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QUALITY OF LIFE AND HEALTH SECURITY AMONG THE SLUM NEIGHBOURHOODS OF MIDNAPORE MUNICIPALITY, INDIA

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Abstract

The concept of quality of life and health security is multidimensional and dynamically varies across places with respect to physical, socio-economic and psychological environments. Health security can improve quality of life, health status, life expectancy and adaptive capabilities as well as prevent disease progression. Slums are examples of the most vulnerable localized communities in the urban morphology that face a range of difficulties. This study aimed to examine the spatial distribution and correlation of and between the quality of life and health security among the slum neighbourhoods of Midnapore municipality as well as to find the similarity among the methods employed under study. The modified quality of life (QoLI) and health security index (HSI) was developed using inductive and deductive methods with the available datasets through a questionnaire survey. The results of the analysis show that slum neighbourhoods are more vulnerable with least prepared for their health security while living with decent to moderate quality of life. The ordinary least square (OLS) method was examined among the indicators of quality of life and health security showing a statistically significant correlation. This prototype study may help the researcher for further study at a local scale with the specific method whenever needed. Moreover, it is suggested to the local authority, policymakers, NGOs and district planning commission that more community participation, awareness creation and planning interventions can improve the place inequalities of the quality of life and health security among the slum neighbourhoods.

1. **Introduction**

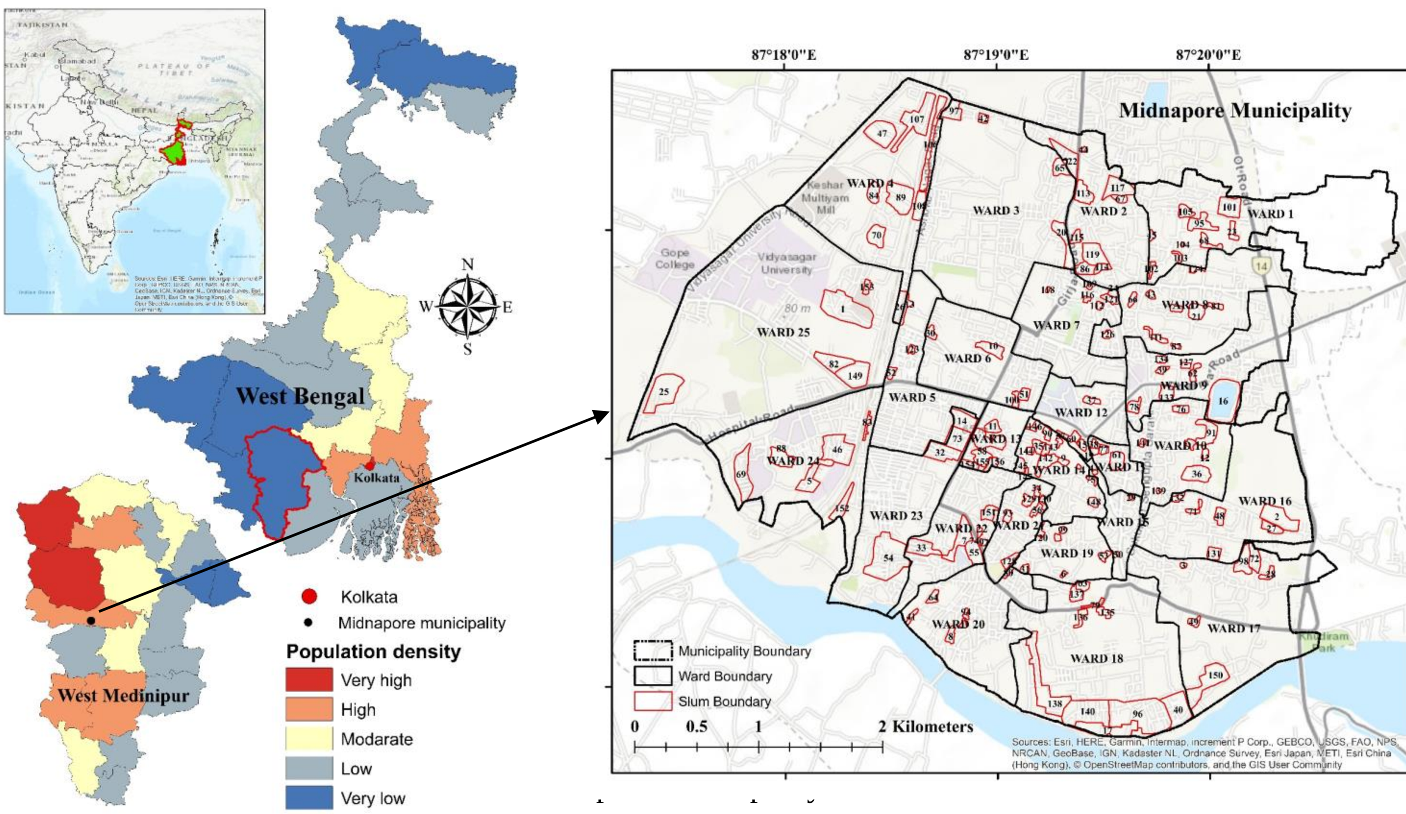
The World Health Organization (WHO, 2020) defines the quality of life as "an individual's perception of their position in life in the context of the culture and value systems in which they live and concerning their goals, expectations, standards and concerns". Quality of life is the degree to which human beings can live within a healthy, comfortable environment and can take pleasure in their livelihoods. Quality of life is multidimensional and has become more holistic which includes socio-economic, emotional, physical and mental health, recreation and leisure time, material, built environment, employment, education, safety, security and freedom and overall healthcare accessibility and social well-being. However, perception of quality of life is highly subjective because it varies from place to place even person to person. For example, rural households with standard income may perceive the standard quality of life as the households living in urban areas. In contrast, health security is a recent concern in the Covid-19 pandemic. According to the World Health Organisation (WHO, 2020), health security encompasses the “activities required to minimise the danger and impact of acute public health events that endanger the collective health of populations living across geographical regions and international boundaries”. Public health security is defined as the activities and measures across geographical regions that reduce vulnerability to infectious diseases and the impact of acute public health incidents caused by overpopulation growth, rapid urbanization, environmental degradation, and the misuse of antimicrobials (Stoeva 2020; Paranjape and Franz 2015). The spread of diseases, pandemics, and epidemics have become a recent global issue, requiring essential resources for rapid and effective healthcare services to the vulnerable groups especially in the developing world (Feldbaum et al. 2006; Chiu et al. 2009). The Global Health Security Agenda advocates health security, aiming to improve detection, prevention, and response to infectious diseases through the initiatives of public health surveillance among the states in the world (Blazes et al. 2016). The shifting nature of human society and severe natural disasters may cause emerging infectious diseases with pandemic potential which demand equal distribution of resources and healthcare facilities and services (Ganapathy et.al 2016). Therefore, every state has a liability to preventing health insecurity and ensures the wellbeing of their populations (Aldis 2008). India has been initiatives to protect health insecurities by launching the Nation Health Protection Scheme (NHPS) 2018 as a part of the Ayushman Bharat Programme, which aiming of covering

500 million people targeted at offering Rs. 5 lac to every BPL family for institutional treatment (R. Srinivisan, 2020).

