variables (educational qualification and Employment) and one Independent variable (ill health cases) used in this analysis. Educational qualification and employment was obtained from various wards through questioner administration, and the ill health cases reports were acquired from General Hospital Mubi. Furthermore, the boundary map of Mubi metropolis wards, were obtained from Survey department, Federal Polytechnic Mubi

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in hard copy format. The map was digitized using ArcGIS software, and georeferenced.

VIII. 3.3 DATA ANALYSIS

IX. 3.3.1 MATERIALS USED:

The research was carried out using spatial analysis. To achieve a reliable result, the following materials were employed in the data analysis. Geographical Information Systems (GIS) software used are: ArcGIS10, Microsoft Excel, Microsoft word, which was run with the aid of Acer laptop Computer compatible for this software.

X. 3.3.2 APPLICATIONS OF GIS IN HEALTH

Health administrators, including policy makers, epidemiologists, medical officers and statisticians have used GIS. [23].Some of the applications of GIS in public health include among others:

- Find out geographical distribution and variation of diseases
- Map out populations at risk and stratify risk factors
- Identify gaps in immunizations
- Forecast epidemics
- Route health workers, equipment and supplies to service locations
- Locate the nearest health facility.
- Document health care needs of a community and assess resource allocations
- Plan and target interventions
- Monitor diseases and interventions over time
- Monitor the management of health centres
- Publish health information using maps on the Internet

XI. 3.3.3 SPATIAL ANALYSIS

Spatial analysis is a technique used to locate clustering within small areas. Cluster and outlier analysis was carried out (Anselin Local and Global Moran l), using the ArcGIS10 package. The result to explain the Anselin Local and Global Moran l is shown in [Table1.].

```
Executing: HighLowClustering test_health Ill_health_case_ NO_REPORT
INVERSE_DISTANCE EUCLIDEAN_DISTANCE NONE # #
Start Time: Tue Nov 24 10:58:57 2015
Running script HighLowClustering...
WARNING 000845: A minimum of 30 input features for analysis is ideal.
WARNING 000853: The default neighborhood search threshold was
2288.88305511212.
      General G Summary
Observed General G:  0.000199
Expected General G:  0.000223
Variance:            0.000000
z-score:             -0.207995
p-value:             0.835233
Writing html report....
C:\Users\user\Desktop\testing_health\GeneralG_Result.html
Completed script HighLowClustering...
Succeeded at Tue Nov 24 10:58:58 2015 (Elapsed Time: 1.00 seconds)
```

Table 1. Cluster Analysis

A. 3.3.4 Regression models

Relationships between Ill Health as dependent variable, educational qualification and employment as explanatory variables were modeled by using conventional ordinary least squares (OLS) and geographically weighted regression (GWR) analysis. The first one was fitted to the whole study region (global OLS), the later used the location information for each observation and allows the model's parameters to vary in space. The result obtained from OLS is shown in [Table 2.]

The ordinary least squares methods (OLS) use the simple linear model:

$$y=a+\beta*x+\varepsilon \qquad (1)$$

where a is the intercept of the line on the y axis (where $x = 0$), β is the slope coefficient for explanatory variable x, and ε is the deviation of the point from the regression line. Fitting the best-fit regression model incorporates the problem to find a and β so that the total error Σ εi2 is minimized

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Table 2. Ordinary Least Square result

Summary of OLS Results

Variable	Coefficient	StdError	t-Statistic	Probability	Robust_SE	Robust_t	Robust_Pr	VIF [1]
Intercept	62.702562	4.428843	14.157774	0.000000*	2.344959	26.739301	0.000000*	--------
EDUCATED___	-0.447760	0.080396	-5.569456	0.001812*	0.034526	-12.968686	0.000000*	3.351392
EMPLOYED___	-0.248313	0.124042	-2.001853	0.115836	0.067339	-3.687495	0.019322*	3.351392

OLS Diagnostics

Number of Observations:	7	Number of Variables:	3
Degrees of Freedom:	4	Akaike's Information Criterion (AIC) [2]:	37.041824
Multiple R-Squared [2]:	0.978259	Adjusted R-Squared [2]:	0.967388
Joint F-Statistic [3]:	89.991635	Prob(>F), (2,4) degrees of freedom:	0.000473*
Joint Wald Statistic [4]:	807.659303	Prob(>chi-squared), (2) degrees of freedom:	0.000000*
Koenker (BP) Statistic [5]:	0.689646	Prob(>chi-squared), (2) degrees of freedom:	0.708346
Jarque-Bera Statistic [6]:	0.633348	Prob(>chi-squared), (2) degrees of freedom:	0.728568

This study however, acknowledges that when modeling the spatial Health relationship, one should take into account that one has to deal with a phenomenon of non-stationarity of this relationship. Non-stationarity means that the relationship between variables under study varies from one location to another. Geographically weighted regression (GWR), a Local regression techniques which help to overcome the problem of non-stationary and calculate the regression model parameters varying in space [7].

