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Population Change, Health, Environment and Development: An Interrelationship

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Abstract: Attempts have been made to investigate the interrelationship among population change, health, environment and development in global level using secondary data from WHO and United Nations. USA (for Index of Health facilities (IH) and Environment (IE)) and Switzerland (for Index of Development (ID) and Quality of Life (IQL)) were at the top ranking position in 1990 but in 2000 they came down to 2nd and 3rd position. Cross tabulation analysis reveals all the indices are significantly associated with one another in both the years. With respect to quality of life using stepwise regression analysis, results shows that ID and IH are at first and second step and same for both the years. However, at the third step they are different. The path analysis also indicates that quality of life improved when health facilities increased but the quality of life decreased with increase in population in both the years.

Key words: Index of health facilities, environment, development and quality of life and path analysis, population, Japan

INTRODUCTION

The integration of population and development is challenging and difficult undertaking. All the countries of the world have realized the importance of this integration. However because of the lack of knowledge on cause and effect relationships, developing countries have been facing enormous difficulties of the implementation level (Population Council, 1992). The integration of population and development planning simply means the explicit consideration of socio-economic and demographic interrelationships in the formulation of development policies and programs aimed at achieving the country's development objectives. Since, development is intended to improve the quality of life but if affects the environment (Rahman *et al*., 2005). Economists and environmentalists increasingly agree that efforts to achieve better living standards and to protect environment can be closely linked and are mutually reinforcing. In the context of population and development integration health infrastructure facilities and environment problems cannot be separated from population problems. There is no doubt that population growth increases the demand for health services and various factors affect the health status of the population. Thus, the performance of the health care sector obviously remains an important factor (United Nations, 1988). Several studies showed that slowing the increase in population by time to improve living standards on a sustainable basis and can take pressure off the environment (Green, 1992; WDR, 1992; Roodman, 1998; Upadhyay and Robey, 1999). Therefore, in the process of improving the quality of life a concerted and integrated effort should be given to harmonize the links among population, health, environment and development. The present study is an attempt to examine the interrelationships among the indices of health, environment, development and quality of life. The analysis is undertaken at global level as country basis. The defined indices are: Index of Health facilities (IH), Index of Environment (IE), Index of Development (ID) and Index of Quality of Life (IQL).

Objectives: The main objectives of the study are:

- To determine the several indices for different countries of the world and their corresponding ranking positions
- To examine the association among four indices (ID, IE, IH and IQL) with population change (%) and to identify the most influential variables for selection of the best regression model on the dependency of index of quality of life (IQL)

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- To find out the direct and indirect effect of the selected indices on IQL

MATERIALS AND METHODS

Data sources, construction of indices and methodology: The study is based on the data of WHO and United Nations. The researchers have mainly used World Health Statistics 2006 (WHO, 2006) and national trends in population, resources, environment and development 2005: country profiles (United Nations, 2006) data prepared by WHO and United Nations Department of Economic and Social Affairs, Population Division, respectively. The study also uses data from GEO data portal (UNEP, 2006) prepared by United Nations Environment Programme (http://geodata.grid.unep.ch/).

Population is considered as one of the components in the study. Here Percentage of Population Change (PPC) is measured dividing by the difference between population sizes at different dates by the population at earlier date (Shryock *et al*., 1975).

The Index of Health facilities (IH) has been constructed using the variables such as number of physician, number of nurses, number of midwives, number of dentists, number of pharmacists, number of public and environmental health workers, number of community health workers, number of other health workers, number of lab technicians, number of health management and support workers and number of hospital beds.

The Index of Environment (IE) includes the variables of population density (measured in per hector), access to safe water (measured in total percentage), access to sanitation (measured in total percentage), commercial energy use/capita (measured in US $ 1 kg oil) and carbon dioxide emission (measured in 1000 metric tons).

The development index denoted by ID is constructed using Gross Domestic Product (GDP) per capita (measured in terms of US $). Similarly, another index name as Index of Asset (IA) constructed using the variables such as telephone main lines in use per 1000 people, television sets per 1000 people, internet hosts per 1000 people, mobile phone subscribers per 1000 people and motor car per 1000 people.

Finally, the Index of Quality of Life (IQL) has been constructed by averaging the indices of IE, IH, ID, IA, adult literacy (measured in years) and life expectancy (measured in years).

