A study of district level development factors influencing infant mortality rate and life expectancy in the Indian Thar Desert

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Abstract

This study used a multiple regression analysis to examine socio-economic characteristics, physical amenities and health care at a district level and attempted to identify factors that specifically influence infant mortality rates (IMR) and life expectancy (LE) in the Indian Thar Desert. Twelve explanatory variables were considered. The criteria for inclusion of the variables in the regression model, out of those considered, was to include those for which the desert to non-desert ratio of square of their correlation coefficient (r^2%) with IMR and LE exceeded one. In addition, the human poverty index was included. The step down technique retained 6 variables in the regression model in the case of IMR and 4 in the case of LE. R^2% was 84% with retained variables to explain variation in IMR and LE in desert and quite low in non-desert. The number of health institutions and percentage of households visited by a health worker in the last 3 months, ranked top in influencing IMR and LE. The attributable regression suggests that the little increase (5%) in health institutions (health sub centres at village level) and doubling the number of health workers visiting households can better account for IMR and LE in the desert.

Keywords: infant mortality, life expectancy, health, correlates, multiple regression, desert.

Introduction

The Indian Thar desert is an arid region around 800 km long and 400 km wide in the north-west of India, spreading across the states of Rajasthan, Haryana and parts of Gujarat. It receives an average annual rainfall of less than 25 cm while the mean temperature varies from 24–26°C in summer and 4–10°C in winter. In parts of this desert, during summer it rises nearly to 50°C and in winter it falls nearly to freezing point. The study took place in Rajasthan, which occupies two thirds of the desert. It is a state of 32 districts out of which 11 are declared desert districts. There have been common and comparable state efforts of development among all its districts, but different topography and cultural practices have resulted in differences among desert and non-desert districts in the state with respect to certain parameters. Thus it was expected that there would be different influencing factors affecting Infant Mortality Rate (IMR) and Life Expectancy at birth (LE) in the desert and non-desert districts.

Method

This study looked at the following district level factors: percentage of literacy, poverty, road development, the percentage of households (H/H) having electricity or toilet facilities, the number of health institutions, immunisation coverage and the health care in terms of households visited by a health worker or the women visiting the health centre in the last 3 months. The study assessed 12 factors in all to describe socio-economic characteristics, physical amenities and health care at district level. This paper attempts to identify those variables out of the variables considered, which specifically influence the response variables, the IMR and LE in the desert part of the state. Measures to be taken in addressing IMR and LE in the desert are prioritised. Since IMR and LE are considered to be good indicators of the health of a population, these results may be extrapolated to other desert dwelling populations.

Data from the Indian Institute of Health Management Research in Jaipur was used for the study (Rajasthan Health Scenario 2000). For each of the independent study variables, the square of the coefficient of correlation, expressed in percentage (r^2%) was computed for its association with IMR and LE (dependent variables) separately for the desert and non-desert districts of the state. Variables for which the ratio of r^2% in desert to non-desert districts exceeded 1, both for IMR and LE were included in multiple regressions. The model also included the variable, human poverty index. The step down technique was used to retain significant ($P<.05$) variables in the models both for IMR and LE. The amount of regression attributed to the variables retained was used to prioritise health care related variables to influence IMR and LE in the desert.

Results

Table 1 gives the mean and standard deviation (SD) of the twelve variables considered, with their notations (X_1-X_{12}) to describe socio-economic, physical and health care status in the desert and non-desert districts of the state.

Table 1: Mean and SD of the considered variables in desert and non-desert parts of the state.

Variable Notation	Description	Desert		Non-desert	
		Mean	SD	Mean	SD
X_1	Percent Literacy	60.16	7.85	59.14	7.07
X_2	Human development Index	45.16	6.32	44.01	6.15
X_3	Human Poverty Index	63.05	3.47	62.06	3.65
X_4	Road Development Index	66.55	17.45	50.27	13.11*
X_5	Percentage of H/H having electricity	34.09	11.39	33.12	9.05
X_6	% of H/H with toilet facility	21.18	13.16	16.06	7.03
X_7	% of Urban poor	12.74	5.22	15.28	7.01
X_8	% of families below poverty line	23.17	9.04	36.17	15.07*
X_9	Number of health institutions	435.45	132.39	346.19	132.97*
X_{10}	% of complete immunisation	35.42	11.20	37.17	12.6
X_{11}	% of women visiting health facilities in last 3 months	13.46	5.19	13.78	4.24
X_{12}	% of H/H visited by a health worker in last 3 months	16.39	6.45	22.15	8.49*