Geographically weighted regression (GWR) is a method which has been improved over the traditional ordinary least square regression. It is a local regression technique that allows the model parameters to vary across the space, [21]. In the case of health issues with different manifestation due to environmental factors and changes in climate, it is incorrect to hold that the same linear relationship is appropriate in all places. Although the local technique does not allow extrapolation beyond the region in which the model was established, it does allow the parameters to vary locally within the study area and may provide a more appropriate and accurate basis for descriptive and predictive. [18,21]. [Table 3.] shows the result from GWR.

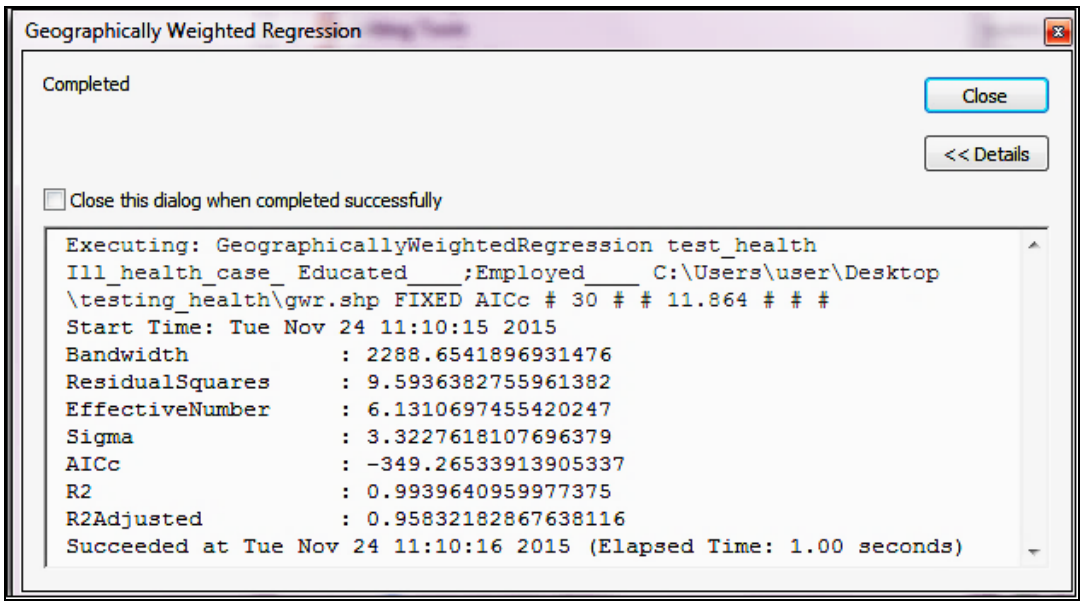
The estimation of the parameters for two independent variables with GWR is given by the equation:

$$= \beta \mu \nu + \beta \mu \nu + + \beta \mu \nu + \varepsilon \; n \; n \; y \; (\; , \;) \; (\; , \;) x \; ..... \; (\; , \;) x$$

0 1 1 (2)

The variable x represents a regression point, d as shown in fig. 3. is the distance between regression point *i* and data point *j*, *ij w* is the weight of data point *j* at the regression *i*.

Table 3. Geographically weighted regression result



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XII. 3.4 DEFINITION OF VARIABLES

Dependent Variable

Y_1 – Percentage of People reported ill health

Explanatory Variables

X_1 – Percentage of educated people per ward

X_2 – Percentage of level of employment of people per ward

XIII. 4.0 RESULT AND DISCUSSION

The analysis focuses on issues of factors influencing health status of people in Mubi metropolis. This involve the use of GIS spatial technique such as Anselin Moran's 1 and Geographically Weighted Regression, also focuses on how level of education and employment can be used to measure the influence of people's health. Various maps were used to study spatial dependency. The research question was to find out whether there is correlation between education, employment and health status.