Health security is closely related to the quality of life of a group of people in a particular geographical region. For example, a household with standard quality of life is least vulnerable to health insecurities. Low standard quality of life and health insecurities are common in urban slums (Hamren et al. 2014) in India than their rural counterparts. In India, the emergence of urban areas would also promote regional disparities in towns or cities due to population explosion and the poverty-induced influx of rural to urban migration is characterised by uneven growth (Premi 1991; B. Ray 2017). The nature of urbanisation is well described as over-urbanisation or pseudo-urbanisation (Breese 1969; B. Ray 2017; Datta 2006; Kundu 1983; Yadav 2015; Sastry 2009) may cause by the weak economic foundation and rural push principal components (Breese 1969). The pseudo-urbanisation of India would promote decay of urban environment, deterioration of urban services, poverty, unemployment, growth of slums and an overall degradation in the quality of urban life (Sen and Ghosh 1993; Renzaho et al. 2016; Darkey and Kariuki, 2013). India is urbanising at a steady rate with the growth of its population. The number of urban agglomerations and/or towns within ten years (from 2001 to 2011) has significantly increased is about 2774 with a growth rate of 3.35% (Census of India 2011). The trends of urbanisation in India is towards large cities, so-called class-I cities (having a population of more than 1,00,000) characterised by the continuous growth of population (Kundu 1983) than the all other class of cities. It is well known that urbanisation in developing countries like India is always with inadequate development of infrastructural facilities characterised by rurban migration influx and excessive concentration of population in class I cities. Class-I cities of India have reached saturation levels to their carrying capacity of population (Kundu 1997), which cannot absorb the rural migrants. Therefore, urban areas show the growing imbalance and inequalities in terms of population distribution, infrastructural facilities including housing, educational facilities, health facilities, water supply, sewerage, transport facilities and other basic amenities, solid waste management, pollution control with the enactment of law and order. This leads to the proliferation of filthy slums in which rural illiterate, unskilled and low wages migrants are living with the lack of standard shelter, drinking water, electricity, sanitation etc (Datta 2006; Nayak 1962; Kundu et al. 1999; Ghosh 2013; Alaazi et al. 2020) generates the low quality of life and health insecurities (Pyne and Ravindran 2020). In India, about 40% slum population live in class-I cities with multiple deprivations such as basic amenities, sanitation, room density, land tenure, unemployment, under-employment, malnutrition, morbidity, mortality, higher incidence of crime and social unrest. Any groupings of these principal components are unfavourable to health and hygiene and lack of safety and security (Mudey et al. 2017; Komalawati& Lim 2020; Rains et al. 2018). Slums are also exposed to communicable and chronic diseases like respiratory diseases, gastrointestinal disorders, skin diseases, malaria, fever and tuberculosis, etc due to unhygienic living conditions and inadequate healthcare services. Thus, slums are believed to be deprived groups regarding socio-economic, environmental, healthcare services and living conditions (Roy 2016). However, from the perspectives of social exclusion and deprivation, slum dwellers have a strong social cohesion (B. Ray, 2016; Onda et al. 2019) and a network of social connections. Hence, all these principal components have significantly contributed to the quality of life and health security. This study investigated 1) the quality of life and health security among the slums of Midnapore city 2) the relationship between quality of life and health security in the study area.

2. **Study site**

The city of Midnapore municipality is a fast urbanising city of Paschim Medinipur in West Bengal covers an area of 20 km^{2}and situated in 22º 23´ 42´´ N to 22 º 26´ 30´´ N and longitude 87 º 17´ 30´´E to 87 º 20´ 30´´E along the north bank of the river kasai. (Fig.1), where almost having a population of 1, 68,496 as per the Census of India 2011 as well as density varying from 3006-29000 per km^2. In contrast, the slum population was 50,943 (Midnapore municipality, 2012) which thus constitutes 30.09% of the total population of this city distributed across 25 wards under Midnapore municipality. The concentration of slums is high in the central, northwest and northeast parts of the city. These slums pockets or bastees are legally recognised as a notified slum by the municipal authority of Midnapore with providing basic services such as water, garbage removal, electricity, and healthcare facilities. The influxes of rural migrants with different cross-cultural ethnic groups are gradually expanding slum areas without available basic resources which in turn play a vital role in the quality of life and health security.



3. **Data and Materials**

The concept of quality of life and health security is multidimensional, includes all facets of human life within their living environment. Different theories have measured quality of life and health security based on different concepts of well being, quality of life, safety and security (Cobb 2000). UN-Habitat and WHO have been measured QoLI and global HSI based on a set of indicators. For the study, both subjective and objective sets of indicators have been selected for the development of QoLI and the HSI in the context of the study area. In addition, we have been added a few other components or variables beyond the recommended elements by the WHO due to the distinctive nature of the study area based on empirical observation and focus group discussion. The final set of variables or indicators were chosen for the study summarised in Table 2 and Table 3. The broad-ranging indicators include a household's socio-economic conditions, physical and psychological health, built environment, availability of basic amenities, healthcare facilities, accessibility and services and social relationships to their living environment.

This study adopted different inductive and deductive approaches for the development of QoLI and HSI in the context of the distinct socio-physical environments of the study area (Cutter et al. 2003; Hummell et al. 2016; Aksha et al. 2019; Kirby et al., 2019; Roy, 2016; Yoon, 2012). To construct both the index, we collected socio-economic, demographic, built environment and healthcare-related data through the well-structured questionnaire survey from 156 notified slum neighbourhoods. We have used a simple random sampling method, and 10% of the entire slum households i.e. roughly 800 households of the study area were sampled. Comprehensively, based on the population composition of the slum neighbourhoods, households (ranging from 5 to 10 households) in each slum neighbourhood were randomly selected for the survey. From the selected households, we have targeted household heads or other senior members for the interview. At the time of the survey, the average age of the household heads or other senior members was 48.02 years (Table 1). Using all accessible data from the survey, Table 2 and Table 3 provides the mean and standard deviation of the selected variables or indicators used to construct the QoLI and HSI. The selected households are characterised by different socio-economic, caste, religion, ethnicity, did not regard as any particular community due to analytical problems. According to the survey, households experiencing yearly health shocks are 2.45 persons with an average family size of roughly 5 persons as well as 3.54 literate persons. However, working persons per family are 1.43 with a per capita income of INR.2526.72 (Table 1).

Table 1: Respondent's characteristics

Characteristics	**Average**
Health shock experiences (yearly)	2.45
Monthly per capita income (rupees)	2526.72
Household's size (persons)	4.9
Age of household head (yrs.)	48.02
Literate in a household (persons)	3.54
Employed in a household (persons)	1.43

Table 2: Variable used for analysing the quality of life

Variables		Description	Mean	Standard deviation
Housing condition	Pucca floor	Percentage of households have pucca floor	70.83	22.689
	Pucca wall	Percentage of households have pucca wall	79.04	35.338
	Pucca roof	Percentage of households have pucca roof	56.15	26.772
	Room dampness	Percentage of household face room dampness	45.58	23.314
	Overcrowding	Percentage of households faces overcrowding	49.57	12.594

