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FACTORS AFFECTING THE INCIDENCE OF COMMUNICABLE DISEASES

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Short Profile

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ABSTRACT:
A large portion of the global burden of disease can be attributed to communicable diseases. Deaths due to communicable diseases can be avoided when the victim has the required means to seek available health care. Poor sanitation, inadequate access to health care and poverty are all contributing factors. This paper attempts to analyse the importance of these factors in determining the incidence of communicable diseases. We find that poverty and poor sanitation contribute in a significant manner to increase the incidence, but public health expenditure doesn't seem to reduce it. The policy implication of this finding is to improve the targeting of public health expenditure so as to tackle this substantial burden of disease.

KEYWORDS
communicable diseases, global burden of disease, policy, health, poverty, sanitation

INTRODUCTION:

Communicable diseases constitute around 25% of the global burden of disease (De Gregorio et al., 2004; Benenson, 1970). The situation is worse in developing countries: in India alone, communicable diseases contribute to more than 50% of the burden of disease (Mathers et al., 2008). Deaths due to communicable diseases can be avoided when the victim has the required means to seek available health care, and it can be assumed that in poor, developing countries, timely access to quality medical facilities is rare (Misra and Puri, 2005).

Such readily preventable diseases are often transmitted through vectors that breed in unhygienic conditions. In 2004, around 40% of the world's population had no access to sanitation (De Gregorio et al., 2004). Lack of sanitation exposes people to sanitation-related diseases like cholera, typhoid, hepatitis, diarrhoea and polio (Gwatkin et al., 1999).

Public government expenditure, targeted at improving access to quality sanitation can prevent the incidence of such ailments.

OBJECTIVES

Considering the above facts, this paper attempts to analyse how the incidence of communicable diseases is correlated with public health expenditure, sanitation and poverty, using a standard OLS analysis.

METHODOLOGY

Sampling & Data Collection

Stratified sampling was used to select 49 countries for a cross section study. Stratification was done according to distribution of world population in the respective regions (Haub, 2001). Data was collected for the year 2002.

Continent	%age of World Population	No. of countries chosen	Countries chosen
Europe	11.37	6	Belarus,Romania ,Spain,Germany,Finland,Bulgaria
Asia	60.59	23	China, Japan, Democratic Republic of Korea, Mongolia, Russia, Timor- Leste, Thailand, Vietnam, Indonesia, Philippines, Cambodia, Bhutan, India, Pakistan, Nepal, Bangladesh, Sri Lanka, Kazakhstan, Kyrgystan, Tajakistan, Turkey, Yemen, Jordan
Australia	0.52	1	Australia
Americas	13.71	10	Brazil, Argentina, Colombia,Cuba, Dominican Republic,Nicaragua, Guatemala,US, Canada, Mexico
Africa	13.81	9	South Africa,ethiopia,Congo,Kenya, Tanzania, Rwanda ,Ghana, Nigeria,Egypt
TOTAL	100	49	

Choosing the variables

Three regressors were selected:

% of population with sustainable access to improved sanitation:

Improved sanitation facilities are defined in terms of the types of technology and levels of services that are more likely to be sanitary than unimproved technologies. Improved sanitation includes connection to public sewers, connection to septic systems, pour-flush latrines, simple pit latrines and ventilated improved pit latrines. Not considered as improved sanitation are service or bucket latrines (where excreta is manually removed), public latrines and open latrines.

General government expenditure on health as a percentage of total government expenditure:

General government expenditure on health (GGHE) is the sum of outlays for health maintenance, restoration or enhancement paid for in cash or supplied in kind by government entities, such as the Ministry of Health. It includes transfer payments to households to offset medical care costs and extra budgetary funds to finance health services and goods.

Population living below poverty line:

Percentage of population living on less than a $ a day.

The regressand was chosen as:

% of years of life lost to communicable diseases:

WHO defined indicator was used. The YLLs (percentage of total) indicator measures the YLLs due to a particular cause of death (here, communicable diseases) as a proportion of the total YLLs lost due to premature mortality in the population.

DEVELOPING THE MODEL

The following equation was estimated using the data:

$$com\_yrs = B_1 + B_2 GE + B_3 san + B_4 pov\_pop + u$$

where,

com_yrs= % of years of life lost to communicable diseases
GE= Government health expenditure as a percentage of total expenditure
san=% of population with sustainable access to improved sanitation
pov_pop=% of population living below poverty line (a $ a day definition)
B_1, B_2, B_3 and B_4 are regression coefficients
and
u is the stochastic error term.