XIV. 4.1. ORDINARY LEAST SQUARE (OLS) MODEL RESULTS:

There are six important checks that should be considered to insure that an OLS model is properly specified, before it can be trusted. These includes: Signs of the coefficient, Redundancy in explanatory variables, Statistical Significance of the Explanatory Variables Coefficients, Jarque-Bera Test, Model Spatial Autocorrelation, Model Performance, and Koenker Test. A positive signed coefficient indicates a positive relationship and a negative signed coefficient indicate negative relationship with the independent variable. This study as seen in [Table 2.] indicates that Education level and Employment are negatively related with Ill-health, with stronger relationship with Education level. This suggests that when number of educated people is high, number of ill-health cases will be low, and vice versa. An asterisk next to each variable probability indicates that the coefficient is significant. It is identified when Variables Inflation Factor (VIF) value for any of the variables is close to 7.5 or greater, which suggest that smaller VIF value is better as proposed by [3].The t-statistics test the hypothesis that the value of each coefficient estimate is not significantly different from zero (this is, their values are large enough to assume that they are not zero in the data population where the samples are drawn). Observing the t-statistics of each variable coefficient estimate with VIF 3.351 in [Table 4.]., shows that level of education and employment coefficient estimate are statistically significant. Literature such as in the regression analysis of [3]. showed that, for a result model to be viable or trusted, the Jarque-Bera statistics should NOT be significant; that is, it should not have an asterisk next to its value. [Table 4.] shows Jaque-Bera Statistic 0.633348 without an asterisk, indicating that the OLS model can be trusted. The Jarque-Bera test measures the values from a regression model to determine whether the residuals are normally distributed (Bell curve shape) or not. The best expected result is to have the Jarque-Bera as non-statistically significant, as shown in the spatial Autocorrelation report in fig. 3, since being significant indicates existence of bias in the model. This view is supported in the works of [3].

Table 4. Ordinary Least Square result

Summary of OLS Results

Variable	Coefficient	StdError	t-Statistic	Probability	Robust_SE	Robust_t	Robust_Pr	VIF [1]
Intercept	62.702562	4.428843	14.157774	0.000000*	2.344959	26.739301	0.000000*	--------
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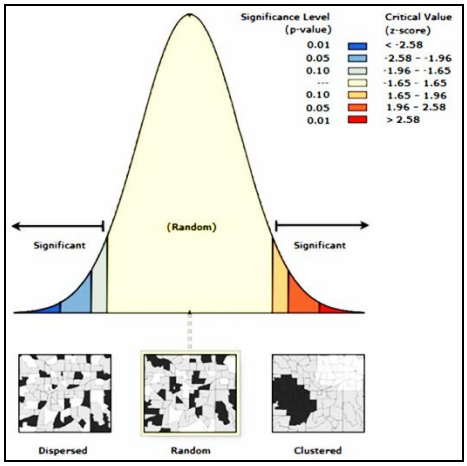

Fig. 2. OLS Spatial Autocorrelation Report

Given the z-score of -0.17, the pattern does not appear to be significantly different than random

The adjusted R-Squared (R^2) indicates the dependent variable variation has been explained by the model and value ranges from 0 to 1.0. Generally, R^2 value of 0.5 or higher indicates a useful explanation of the variation; however, a good value of R^2 will depend on what is being modeled. The R^2 from this research OLS model is given as 0.978 which measures the amount of variation explained by the variable; therefore 97% is determined by the predictor variable, 3% is caused by something else. The adjusted R^2 is 0.967; this shows that 96% of the independent variables can predict the model as shown in [Table 4.] According to literature as explained above, the value of the R^2 produced by the model is reasonable to accept that the model has explained a good variation of the dependent variable.

A. 4.2 Geographically Weighted Regression (GWR) Model Results:

When OLS (global model) is compared with the results of GWR (local model), the global R^2 is 0.97 while the result of R^2 of the GWR model is 0.99. This indicates strong improvement of R^2 in the GWR model. Choosing Akaike's Information Criterion (AICc), as the measure for goodness of [15]. fit of the model to the data, the value of AICc in the global model (OLS regression) is 37.042, and the local model (GWR) value is -349.27, indicating an evidence of improvement in the fit of the model to the data, although in this case, is a weak improvement. Geographically Weighted Regression (GWR) has proved great improvement over OLS in examining the dynamics of ill-heaith as a non-stationary factor. The assumption that spatial non-stationarity and scaling from global to local modelling will significantly improve the prediction power of the model has been supported.

This research has revealed that Sabon-layi ward has the highest reported ill-health cases. On the other hand, this ward has the lowest number of employed and educated people as shown in [Table 5.] Furthermore, Kolere ward has the lowest percentage of ill-health reported cases, with the highest percentage of the corresponding employment and educated people. Generally this study shows that employment education has great impact of people's health status. The investigation also reveals that low educated people tends to suffer poorer health condition, while highly educated people tend to be in good condition of health.