	Separate bathroom	Percentage of Households has a separate bathroom	73.59	23.027
	Separate kitchen	Percentage of Households has a separate kitchen	63.59	25.118
	Ventilation facility	Percentage of Households can ventilate the house freely	77.63	21.285
	Fuel used for cooking	Percentage of households used LPG for cooking	74.42	22.353
Access to drinking water	Drinking private tap water	Percentage of households use private tap water	11.54	16.071
	Drinking public tap water	Percentage of Households use public tap water	85.13	17.579
	Water purifier	Percentage of Households has a water purifier	7.50	12.579
Economic condition	BPL	Percentage of households under Below Poverty Line(BPL)	30.06	22.041
	Per capita income	Average per capita income in the study area	31.17	19.115
	Any loans taken	Percentage of households carry the burden of the loan	44.23	25.094
	Unemployment rate	Percentage of the unemployment rate	47.30	11.098
Occupation	Earning members associated with the service sector	Percentage of Earning members associated with service sector	14.77	16.661
	Earning members in small business and informal sector	Percentage of Earning members associated with small business & informal sector	36.61	22.721
	Earning members in daily wage labour	Percentage of Earning members associated with Daily wage labour	36.43	27.773
Availability of food and nutrition	Per capita food expenditure	How much is spent on food and nutrition per capita	70.71	20.794
House ownership	Migrated	Percentage of households migrated from different places	13.21	17.960
	Own house	Percentage of households have own house	81.15	18.067
Asset	Owning TV	Percentage of Households have TV	79.68	21.325
	Owning cycle	Percentage of Households have Cycle	87.50	16.796
	Owning vehicle	Percentage of Households have a vehicle	36.22	24.133
	Owning Phone	Percentage of Households have phone	93.27	12.295
Education	Distance to nearest school/institution	Whether there is a school within 1 km	49.74	24.573
	Literacy rate	Percentage of population who can read and write	72.23	15.701
Health and social care	Distance to nearest health care centre	Whether there is a health care centre within 2km	35.71	22.321
	Use sanitary napkin	Percentage of women households use a sanitary napkin	39.94	18.474
	Leisure time with family	Percentage of people spend their leisure time with family	5.71	11.535

	Leisure time watching TV	Percentage of people spend their leisure time watching TV	25.77	18.701
Sanitation	Sewerage system	Percentage of Household has a poor sewerage system	11.41	18.012
	Availability of public toilet	Percentage of households use a public toilet	87.56	16.279
	Condition of drain	Percentage of households facing poor drainage system	78.46	20.888
	Solid waste management	Percentage of households scattered waste material	25.38	24.531
	Facilitated solid waste collection	Percentage of household facilitated solid waste collection daily	10.45	13.835

Table 3: Variable used for analysing health security

Variables		Description	Mean	Standard deviation
Accessibility of health care centre	Distance to nearest health care centre	Whether there is a health care centre within 2km	35.71	22.321
	Source of transport provide reaching the health care centre	Transportation to health care centre arranged by family	81.79	23.514
Awareness about health	Satisfaction level of health infrastructure	Percentage of households satisfied health infrastructure facility	55.71	27.241
	Awareness about health and nutrition	Percentage of households aware about health and nutrition	33.72	20.921
	Taken regular health check-ups and medicine	Percentage of households taken regular health check-ups and medicine	11.41	14.567
	Maintains personal hygiene	Percentage of households maintain personal hygiene	55.91	6.020
	Disease prevention equipment’s	Percentage of households use disease prevention equipment’s	24.62	8.652
	Perception of family health	Percentage of people realize about family health	76.67	18.917
Food and nutrition	Prevalence of malnutrition	Percentage of people are malnourished	13.654	6.6864
	Food insecurity	Percentage of people are suffering from food insecurity	70.71	20.794
Accommodation and poverty	BPL	Percentage of households under Below Poverty Line (BPL)	30.06	22.041
	Drinking water treatment	Percentage of household care for drinking water	18.27	16.575
	The environment of housing condition	The housing environment of the households	58.55	8.974

Prevalence of disease	Interval of sickness	Often suffering in the prevalence of diseases	15.90	17.260
	Infectious disease	Percentage of infectious disease	38.61	23.033
	Chronic disease	Percentage of chronic disease	10.52	16.445
	Hiding disease	Percentage of Hiding disease	1.78	5.234
Health facility	Health card	Percentage of households have a health card	50.96	23.162
	Health insurance	Percentage of households have health insurance	22.76	19.824
Gender-based violence	Women violence	Percentage of households facing women violence	16.92	14.881

4. Methodology

This study was analysed the quality of life and health security of slum neighbourhoods in the Midnapore municipality using inductive and deductive methods. Most of the researchers were used an inductive measurement approach for the different purposes of social vulnerability and social related problems (Abson et al., 2012; Roy, 2016; Yoon, 2012) and developed indexes using different equations. In this study, we have used to combine inductive and deductive approaches to devise health security and quality of life index. The variables have been used to find out the quality of life and health security status of the people in the slum neighbourhoods and those variables are to be determined QoLI such as housing condition includes concrete floor, room dampness, overcrowding etc, sanitation includes sewerage system, condition of drain etc, economic conditions include per capita income, unemployment etc, and for HSI, e.g. awareness about health includes maintaining personal hygiene, taken regular health check-up etc, the prevalence of diseases includes an interval of sickness, etc. In order to devise these two indexes, principal component analysis (PCA) of inductive approach and standardized method (z-scores, the ratio of value, and min-max rescaling transformation) of deductive approach has been used. Moreover, the methods we have used to develop indexes from the inductive and deductive approaches are shown by comparison through Pearson correlation coefficient and GIS mapping to visualize the spatial distribution.

4.1 Inductive approach—principal component analysis

A systematically modified index can be developed with the help of an inductive approach by a group of datasets from the literature of the QoLI and HSI. A dataset of 37 variables of the quality of life and 20 variables of the health security was used in principal component analysis to measure the multivariate nature of a population. Principal Component Analysis (PCA) is a data reduction methodological tool in SPSS v26 using large datasets of variables that transform into a smaller dimension or set of components depend on their correlation (Abdi and Williams, 2010; Hoseinzadeh et al., 2016). From the quality of life and health security datasets, fourteen and nine components were extracted using Varimax rotation and Kaiser Normalization (Kirby et al., 2019). These principal components of quality of life and health security are explained variance of 67.37% and 66.04% respectively. Only those variables with Eigen value are higher than 1.0, were extracted as a latent variable and we assigned their cardinality based on their influences on the quality of life and health security. Using similar weighting and additive approaches like in similar studies, each component is multiplied by their explanatory variance and then added to get their index score (Cutter et al. 2003; Hummell et al. 2016; Aksha et al. 2019). Our modified QoLI and HSI for Midnapore city was calculated for each spatial unit (156 neighbourhoods) by adding the principal component values, derived as:

$$I_{slum} = \sum PC_{i\_i} \times V_i \quad (1)$$

Where, I_{slum} indicate the index score of the slums; PC_i is the principal component; V_i is the variance of each component.

4.2 Deductive approach—standardization (z-score, ratio of value, and min-max rescaling)
The deductive approach has been selected limited variables for the development of an index in the social or physical context depend on the knowledge of prior theories from the recent works of literature (Yoon, 2012). There is a wide variety of deductive approaches that researchers can use such as z-score transformation, maximum value transformation and min-max rescaling which have been using for transforming the data unit to a small-scale range. This kind of method is used to devise the final index score. We have employed three standardised methods which discuss as below:

4.2.1 Z- score transformation
The z-score reflects an ideal normal deviation with variation across the standard normal distribution, which is equal to zero and a normal distribution equal to the standard deviation. Z score was calculated with the following equation:

$$Z = (\text{Score} - \text{mean})/\text{standard deviation} \quad (2)$$

The variables which we have been selected to devise the quality of life and health security indexes are standardized with a z-score and then all the values are added to make a composite index score (Yoon, 2012; Zahran et al. 2008).