* Significant (P <0.05)

Table 2 gives the ratio of r^2% in desert to non-desert, for each of these variables, when their association is considered with IMR and LE respectively. The criteria of consideration of variables for the multiple regression, yielded only seven variables; literacy rate (X_1), road development index (X_4), electricity provision percentage (X_5), percentage of households (H/H) with toilet facilities (X_6), number of health institutions (X_9), percentage of complete immunization (X_{10}) and percentage of rural H/H visited by a health worker in last there months (X_{12}). In addition to these, we also included human poverty index (X_3).

Table 2: Variables with their desert to non-desert ratio of r2 % for IMR and LE

Variable Notation	Description	Ratio of r2%	
		IMR	LE
X_1	Percent Literacy	3.68	69.44
X_2	Human development Index	0.83	1.09
X_3	Human Poverty Index	0.61	0.25
X_4	Road Development Index	150.0	169.0
X_5	Percentage of H/H having electricity	1.55	0.78
X_6	% of H/H with toilet facility	5.82	2.47
X_7	% of Urban poor	0.07	0.49
X_8	% of families below poverty line	0.88	0.36
X_9	Number of health institutions	351.5	8.03
X_{10}	% of complete immunisation	61.0	90.25
X_{11}	% of women visiting health facilities	0.61	1.15
X_{12}	% of H/H visited by a health worker in last 3 months	8.02	152.11

Using the step down technique, the variables retained in multiple regressions with IMR and LE in the desert are given respectively in Tables 3 and 4, together with the amount of regression attributed to variables retained and performance of the model in the desert and non-desert as measured by the values of coefficient of determination (R^2%).

Table 3: Variables retained in multiple regression with IMR in desert, the amount of regression attributed to these variables and performance of the model in desert and non-desert areas

Variables retained	Amount of regression attributable to variables retained	Percentage contribution to regression by the variables	Enhanced percentage contribution of health care related variables, if they alone are considered to account for all regression contribution	Performance of regression model (R^2%)
X_9	314.458	47.48	5.31	Desert 84.63%
X_{12}	171.329	25.87	93.27	
X_3	108.24	16.34		Non-desert 32.75%
X_5	27.188	4.11		
X_6	25.419	3.84		
X_{10}	15.651	2.36		

Table 4: Variables retained in multiple regression with LE in desert, the amount of regression attributed to these variables and performance of the model in desert and non-desert

Variables retained	Amount of regression attributable to variables retained	Percentage contribution to regression by the variables	Enhanced percentage contribution of health care related variables, if they alone are considered to account for all regression contribution	Performance of regression model (R^2%)
X_{12}	126.27	46.62	7.2	Desert 84.72%
X_9	54.323	20.06	149.2	
X_3	48.229	17.81		Non-desert 16.38%
X_5	42.005	15.51		

It is observed from Table 1 that there has been common and comparable state efforts of development in the desert and non-desert parts of the state, as all the considered variables matched well except road development, percentage of families below poverty line, number of health institutions and the percentage of households visited by a health worker in last three months, for which significant differences are noted. It is also observed from this table that there has been good socio-economic development in the desert. However, provision of electricity and toilet facilities in households is still poor (34 and 21% respectively). Towards health care development, complete immunization is only 35%. Access to health care is also poor as reflected by 13% of women visiting a health facility or 16% of households visited by a health worker in last three months. Table 2 provides the ratio of correlations (r^2%) of the variables considered, with IMR and LE respectively in desert to non-desert. The criteria of selecting those variables among these, for which this ratio exceeded 1, both for IMR and LE has its merit reflected in R^2% values in the multiple regression of these variables with IMR and LE respectively in the desert and non-desert. From Table 3, R^2% in the desert is 84.63% and in non-desert, it is 33% for IMR and 85 % and 16% respectively for LE. Performance in the regression model justifies the criteria of the variable selection process for the regression. The values of R^2 % also explain the variability in IMR and LE by the retained variables in the regression in the desert as compared to the non-desert. The amount of regression attributable to the retained variables is also given for IMR and LE in these tables in descending order of their magnitude. This reveals the relative importance of these variables in explaining the variation in IMR and LE in the desert.