The present study considers only a few sets of variables related to population, health facilities, environment, development and assets. Many are left partly owing to unavailability of data at the country levels. Calculation of single variable index is made as follows:

Let X_{ij} denotes value of ith variable for jth country. The researchers may get an index called the single variable index at the country level by using the following equation:

$$IV_{ij} = \frac{(X_{ij}) - \text{Min.}(X_{ij})}{\text{Max.}(X_{ij}) - \text{Min.}(X_{ij})} \times 100$$

where, (X_{ij}), Min. (X_{ij}), Max. (X_{ij}) and IV_{ij} are respectively the actual, minimum, maximum and index value of X over the countries. Based on each indicator which include >1 variable, weight for each variable has been measured as:

$$W_{ij} = \frac{\frac{1}{\sqrt{\text{Var.}(IV_{ij})}}}{\sum_{i=1}^{k} \frac{1}{\sqrt{\text{Var.}(IV_{ij})}}}$$

Where:

Var. (IV_{ij}) = The variance of index value of ith variable for jth country

k = The number of variables

The choice of weights in this manner ensures that large variations in any one of the indicators will not unduly dominate over the contribution of the indicators and distort inter country comparisons.

Thus, using the weight and index value, a weighted combined index is obtained using the following equation:

$$C_{ij} = \sum_{i=1}^{k} W_{ij} \times IV_{ij}$$

Where:

W_{ij} = The weight value

IV_{ij} = The index value of ith variable for jth country

k = The number of variables

All the above indices are computed in the same way as Gupta (1989) and Rahman (1999). Then, to examine the association among the indices and PPC, contingency analysis is performed. The stepwise regression is undertaken to evaluate the strength of these indices and selection of the best regression model. Finally the causal link among the indices and percentage population change and their direct and indirect effect on quality of life is provided by path model analysis.

RESULTS AND DISCUSSION

Country variation by constructed indices: The researchers would like to identify the ranking position of each country of the world on the basis of ID, IE, IH and

Table 1: Top ten countries by constructed indices

Years	Indices
IH	
1990	United States of America (1), Ireland (2), Jordan (3), Iceland (4), Finland (5), Cuba (6), Tonga (7), Israel (8), Australia (9) and Lebanon (10)
2000	Romania (1), United States of America (2), Ireland (3), Finland (4), Iceland (5), Netherlands Antilles (6), Tonga (7), Jordan (8) Cuba (9) and Australia (10)
IE	
1990	United States of America (1), China, Macao Special Administrative Region (2), Japan (3), Russian Federation (4), Canada (5), Australia (6), Trinidad and Tobago (7), China (8), Finland (9) and Sweden (10)
2000	China, Macao Special Administrative Region (1), United States of America (2), United States Virgin Islands (3), Japan (4), Occupied Palestinian Territory (5), Russian Federation (6), Canada (7), Australia (8), Trinidad and Tobago (9) and China (10)
ID	
1990	Switzerland (1), Luxembourg (2), Sweden (3), Norway (4), Finland (5), Denmark (6), Japan (7), Iceland (8), United States Of America (9) and France (10)
2000	Luxembourg (1), Norway (2), Switzerland (3), Sweden (4), Finland (5), Denmark (6), Iceland (7), Japan (8), United States of America (9) and Austria (10)
IQL	
1990	Switzerland (1), Sweden (2), Finland (3), Norway (4), Luxembourg (5), Iceland (6), United States of America (7), Denmark (8), Japan (9) and Canada (10)
2000	Luxembourg (1), Norway (2), Switzerland (3), Sweden (4), Finland (5), United states of America (6), Iceland (7), Japan (8), Denmark (9) and Canada (10)

Parenthesis indicates the ranking position

Table 2: Results of contingency analysis

Attributes	1990	2000	DF
IQL vs. PPC	65.864*	87.160*	4
IQL vs. IH	78.783*	123.257*	4
IQL vs. IE	37.280*	59.773*	4
IQL vs. ID	169.274*	156.815*	4
PPC vs. IH	15.823*	77.610*	4
PPC vs. IE	18.433*	38.336*	4
PPC vs. ID	41.591*	46.927*	4
IH vs. IE	21.653*	42.318*	4
IH vs. ID	115.709*	105.013*	4
IE vs. ID	36.927*	43.597*	4

*:p<0.001

IQL in 1990 and 2000. Lacks of the relevant indicators of the four indices only 188 countries have been included out of all countries of the world. To shorten the Table 1, the researchers take only the top 10 countries. From Table 1, the researchers observed that USA was at the top ranking position according to IH and IE in 1990 but in 2000 it came down to 2nd position. The researchers also observed that Switzerland was at the top ranking position according ID and IQL in 1990 but in 2000 it came down to 3rd position.