4.2.2 Maximum value transformation (ratio of value)
The maximum value transformation defines as the ratio of the value of the variables (X_i) to the maximum value (X_{max}) among the variables. The derived rescaling values are ranges between zero to one, while the higher value represents the standard quality of life and health security. The derivation of the index is as follow:

$$R_i = \frac{X_i}{X_{max}} \quad (3)$$

Where, R_i is the normalised value of variable of X_i. We have used aggregate score for the devise of QoLI and HSI derived from the maximum value transformation.

4.2.3 Min–max rescaling transformation
Min-max rescaling is a standardization method where each variable is compressed into a specific range of values between zero to one. The rescaling score obtained from the minimum value (X_{min}) among the variables subtract from each variable (X_i) divided by the range of variable value (maximum value (X_{max}) subtract from the minimum value (X_{min}) among the variables). The score of min-max rescaling towards zero indicates most awful and towards one indicates the

more prominent for developing an index. The mathematical formula derived by (Cutter et al.2010; Bernard 2007):

$$V_i = \frac{X_i - X_{min}}{X - X_{min}} \quad (4)$$

Where, V_i is the normalised value of variable of X_i.

4.3 Cluster-outlier analysis

Cluster-outlier analysis (Anselin Local Moran's I) available on Spatial statistics tool of ArcGIS v 10.4 environment based on inverse distance weight (IDW) technique using fixed distance band of 928 meters is used to identify groupings or spatial cluster according to the type of association of a dataset (Mitchell 2005; Martin et al., 2019; Jana and Sar 2016; Aksha et al., 2019). We used the cluster-outlier analysis to identify whether the quality of life and health security among the slum neighbourhoods is in a statistically significant spatial pattern (clustered or random) or inconsistency. For each spatial neighbourhood, the scores were mapped using ArcGIS v 10.4 to visualize the distribution and pattern of quality of life and health security of the slum neighbourhoods based on Z-scores. The Z score and P-value are predicted to assess which value is surrounding at a statistical significance level. For example, a high positive Z-score that has either high or low values surroundings and a low negative Z-score is significant for the outlier category (Nelson and Boots 2008; Martin et al 2019). The mathematical formula for the Local Moran's I Statistic of spatial association (www.resources.esri.com) is given as:

$$I_i = \frac{x_i - \overline{X}}{S_i^2} \sum_{j=1, j\neq 1}^{n} w_{i,j}\left(x_j - \overline{X}\right)$$

Where x_i is an attribute value for a feature i$\overline{X}$ is the mean of the corresponding attribute value and $x_{i,j}$ is the spatial weight between feature i and j

And;

$$S_i^2 = \frac{\sum_{j=1, j\neq 1}^{n}(x - \overline{X})}{n - 1}$$

With n equating to the total number of features and the z_{I_i} score is computed as:

$$z_{I_i} = \frac{I_i - E[I_i]}{\sqrt{V[I_i]}}$$

Where:

$$E[I_i] = -\frac{\sum_{j=1, j\neq 1}^{n}}{n - 1}$$

$$V[I_i] = E[I_i^2] - E[I_i]^2$$

4.4 Ordinary least square regression

Ordinary Least Squares regression (OLS) is more known to be a linear regression algorithm estimating the unknown parameters based on the linear regression (simple or multiple) model with the assumptions of linearity, no endogeneity, normality and homoscedasticity, no autocorrelation, and no multicollinearity. Based on the principle of least squares, the coefficient was estimated to minimize the sum of squared residuals (SSR) while the smaller the differences, the better the model fits with the datasets. Thus, OLS is used to find the relationships among the observed dependent variables and predicted variables by the linear function. Ordinary Least Squared (OLS) estimates with explanatory variables (p), which is derived as:

$$Y = \beta_0 + \Sigma_j = 1..p\ \beta_j X_j + \varepsilon$$

Where Y is the dependent variable, β_0 is the intercept of the model, X_j corresponds to the j^{th} explanatory variable of the model (j= 1 to p), and ε is the random error with expectation 0 and variance σ^2. Besides, the estimation of the value of the predicted dependent variable (Y) for the i^{th} observation is given by the equation:

$$Y_i = \beta_0 + \Sigma_j = 1..p\ \beta_j X_{ij}$$

The OLS method corresponds to minimizing the sum of square differences between the observed and predicted values. This minimization leads to the following estimators of the parameters of the model:

$$[\beta = (X'DX)^{-1} X' Dy\ \sigma^2 = 1/(W - p*)\ \Sigma_i =_{1..n} wi(y_i - y_i)]$$

where β is the vector of the estimators of the β_i parameters, X is the matrix of the explanatory variables preceded by a vector of 1s, y is the vector of the n observed values of the dependent variable, p* is the number of explanatory variables to which added 1 if the intercept is not fixed, w_i is the weight of the i^{th} observation, and W is the sum of the w_i weights, and D is a matrix with the w_i weights on its diagonal. Also, the vector of the predicted values can be written as follows:

$$Y = X\ (X'\ DX)^{-1}\ X'Dy$$

When a large number of explanatory variables are available, OLS is useful for estimating the unknown parameters based on the number of observations. We were used OLS to explore the relationship between QoLI with the variables of health security (Table 7) as well as with the variables of the quality of life (Table 8). With the help of OLS, the effects of various explanatory variables on the quality of life and health security were estimated by determining coefficients for each component extracted by principal component analysis. These coefficients were calculated based on weighted variables of quality of life and health security.

5. Results and Discussion

5.1. Results of the different index and GIS mapping

We have employed inductive and deductive methods for assessing the quality of life and health security of slum neighbourhoods of the study area. Firstly, the principal component analysis was extracted fourteen components for quality of life and nine components for health security respectively with Eigen values greater than 1.0 based on loaded variables and their cardinality. In total, the principal components explain 67.01% and 66.049% variance of the data for both the quality of life and health security respectively. Descriptions of the fourteen and nine components respectively, signs denoting their effect on the quality of life and health security, and loadings are presented in Table 4 and Table 5. Total scores for slum neighbourhoods were calculated by adding the scores of fourteen and nine components derived by the product of each component with its variance based on their cardinality. Secondly, the z-score transformation is used to find the z-scores (Eq. 2) of the variables and adding these scores to make a composite index of quality of life and health security for the slum neighbourhoods. The maximum value transformation is also used to find the ratio values of the variables by their maximum value to breed index values (Eq. 3). The higher value represents the standard quality of life and health security of the slum neighbourhoods and vice-versa. Fourthly, min-max rescaling transformation was employed for breeding composite index of quality of life and health security for the slum neighbourhoods (Eq. 4). The value of one represents a decent quality of life with standard health security. Finally, the cluster-outlier analysis was employed to visualize the spatial distribution of the four index scores for the slum neighbourhoods using local Moran's I statistics.
Based on estimated Z-scores values from local Moran's I statistics, scores were grouped into five quintiles from high (>1.5 SD) to low (< -1.5 SD). Subsequently, total scores were mapped using ArcMap v10.4, (Fig. 2, 3) and the value of each component to visualize the quality of life and health security across Midnapore city (Fig. 4, 5). For the quality of life and health security, the Z-score value ranges between ±1.5 S.D. The value between ± 0.5 represents the moderately quality of life, and the value between 0.5 to 1.5 and >1.5 indicates the well and decent quality of life respectively, while the value -0.5 to -1.5 and >-1.5 indicates the distressed and degraded quality of life respectively. The ranges of the score are in the same domain for the health security, for example, the value between ± 0.5 represents the moderately prepared, and the value between 0.5 to 1.5 and >1.5 indicates the more and most prepared for health security respectively, while the value -0.5 to -1.5 and >-1.5 indicates the least prepared for health security and vulnerable respectively.