Hypothesis Testing

All the regressors were assumed to have a significant effect on the regressand, hence the null hypothesis states that their coefficients are significantly different from zero.

$H_0 : B_2=0$
$H_1 : B_2<0$ (since a rise in government expenditure is assumed to result in a decrease in years of life lost due to communicable diseases)

$H_0 : B_3=0$
$H_1 : B_3<0$ (since a rise in access to sanitation is assumed to result in a decrease in years of life lost due to communicable diseases)

$H_0 : B_4=0$
$H_1 : B_4>0$ (since a rise in BPL population is assumed to result in an increase in years of life lost due to communicable diseases)

All the above one-tailed tests were conducted at 5% level of significance. (α=0.05)

RESULTS AND OBSERVATIONS

The following results were obtained:

The regression equation is

com_yrs = 79.4 - 0.515 GE - 0.602 san + 0.317 pov_pop

Predictor	Coefficient	t	p
Constant	79.375	8.78	0.000
GE	-0.5149	-0.97	0.337
san	-0.6020	-5.34	0.000
pov_pop	0.3169	2.13	0.039

R^2= 76.1% R^2 (adjusted) = 74.5%

Analysis of variance

Source	DF	SS	MS
Regression	3	26525.8	8841.9
Residual Error	45	8320.2	184.9
Total	48	34846.0	

F=47.82 p=0.00

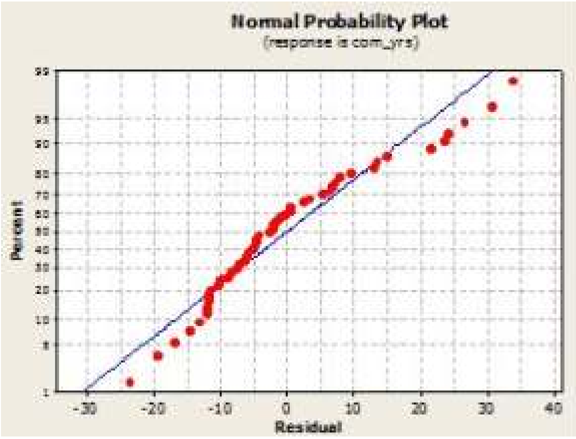
It can be seen that:

• "Correct" (or expected) signs of all coefficients were obtained.
• R_2 is quite high (0.76). F-test for R2 is also significant at 5% level of significance.
• B_2 is not statistically significant, i.e. government public expenditure doesn't seem to have a significant impact in reducing incidence of communicable diseases. This could be due to violation of Classical Linear Regression Model assumptions (examined later). However, one explanation for this could be that the focus of expenditure is not on the correct path. For instance, in India, focus of health expenditure was, for a long time, targeted on reproductive health and population reduction. The over-emphasis on

curative rather than preventive health measures led to communicable diseases contributing to almost 50.3 % of the burden of disease in India. Thus, inefficient use of resources and problems of corruption etc. probably prevent this variable from having any significant impact.
•Other variables are statistically significant, as expected.

Data testing

The data was tested to examine whether three CLRM assumptions are satisfied:



1.As can be seen, residual plot approximates a line. It can be assumed that the residuals are normally distributed.

2.Multicollinearity

Correlation

	GE	san	pov_pop
GE	1	0.494	-0.29
san	0.494	1	-0.74
pov_pop	-0.29	-0.74	1

As seen, there seems to be high pair wise correlation between population below poverty line and sanitation. This is expected, as poverty and access to sanitation are usually highly negatively related. Other correlation coefficients are not very high, and have the correct signs.

3.Autocorrelation

Durbin-Watson statistic = 1.97045
The value is very close to 2. Thus we don't reject the null hypothesis of zero autocorrelation. There doesn't seem to be significant auto correlation: this is to be expected as this is a cross section study.

RETHINKING THE MODEL

Since all variables are in percentages, we should use natural logarithms of the variables (Gujarati and Porter, 1999). Estimating a double-log regression, we get:

$\ln(com\_yrs) = B_1 + B_2 \ln(GE) + B_3 \ln(san) + B_4 \ln(pov\_pop) + u$

where,

ln denotes natural logarithm of the respective variable.

Hypothesis Testing:

The null hypotheses are same as in the above model.