Contingency analysis: To test the association among the four indices and percentage of population change, the researchers rank 188 countries according to them and categorize into three groups as low, medium and high ranking countries. First 63 countries whose scores are lowest according to the indices are categorized as low ranking then, next 63 countries are categorized as medium ranking and last 62 countries which are highest scored are categorized as high ranking countries. Table 2 shows the values of Chi-square among the indices and percentage of population change and their significance level. The researchers observed that all the indices are significantly associated with one another in both 1990 and 2000 years.

Table 3: Results of stepwise regression analysis

	Most influential variables and R^2			
Dependent variables	1st step	2nd step	3rd step	4th step
1990				
IQL	ID (0.730)	ID, IH (0.799)	ID, IH, PPC (0.823)	ID, IH, PPC, IE (0.833)
2000				
IQL	ID (0.688)	ID, IH (0.767)	ID, IH, IE (0.789)	ID, IH, IE, PPC (0.811)

Parenthesis indicates the value of R^2

Stepwise regression analysis: In order to search for the best regression model the researchers have introduced the stepwise regression analysis for evaluating the most influential variables step by step. The results of such analysis are shown in Table 3. From Table 3, it has been found that index of development has come out to the most influential variable for shaping the trend of index of quality of life in both 1990 and 2000. The results also show that ID and IH are at second step which are same for years 1990 and 2000. However, at the third and last steps they are different.

Path model analysis: Path analysis helps in estimating the magnitude of the linkage between interrelated variables and provides information about the underlying causal process. However, the fundamental task here is to construct a path diagram in which direction (indicated by arrowheads) should be causally meaningful. This study employs a recursive path model (Alwin and Hauser, 1975).

In the path diagram, the causal links among the variables are assumed to be a conceptual framework conceived in advanced. It is to be noted that the data sets have no role to play in deciding either the causal links among the variables or the variables to be included in the

Table 4: Analysis of the effects of ID, IE, IH and PPC on IQL through endogenous variables and their percentages

Endogenous variables	Exogenous variables	Direct effect	Implied effect	Total association	Total effect	Non-causal effect	Indirect effect via X_3	Indirect effect via X_4
1990								
X_5	X_1	-	0.543 (68.22)	0.831	0.796	0.035	0.226 (28.39)	0.027 (3.390)
	X_2	-	0.103 (54.79)	0.356	0.188	0.168	0.090 (47.87)	-0.005 (2.660)
	X_3	0.315 (83.78)	-	0.782	0.376	0.406	-	0.061 (16.22)
	X_4	-0.179 (100.0)	-	-0.453	-0.179	-0.274	-	-
2000								
X_5	X_1	-	0.621 (80.96)	0.828	0.767	0.061	0.167 (21.77)	-0.021 (2.740)
	X_2	-	0.165 (79.33)	0.416	0.208	0.208	0.046 (22.12)	-0.003 (1.440)
	X_3	0.181 (59.54)	-	0.699	0.304	0.395	-	0.123 (40.46)
	X_4	-0.186 (100.0)	-	-0.472	-0.186	-0.286	-	-

Parenthesis indicates the percentage of total absolute effect on index of quality of life through endogenous variables; Non-causal effect = Total association - Total effect

path analysis. According to the causal ordering of the variables, the researchers may denote the selected set of variables into three groups which are given:

Exogenous variables:

X_1 = Index of development

X_2 = Index of environment

Endogenous variables:

X_3 = Index of health

X_4 = Percentage of population change

Dependent variable:

X_5 = Index of quality of life

In this model each variable is assumed to be dependent upon all prior causal variables. Under additional assumptions of linearity and additivity the system of equation are as follows:

$$X_3 = P_{31}X_1 + P_{32}X_2 + P_{3u}R_u$$

$$X_4 = P_{41}X_1 + P_{42}X_2 + P_{43}X_3 + P_{4v}R_v$$

$$X_5 = P_{51}X_1 + P_{52}X_2 + P_{53}X_3 + P_{54}X_4 + P_{5w}R_w$$

where, P_{ji} 's are path coefficients from X_i to X_j and R_u, R_V and R_w are random disturbance terms. This system of equations which is known as structural equations give us estimates of path coefficients and represent the weight attached to each link in the causal chains.