Table 4: Results of principal component analysis for Quality of life

Principal Component	Cardinality	Variables	Loadings	Explained variance (%)	Eigen value
PC1	(+)	Separate bathroom	.720	12.717	4.705
		Separate kitchen	.655		
		Sewerage system	-.434		
		Ventilation facility	.517		
		Fuel used for cooking	.616		
		Per capita food expenditure	.342		
PC2	(+)	Pucca floor	.750	6.658	2.464
		Pucca wall	.785		

		Pucca roof	.783		
PC3	(+)	Drinking private tap water	.934	6.374	2.358
		Drinking public tap water	-.909		
PC4	(+)	Overcrowding	.758	5.427	2.008
		Per capita income	.726		
PC5	(+)	Water purifier	.347	4.833	1.788
		Any loans taken	-.688		
PC6	(+)	Migrated	.596	4.404	1.630
		Own house	-.787		
		Owning phone	.506		
		Literacy rate	.364		
PC7	(+)	Availability of public toilet	.661	3.987	1.475
		Solid waste management	-.666		
PC8	(+)	Condition of drain	.526	3.825	1.415
		Earning members in small business and informal sector	.748		
		Earning members in daily wage labour	-.507		
PC9	(+)	Distance to the nearest school	.799	3.716	1.375
		Facilitated solid waste collection	.689		
PC10	(+)	Unemployment	.452	3.449	1.276
		Leisure time with family	.798		
PC11	(+)	Earning members associated with the service sector	.474	3.275	1.212
		Leisure time watching Tv	.696		
PC12	(+)	Use sanitary napkin	.804	3.028	1.120
PC13	(+)	Owning Tv	.560	2.943	1.089
		Owning cycle	.875		
PC14	(+)	Room dampness	-.437	2.374	1.012
		BPL	.686		
		Owning vehicle	.375		
		Distance nearest health care centre	.623		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization
a.Rotation converged in 29 iterations

Table 5: Results of principal component analysis for Health security

Principal Component	Cardinality	Variables	Loadings	Explained variance (%)	Eigen value
PC1	(+)	Distance to nearest health care centre	-.477	11.417	2.283
		Women violence	.724		
		Prevalence of malnutrition	.751		
		Satisfaction level of health infrastructure	.443		
PC2	(+)	Interval of sickness	-.617	10.408	2.082
		Infectious disease	.755		
PC3	(+)	Drinking water treatment	.513	8.529	1.706
		Taken regular health check-ups and medicine	.447		
		Disease prevention equipment's	.545		
		Chronic disease	.639		
PC4	(+)	The environment of housing condition	.525	7.436	1.487
		Food insecurity	.762		
PC5	(+)	Health card	.770	6.444	1.289
		Health insurance	.794		
PC6	(+)	BPL	-.844	6.033	1.207
		Perception of family health	.509		
PC7	(+)	Maintaining personal hygiene	.848	5.593	1.119
PC8	(+)	Awareness about health and nutrition	.867	5.165	1.033
PC9	(+)	Source of transport provide reaching the health care centre	-.469	5.024	1.005
		Hiding disease	.809		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization
a.Rotation converged in 23 iterations

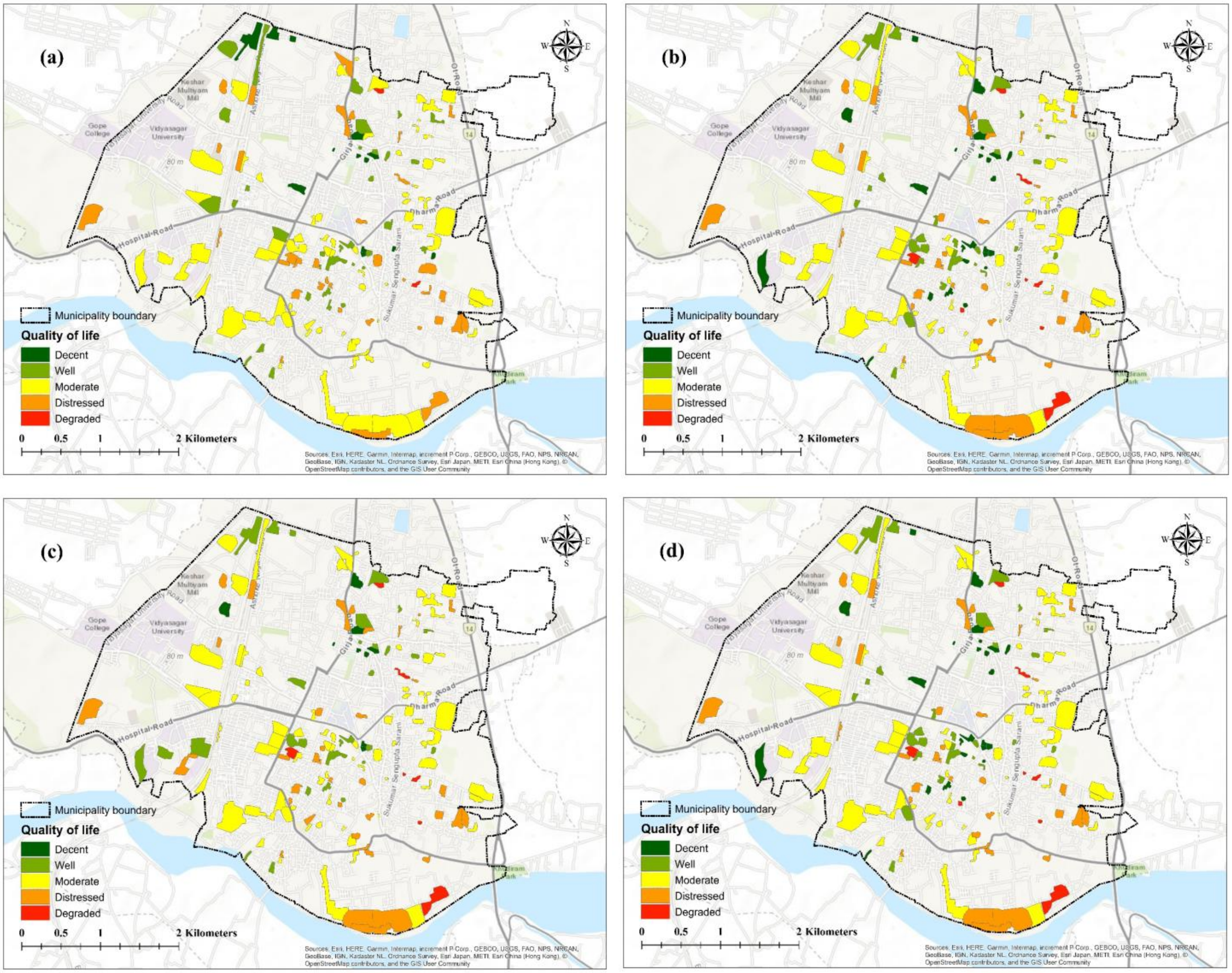


Fig 2: Spatial distribution of different index scores for Quality of life (a) Principal component analysis (b) Z-score transformation (c) Maximum value transformation (ratio of value) (d) Min-max rescaling transformation.