Discussion

It is noted from Table 1 that less attention has been paid towards health care in terms of complete immunisation, adequate number of health institutions, and visits of households by a health worker or motivation of women to visit health centres regularly. However, due attention has been paid to literacy, poverty, provision of electricity and road development but provision of toilet facilities at home still remain poor. Factors affected by the issues of poor accessibility or that were paid less attention by the health service or population were more prominent in explaining the variation in IMR and LE in the desert.

Out of the 12 explanatory variables considered, 7 qualified for inclusion in the regression, as per the laid criteria of inclusion of the variables, which justified its merit in terms of the value of R^2 % (84%). The multiple regression retained only 6 variables; the number of health institutions(X_9), percentage of households visited by a health worker in last 3 months (X_{12}), human poverty index (X_3), percentage of households having electricity (X_5), percentage of households having toilet facilities (X_6) and

percentage of complete immunization (X_{10}); when the considered explanatory variables were regressed with IMR for the desert districts. In case of regression with LE, all these variables, except X_6 and X_{10} are retained; with interchange of position of X_9 and X_{12} in terms of their relative importance in explaining the variation in LE. Poverty (Shah et al 1987 and Shawky 2001), living conditions (Guimarcaes et al 2003), toilet facilities at home (Shawky 2001 and Raham et al 1985), and immunization (Rajan and Navaneetham 1985 and Meza 1985), have already been reported in literature to influence IMR and they have figured here also. Regression here also included the health care related variables X_9 and X_{10} with their top influence. In the desert, poor accessibility highly influences health care and as such, these variables are pronounced influencing variables. Though, the literature also report literacy (Arntzem 1985, Gupta and Baghel 1985, Sufian 1985, Shawky 2001) as an influencing factor for IMR; but this has not figured in the regression. It was probably taken care of by the figured variable, percentage of households having electricity, which exposes people to the media. With regard to LE, its association has been reported with poverty (Messias 1985 and Regidor et al 1985) and also with literacy (Regidor 1985). Again the factors related to health care have figured as top influencing factors with poverty and percentage of households having electricity, which takes care of literacy in the regression model. Immunization and toilet facilities at home figured in case with IMR but not in case with LE. These factors are more important to IMR. Thus the retained variables in the regression logically are consistent with the literature and to the desert situation.

Health care in the desert, which is hindered to a large extent by poor accessibility, is naturally the top influencing factor in the regression. If the health care related variables alone were promoted to address IMR and LE in the desert, it is noted through their regression contribution given in Tables 3 and 4, that the two variables, X_9 and X_{12} (weighed equally in the regression), would be enhanced by 5% and 93% in case of IMR and 149% and 7% in case of LE. This indicates that improvement of health services is perhaps an easier and more manageable way to address IMR and LE in the desert.

Conclusion

Developmental efforts in Rajasthan have been common and comparable in desert and non-desert areas, but more socio-economic development has taken place as compared to the provision of electricity and toilet facilities (reflecting living conditions) and health care. The variables retained in the multiple regression out of those considered by the criteria used, explain well (R^2% =84) the variation in IMR and LE in desert. Among the priority ranking of the factors influencing IMR and LE, the health care related variables - number of health institutions and percentage of households visited by a health worker in last three months have been at the top. These are easily modifiable variables. Accounting for regression by these variables alone suggests that this strategy would have a good impact on reducing IMR and LE in the desert part of the state. The number of health institutions (a small health care unit at a village level) need to be increased by 5% and the percentage of households visited by a health worker in the last three months need to be doubled. If health workers are working to capacity, the latter need implies that the number of health workers posted at a health sub centre needs to be doubled. Later, the number of health institutions should be increased further gradually. At present, there happens to be one health institution per 50,000 persons.

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