Results and observations

The following results were obtained:

The regression equation is

ln_yrs = 6.00 - 0.170 ln_GE - 0.582 ln_san + 0.125 ln_pov

Predictor	Coefficient	t	p
Constant	6.0032	9.37	0.000
ln_GE	-0.1700	-1.27	0.211
ln_san	-0.5819	-3.97	0.000
ln_pov	0.12516	5.39	0.00

R^2= 72.6% R^2 (adj) = 70.8%

Analysis of variance

Source	DF	SS	MS
Regression	3	31.064	10.355
Residual Error	45	11.701	0.260
Total	48	42.765	

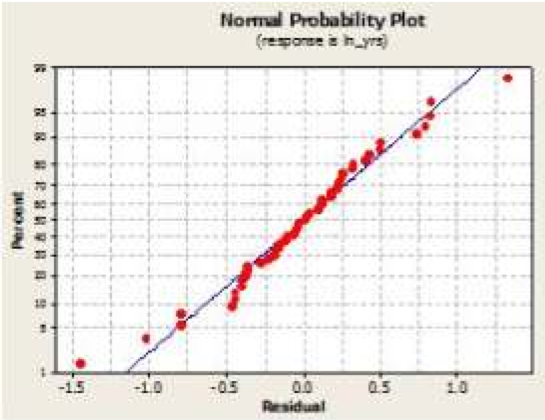
F=39.82 p=0.00

It can be seen that:

• "Correct" (expected) signs are obtained.
• R_2 is high (0.72). F-test for R2 is also significant at the 5 % level of significance.
• B_2 is still not statistically significant, i.e. government public expenditure doesn't seem to have a significant impact in reducing incidence of communicable diseases. Thus, we can accept the explanation that inefficiency in resource utilization and corruption etc. prevent this variable from having any significant impact.
• Other coefficients are statistically significant.

Data testing

We test the data to examine whether 3 CLRM assumptions are satisfied:



1.As seen, the residual plot fits the line very closely. It seems to be a better fit than the LIV model. This could be due to better specification of the model using logs.

2.Multicollinearity

Correlation matrix

	ln_GE	ln_san	ln_pov
ln_GE	1	0.299	-0.383
ln_san	0.299	1	-0.564
ln_pov	-0.383	-0.564	1

There seems to be no “exceptionally” high pair-wise correlation among the variable. This is in contrast to the above LIV model. The reduction in correlation could be a result of better specification of the model using logs.

3.Autocorrelation

Durbin-Watson statistic = 1.70833

The value is quite close to 2. Thus we don’t reject the null hypothesis of zero autocorrelation. There doesn’t seem to be significant auto correlation.

EXTENDING THE MODEL

We extend the model and include a dummy variable. The dummy takes 2 values:

D=0, if the country is developing
D=1, is the country is developed.

The classification of countries in the above-mentioned categories is done on the basis of Human Development Report, 2004. Countries ranked above 63 (that is rank<=63) have been assigned the value

1, and the others have been assigned the value 0.

We estimate the following regression:

$ln(com\_yrs) = B_1 + B_2 ln(GE) + B_3 ln(san) + B_4 ln(pov\_pop) + B_5(D) + u$

The hypotheses for all coefficients except B5 are the same as above. For B5, we set up:

H_0: $B_5 = 0$
H_1: $B_5 < 0$ (since a developing country is assumed to have a low incidence of communicable diseases)

Results and observations

The following results were obtained:

The regression equation is

ln_yrs = 6.20 - 0.146 ln_GE - 0.595 ln_san + 0.0780 ln_pov - 0.668 D

Predictor	Coefficient	t	p
Constant	6.1969	10.62	0.000
ln_GE	-0.1461	-1.20	0.236
ln_san	-0.5948	-4.47	0.000
ln_pov	0.07797	3.07	0.004
D	-0.6681	-3.29	0.002

Analysis of variance

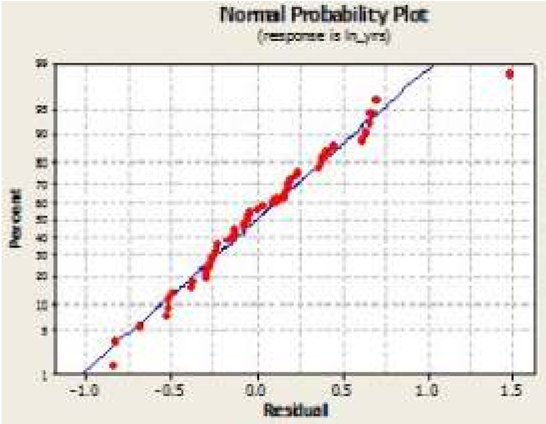
Source	DF	SS	MS
Regression	4	33.3791	8.3448
Residual Error	44	9.3858	0.2133
Total	48	42.7649	