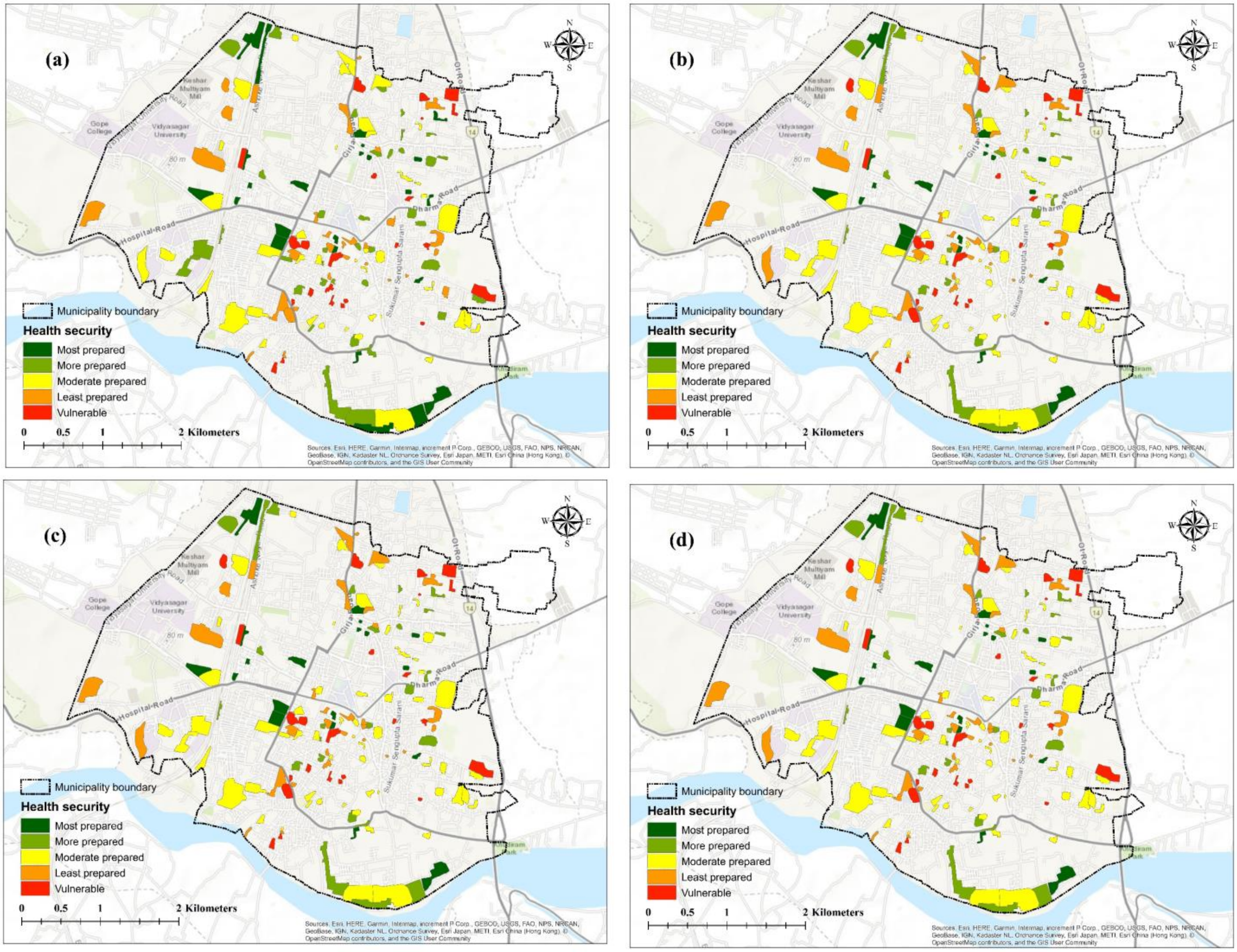


Fig 3: Spatial distribution of different index scores for Health security (a) Principal component analysis (b) Z-score transformation (c) Maximum value transformation (ratio of value) (d) Min–max rescaling transformation.

5.2. Comparison of all indexes

Pearson correlation coefficient is measured and compared the linear correlation between two or more variables that proposed variable strength of association ranges between 1 to -1. In this study, we used the Pearson correlation coefficient to measure the correlation between aggregated four different index scores. The results of Pearson correlation coefficient shown in Table 6, which show the perfect correlation among the four standardization method while assessing the quality of life and health security. The relationship between z-score transformation and ratio of value, between min-max rescaling transformation and the ratio of value and between min-max rescaling transformation and z-score transformation is 1.00 both in quality of life and health security respectively. Also, the strong correlation between PCA and the three standardized deductive methods for modified QoLI and HSI are represented the value of 0.945 and 0.979 respectively. Thus, there is no significant difference among the four standardisation methods for developing an index.

Table 6: Comparison of all indexes by Pearson correlation matrix

Correlations		Principal component analysis		Ratio of value		Z score		Min-max rescaling	
		QoL	HS	QoL	HS	QoL	HS	QoL	HS
Principal component analysis	QoL	1							
	HS		1						
Ratio of value	QoL	.945**		1					
	HS		.979**		1				
Z score	QoL	.945**		1.000**		1			
	HS		.979**		1.000**		1		
Min-max rescaling	QoL	.945**		1.000**		1.000**		1	
	HS		.979**		1.000**		1.000**		1

**p < 0.01

5.3 Relationship between Quality of life and Health security

It is believed that health security is strongly related to the quality of life of the households. The ordinary least square (OLS) regression were employed to find the relationship between QoLI with the indicators of health security as well as the relationship between HSI with the indicators of quality of life. Also, this method was used to find the impact of the components on the quality of life and health security. Moreover, we want to explore the similarity among the four models in terms of the impact of the indicators shown in Table 7 and Table 8. The result shows (Table 7) that PC3 and PC4 of health security have significantly ($p<0.01$) impact on the QoLI such as drinking water treatment, taken regular health check-ups and medicine, disease prevention equipment's, chronic disease as well as housing condition and food insecurity. Moreover, accessibility of health care centres, food & nutrition, and accommodation and poverty are significantly ($p<0.01$) related to the quality of life which fit with the three standardised models. In contrast, Table 8 shows the result of the relationship between HSIs with the indicators of quality of life. The results indicate that no significant components of quality of life have a significantly ($p<0.01$) impact on the HSI. However, housing conditions, access to drinking water, food and nutrition, health and social care are significantly ($p<0.01$) related to health security which fit with the three standardised models.