Discussion of path results: The results of zero order correlation coefficients of various indices of development, environment, health facilities and quality of life and percentage of population change for 1990 and 2000 helps us to get the non-causal effect (correlation) relationship among exogenous variables. Path coefficients are shown in Fig. 1 and 2 and the different types of effects and their percentage are shown in Table 4.

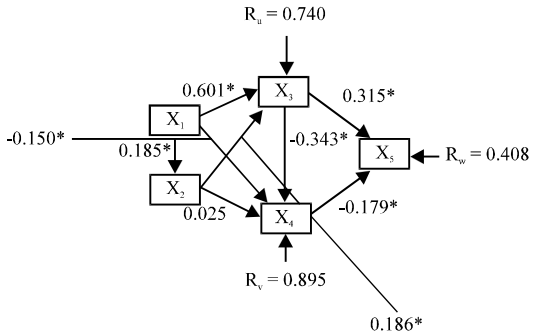

Fig. 1: Interrelationships among the indices and PPC in 1990; *Indicates 5% level of significance

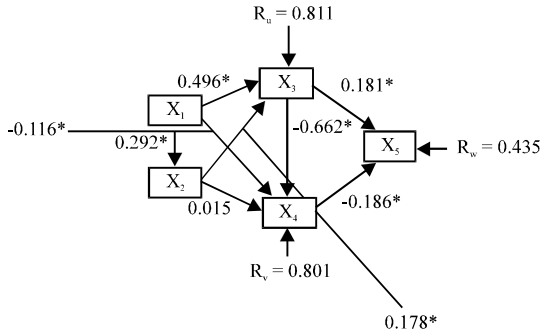

Fig. 2: Interrelationships among the indices and PPC in 2000; *Indicates 5% level of significance

According to Fig. 1 and 2, the researchers observe that 7 paths out of each 8 hypothesized paths are found to be statistically significant. In this study the researchers have to discuss the significant path coefficients only. Using the individual t-test the researchers shall deduce whether the path coefficients are significant or not.

In this model the researchers observe that health facilities (X_3)and PPC (X_4) have significant direct effect on

quality of life (X_5) in both the years. For both years the total effect of X_3 is in positive direction and the total effects of X_4 is in negative direction on quality of life. For the year 1990, the total effect of development on quality of life is 0.796 of which about 28% is transmitted through health facilities and about 3% through PPC and about 68% through its implied effect in the same direction. The total effect of environment on quality of life is 0.188 and about 48% of this effect is transmitted through the health facilities and about 55% through its implied effect in the same direction and then nearly 3% is transmitted through PPC in the opposite direction. For the year 2000, the total effect of development on quality of life is 0.767, of which about 22% is transmitted through health facilities and about 81% through its implied effect in the same direction and about 3% is transmitted through PPC in the opposite direction. The total effect of environment on quality of life is 0.208 and about 22% of this effect is transmitted through the health facilities and about 79% through its implied effect in the same direction and then nearly 1% is transmitted through PPC in the opposite direction. The analysis also indicates that quality of life improved when health facilities increased but the quality of life decreased with increase in population in both the years.

CONCLUSION

Study of population change, health, environment and development interrelationship is a complex one. A sound conclusion on the relationship of these phenomena is difficult if significant data are not available. It is true that while the purpose of development is to improve the quality of livelihood then population has become a factor of utmost consideration. The study demonstrates that the relationship between population and development factors can be explained to a great extent by health and environment. Universal attainment of an acceptable level of health and welfare services should be the main purpose of health development.

Health and welfare systems development should be advocated by all as a social movement for human development. In most developed countries population is growing slowly but levels of per capita consumption are so high that the environment is under pressure (Rahman *et al*., 2004). Also the study supports that quality of life improved when health facilities increased but quality of life decreased with increase in population. Therefore, in the process of improving the quality of life a concerted and integrated attempt should be given to harmonize the links among population change, health, environment and development.

And most priority for the policy makers of the country should be to delineate policies for country's development in the light of population change, health facilities and environmental conditions.

RECOMMENDATIONS

- More studies are needed to examine such relationships
- Policy makers should have to delineate necessary laws, regulations, funds and personnel regarding environment and health facilities to achieve a high standard of living
- A wide range of programs addressing environmental problems including population problems and health facilities should be demonstrated
- Top ranking country's policies should be followed by other countries to improve their conditions in the sector of health, environment, development as well as in living standard
- Timely, accurate and sufficient data should be published to demonstrate the relationship meaningfully which helps the policy makers and experts to take their policy and decisions for country's development

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