XV. TABLE 5. PERCENTAGE OF ILL-HEALTH, EMPLOYED AND EDUCATED PEOPLE IN MUBI METROPOLIS POLITICAL WARDS

Ward	Ill-health case%	Educated (%)	Employed (%)
Lokuwa	13.00	65.00	65.00
Kolere	5.00	94.00	59.00
Lamurde	11.00	72.00	76.00
Nasarawo	8.00	85.00	79.00
Gude	3.00	94.00	76.00
Sabon Layi	43.00	29.00	34.00
Yelwa	38.00	32.00	42.00

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XVI. CONCLUSION

This study has revealed that Sabon-layi ward has the highest reported ill-health cases, Kolere ward has the lowest percentage of ill-health reported cases. Nasarawo ward has the highest percentage of employed people, while Sabon-layi has the lowest percentage of employed people. Gude(Worupatuji) and Kolere wards have the highest percentage of educated people, while Sabon-layi has the lowest percentage of educated people. Generally this study shows that employment and education has great impact on people's health status.

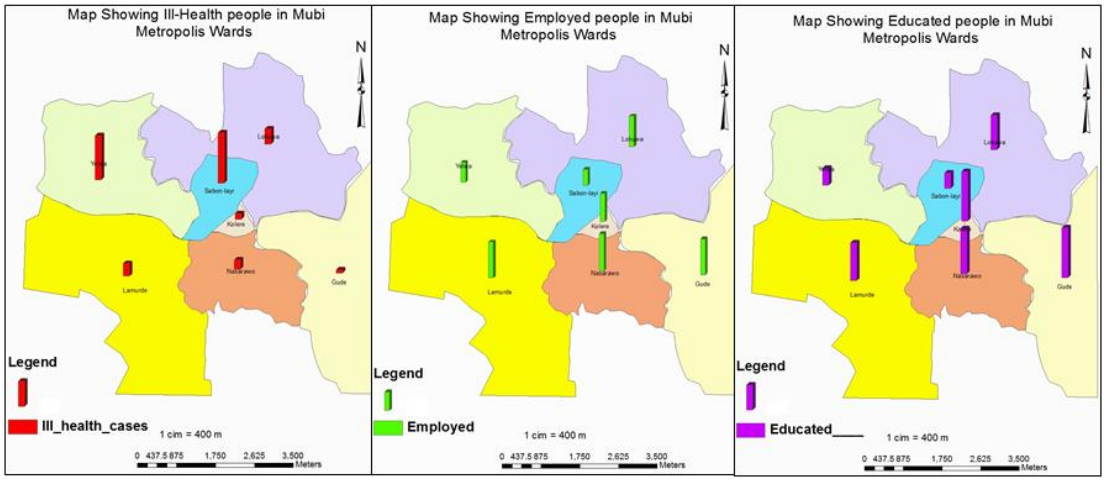

Fig. 3. Percentage of ill-health, employed and educated people in Mubi metropolis political wards

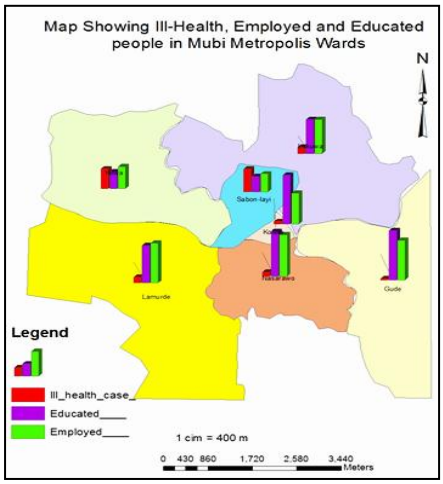

Fig. 4. combined percentage of ill-health, employed and educated people in Mubi metropolis political wards

A. Recommendation

This research considered only two factors that influence health status of people in Mubi metropolis; therefore there is need for the potential extension of the study in the following areas:

There is need to examine these factors considering the various factors level of education from secondary schools certificate to PhD certificate, because there is significant correlation between health status of people and education.

There is need to examine these, bearing in mind the categories of employment such as self-employed, government employed or employed by nongovernmental organization. This is because of the fact that an investigations on health status and employment shows that there is strong positive relationship between the variables [5,19].

Also there is need to examine other socioeconomic factors such as marital status, age categories and ethnicity because of it strong relationship with health status of people.

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