Table 7: Relation between QoLIs and indicators of health security

Variables	Model 1		Model 2		Model 3		Model 4	
	Principal component analysis		Z score		Ratio of the value		Min-max rescaling	
	β	t	β	t	β	t	β	t
PC1	-.059	-.859						
PC2	-.038	-.576						

PC3	.223**	3.331						
PC4	.507**	7.712						
PC5	.088	1.365						
PC6	.148*	2.303						
PC7	.025	.379						
PC8	.040	.618						
PC9	.112	1.656						
Accessibility of health care centre			2.536**	27.110	2.504**	27.141	.153*	2.296
Awareness about health			1.762**	25.796	1.750**	25.985	.109	1.581
Food & nutrition			3.545**	27.663	3.511**	27.780	.214**	3.166
Accommodation and poverty			7.567**	28.134	7.496**	28.258	.462**	6.871
Prevalence of disease			.712**	18.575	.681**	18.017	.047	.699
Health security			2.098**	26.433	2.066**	26.401	.128	1.890
Gender-based Violence			-1.127**	-23.121	-1.122**	-23.348	-.068	-1.011
Constant	6314.955**		22.767**		5.173**		1148.346**	
Number	156		156		156		156	
R-squared	.412		.894		.897		.380	
Adjusted R-squared	.376		.888		.891		.351	

*p < 0.05, ** p < 0.01

Table 8: Relation between indicators of HSIs and indicators of quality of life

Variables	Model 1		Model 2		Model 3		Model 4	
	Principal component analysis		Z score		Ratio of the value		Min-max rescaling	
	β	t	β	t	β	t	β	t
PC1	-.097	-.903						
PC2	.056	.649						
PC3	-.012	-.133						
PC4	-.018	-.175						
PC5	.073	.864						
PC6	-.036	-.380						
PC7	-.122	-1.390						
PC8	.075	.827						
PC9	-.092	-1.065						
PC10	.043	.472						
PC11	.023	.242						
PC12	-.116	-1.364						

PC13	.046	.518						
PC14	-.018	-.184						
Housing condition			.214**	2.786	.214**	2.786	.214**	2.786
Access of drinking water			.185**	2.718	.185**	2.718	.185**	2.718
Economic condition			.071	.990	.071	.990	.071	.990
Occupation			.125	1.833	.125	1.833	.125	1.833
Food and nutrition			.334**	4.863	.334**	4.863	.334**	4.863
House ownership			-.055	-.798	-.055	-.798	-.055	-.798
Asset			-.058	-.775	-.058	-.775	-.058	-.775
Education			.083	1.238	.083	1.238	.083	1.238
Health and social care			.232**	3.388	.232**	3.388	.232**	3.388
Sanitation			.214	2.786	-.072	-1.066	-.072	-1.066
Constant	6437.045**		-4.269**		.303**		-.426**	
Number	156		156		156		156	
R-squared	.068		.385		.385		.385	
Adjusted R-squared	-.024		.343		.343		.343	

*p < 0.05, ** p < 0.01

5.4 Discussion

Our modified QoLI and HSI for Midnapore city was calculated for each spatial unit (156 neighbourhoods) by adding the scores derived from principal component values, Z-score transformation, Maximum value transformation (ratio of value), and Min-max rescaling transformation. The overall score for the final modified QoLI and HSI were developed by combining these four models scores and mapping in ArcGIS v 10.4 platforms. Based on estimated Z-scores values from local Moran's I statistics, scores were grouped into five quintiles from high (>1.5 SD) to low (< -1.5 SD). Subsequently, total scores were mapped using ArcMap v10.4, (Fig. 2, 3) and the value of each component to visualize the quality of life and health security across Midnapore city (Fig. 4, 5). For the quality of life and health security, the Z-score value ranges between ±1.5 S.D. The map of the quality of life (Fig. 4) exhibit the slum neighbourhoods with decent quality of life such as Rammohannagar, ashoknagar nepali para, Udaypally bastee, Porabanglo bastee, Chatarpara bastee, Beharapara bastee, Singpara bastee, Beltala bastee, Backside of commerce college bastee, Backside of muslim burialground and firebridget, Subhasnagar gargi bastee, backside of mohananada sevashram, Hatisalagoli bastee is located in the eastern, north-west, and the central part of the city. Slum neighbourhoods characterised with degraded quality of life are Berballavpur bastee, Bauripara bastee, mostly located in the north and south-east part of the city. In contrast, the map of health security shows the slum neighbourhoods, for example, Sitalamandir bauripara bastee, Porabanglo bastee, Kamarpara basteee, Amtala khas bastee, Judgecourt horijan pally, Goalapara bastee, Patnabazar bauripara bastee, boxibazar tantipara, Pakijabasteee, Ghusipara bastee, Backside of commerce college, Backside of muslim burialground and firebridget, Mitracompound kamarpara, Talpukur basteee are mostly prepared for their health security distributed towards south-west part of the city. Besides, slum neighbourhoods, for example, Bhunia para station road, Baburchipara bastee, Chandan bastee, Hatharmath bastee, Talpukur colony bastee, Berballavpur bastee, Jelepara bastee are more vulnerable due to their lack of preparedness against forthcoming health shocks.

Following the summarized results from Fig 4 and 5, we detected fewer slum neighbourhoods characterised by the low standard quality of life, but the maximum number of slum neighbourhoods was recognized as moderate to the high level of vulnerability to health shock with lack of preparedness about their health shocks. The reasons behind the fact that most of the slum neighbourhoods are going through vulnerable socio-economic status which forced them to fall in high health risk. The models of our study also estimated the variables which may have an important role behind the vulnerable health security condition of the slum neighbourhoods at a statistical significance level of $P<0.01$ (Table 8). The study investigated that annually average 2.45 people per family have experienced health shocks and are least prepared for health security due to their lack of housing accommodation and access to drinking water, lack of proper food and nutrition as well as lack of healthcare facilities and social care (Table 2 and 3). Moreover, high family size, fewer literate and employed persons in the family (Table 1) may also contribute to their health security, although they have to live a moderate quality of life.