R^2 = 78.1% R^2 (adj) = 76.1% F=39.12 p=0.00

It can be seen that:

- "Correct" (expected) signs are obtained.
- R_2 is high (0.78). F-test for R_2 is also significant at the 5% level of significance.
- B_2 is still not statistically significant, i.e. government public expenditure doesn't seem to have a significant impact in reducing incidence of communicable diseases. Thus, we can accept the explanation that inefficiency in resource utilization and corruption etc. prevent this variable from having any significant impact.
- Other coefficients, including the dummy coefficient, are statistically significant. The differential impact of whether a country is developed or not is given by eB5-1, which is the proportionality factor.

Data testing: To test whether 3 CLRM assumptions are satisfied:



1.The residual plot is a close fit to the line.

2.Multicollinearity

The matrix will be as in the above model. Dummy variable has not been considered for multicollinearity.

3.Autocorrelation

Durbin-Watson statistic = 1.58732

The value is moderately close to 2. Thus we don't reject the null hypothesis of zero autocorrelation. There doesn't seem to be significant auto correlation.

LIMITATIONS OF THE ANALYSIS

Due to limited and scattered data, a few countries had to be dropped. This could have led to incomplete coverage. Also, although data was chosen for the year 2002 for the dependent variable (com_yrs) and one explanatory variable (GE), for the other variables, we were restricted by non-availability of data, and hence had to use data of the years 2000, 2003 & 2006.This has diluted the authenticity of a "cross-section" study.

Heteroscedasticity tests were not conducted, because the software used didn't provide us with the required tool. Also, using a log model considerably reduces this problem.

Due to conflicting data from different sources, especially for data on poverty, we had to use our discretion in choosing a particular data set.

Although we tried to collect a stratified sample, in some continents, the desired number of countries could not be chosen due to non-availability of data. For example, according to population distribution, around 30 countries should have been chosen from Asia, but this was not possible, because most of Asia's population is concentrated in China and India, and data was limited for other countries.

For some countries, a figure of zero (0) was obtained for the poverty variable. We had to change this figure from 0 to 0.001 to be able to fit a double-log model.

Although not apparent in the correlation matrices, there is an inevitable relation between the chosen variables. Social indicators tend to be highly related, even if they didn't seem "statistically" significant.

CONCLUSIONS

The regression analysis has helped us understand the underlying socio-economic model regarding the variables affecting the incidence of communicable diseases. As per the regression model, all the variables except government health expenditure are statistically significant. As mentioned above, this could be due to various reasons such as mistargeting and/or misuse and/or misallocation of government funds.

We first regressed the variables in a linear-in-variables model but found that all CLRM assumptions were not being met as the Normal Probability Plot of the residuals was not a straight line as would be expected. Also, we suspected that there might be a problem of multicollinearity among the explanatory variables as the symptom of high R2 but (one) insignificant coefficient was apparent in the test results. Besides, there is probably a specification error in defining the model as a LIV (since the values are in percentages).

Thus, we conducted a new regression with variables converted to natural logs and found that CLRM assumptions were being met better as the Normal Probability Plot better approximated a straight line. Also, R2 value decreased (but not significantly) while the coefficient of the government expenditure variable remained insignificant. This led us to conclude that while our data is still quite restricted, from what we could see, government 'expenditure' on health is probably not a major influence on the level of mortality due to completely preventable diseases.

In sum, we found that the life years lost to communicable diseases is affected significantly by the level of poverty in the society, the access (or lack of it) to improved sanitation and the status of the economy as a whole. As is expected, the more severe the poverty level (having a significant percentage of population below a poverty line of a dollar a day is certainly indicative of severe and chronic poverty), the greater the percentage of life years lost to communicable diseases. Also, the better the sanitation facilities, the lower is mortality due to diseases caused by unhygienic living. In a developed economy one would normally expect better sanitation facilities to all and lower overall poverty apart from more homogenous and generous social security for health and so, lesser mortality from preventable and treatable ailments. This is held up by our regression. Of course, the finding that government expenditure on health is not very significant goes against conventional logic but this has been so probably due to the diffusion of government expenditure into various targets that may actually go against the notion of generalised basic health like family planning, for instance or immunization against the major diseases. While spending in these areas is surely needed, much more can be done with much little funds if they are directed towards the easily "defeatable" killers like preventable communicable diseases. Also, the corruption that is prevalent in some degree in all the countries of the world is a major stopper to the better flow and reach of well-intentioned government spending.

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