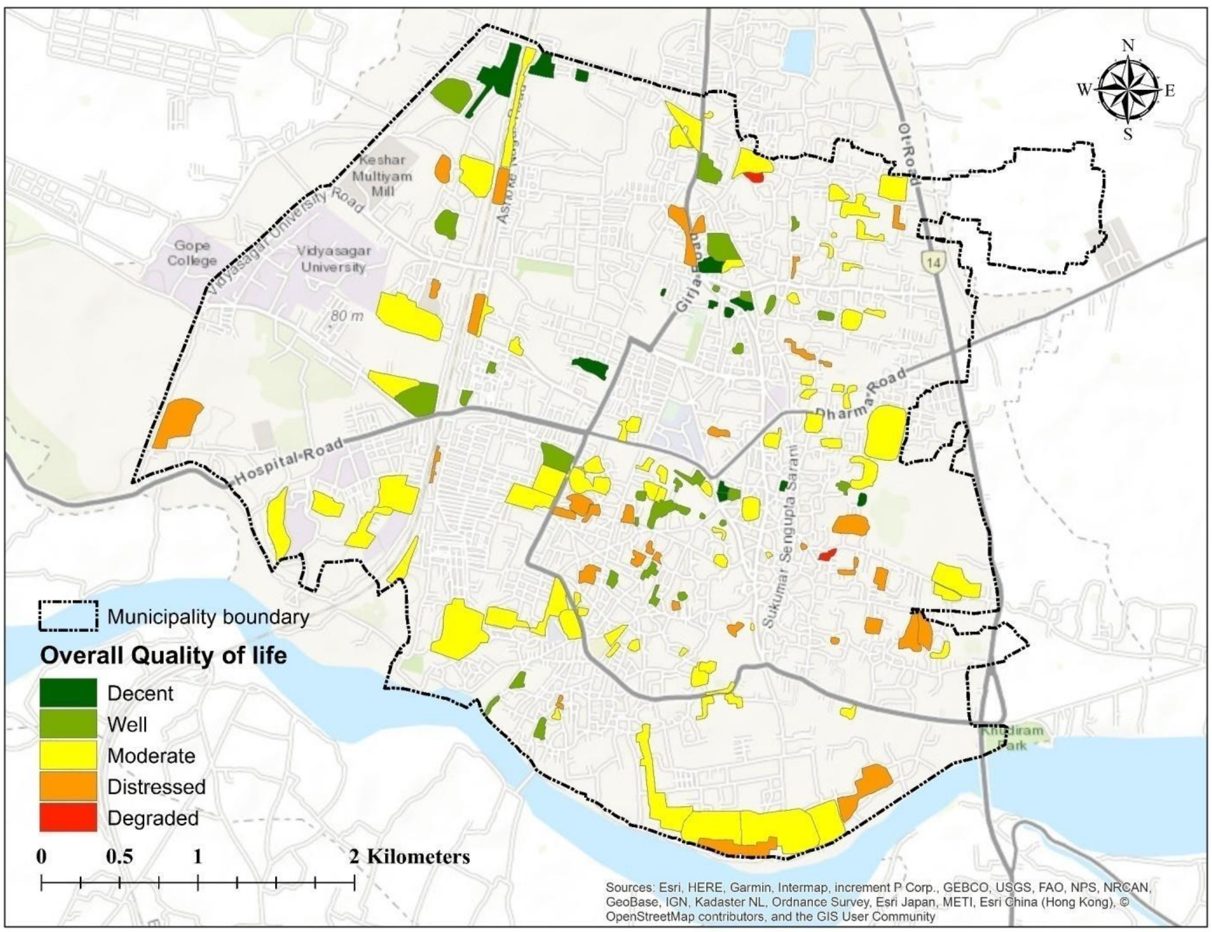


Fig 4: Overall spatial distribution for Quality of life

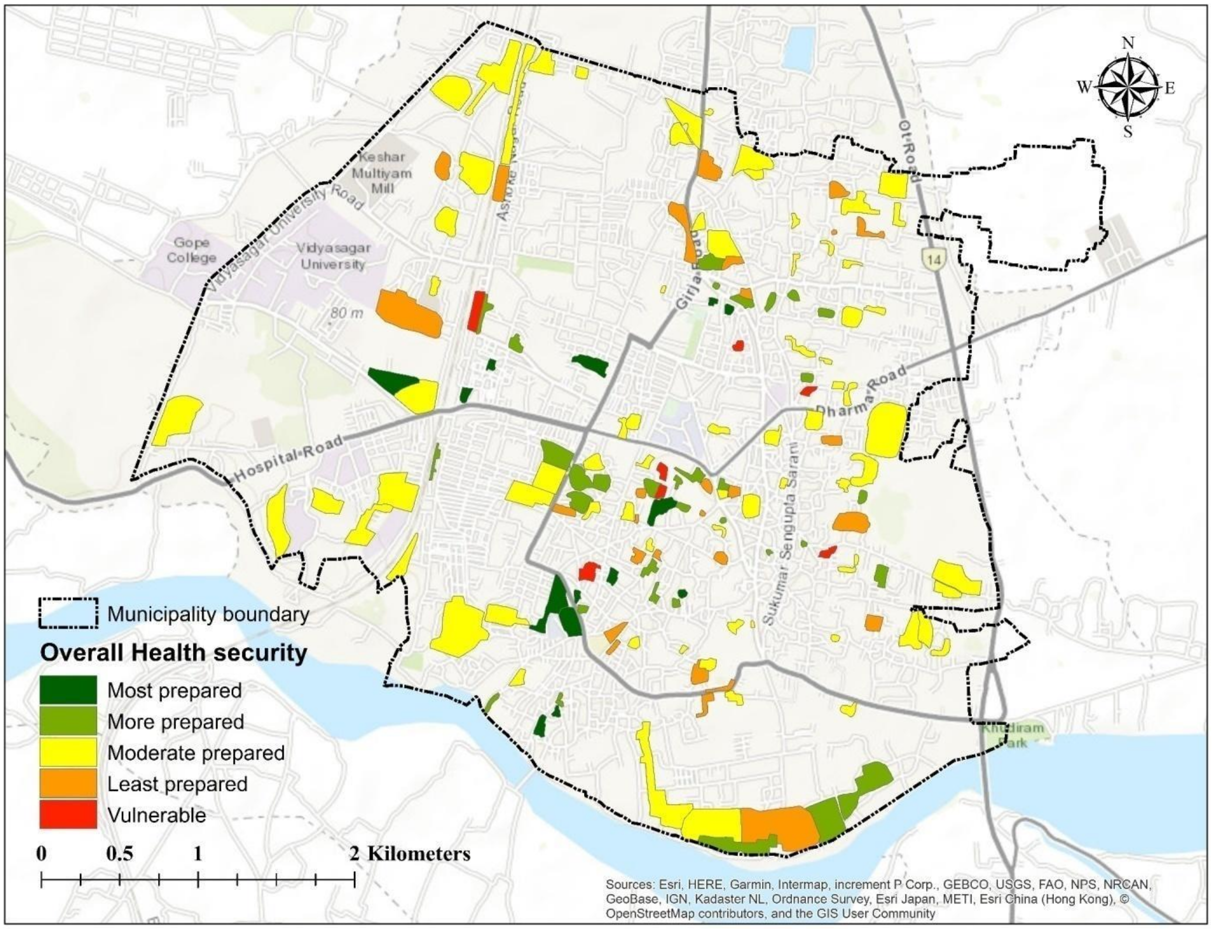


Fig 5: Overall spatial distribution for Health security

6. Conclusion

Our broadest conclusion from this study is clear that 'slum neighbourhoods are more vulnerable than non-slum neighbourhoods' in the context of quality of life and health security. Our study has been investigated the spatial distribution of quality of life and health security with key context visual understanding of slum neighbourhood of Midnapore municipality. The result shows that most of the slum neighbourhoods are more vulnerable to health shocks with the least prepared for health securities, although they have maintained decent to moderate quality of life. Slums neighbourhoods are randomly distributed around the city rather than being clustered in one specific area. Therefore, slum neighbourhoods are not necessarily characterised by the same entities, rather there should be accounted for variability. This make to be an important factor in the relationship between quality of life and health security because that relationship varies considerably across space, as demonstrated by the results from the models which we used in our study. Our analysis can able to predict the quality of life and health security conditions in some parts of the city than in others. However, the methods employed in this study do not necessarily produce the same results for the variables and does not apply in the same space continuum. This does not mean that there is not a consistent spatial pattern of quality of life and health security. Yet, our objective was to find the spatial pattern of quality of life and health security at a small scale spatial unit. The results show that quality of life and health security are not significantly varied at this small spatial scale, but does exhibit the spatial patterns at the scale of slum neighbourhoods. This study is also a complex one with key themes in our findings but can able to evaluate whether the most vulnerable people of Midnapore municipality living in the worst slums. The initiatives of local authorities and government have failed too much improvement in the slum neighbourhoods. This study can be helpful to recognise the various fields of improvement and community participation could contribute to recovering the quality of life and health security in the slums neighbourhoods under study. This study has also explored the relationship between quality of life and health security. Food and nutrition, accommodation, poverty and accessibility of healthcare etc have a significant impact on the quality of life and health security respectively. Therefore, it is suggested to the local authority, policymakers, NGOs and district planning commission that more community participation, awareness creation and planning interventions can improve the place inequalities of the quality of life and health security among the slum neighbourhoods in the broadest perspective of well being and welfare.

Compliance with Ethical Standards

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Declaration of Conflict of interest
There is no potential conflict of interest as reported by the authors.

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Ethical Approval
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent
Informed consent was obtained from all individual participants involved in the study.

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