**Title:**

**Effects of Socio-economic, Demographic and Health Factors**

**on Life Expectancy in the Least Developed Countries**

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**Abstract**

**Background:** Life expectancy is an important measurement of the development and health status. The aim of this study is to build up the relationships of socio-economic, demographic and health factors with life expectancy in the least developed countries (LDCs).

**Methods:** Necessary information and data are collected from 48 (LDCs) from the United Nations agencies. Univariate, bivariate and multiple linear regressions have been conducted to analyze the data. In bivariate analysis correlation analysis and in multiple linear regression, the stepwise multiple linear regression have been adopted for this study.

**Results:** The study results revealed that almost all the factors were significantly correlated with life expectancy. The study had clarified that among the variable deaths, infant mortality rate, population density and gross national income per capita were the significant predicators of life expectancy in LDCs.

**Conclusions:** There are close relations between life expectancy and demographic, socio-economic and health related factors. International efforts should aim at increasing life expectancy by decreasing infant mortality rate, deaths, population density and increasing gross national income per capita in LDCs.

**Keywords:** life expectancy, least developed countries, health factor, demographic and socioeconomic factors, stepwise multiple regressions

**1. Introduction**

Life expectancy at birth (LE) is widely used as an indicator of overall development of a Country. Life expectancy at birth is a well-known demographic measure of population longevity and an important synthetic indicator for assessing economic and social development of a region. Life expectancy has significantly increased but it has also demonstrated persistently high variability between countries over the past half-century. Life expectancy is influenced by a range of socioeconomic and demographic factors (Vagero, 2007, Moser et al 2005, Balan et al., 2011, and Dowd et al., 2010). The vast variation of life expectancy still exists in LDCs. In many of the countries of the developing world, Sub-Saharan Africa in particular, life expectancy has been decreasing. In some of the countries although income and health expenditure is increasing, life expectancy is decreasing (Kabir, 2008).

The level and variability of life expectancy has the important implications for individual and aggregate human behavior. It affects fertility behavior, economic growth; human capital investment, intergenerational transfers, and incentives for pension benefit claims and vary according to genders and areas of residence (Jaba et al., 2010; Zhang et al., 2001; Coile et al., 2002). Thus, life expectancy reflects the health of a country’s people and they receive the quality of care when they are ill (Meara et al., 2008; Shkolnikov et al., 2006). The demographic and socioeconomic predictors of life expectancy may consist of gender, age, education, and Gross National Income (GNI) per capita (Meara et al., 2008; Shkolnikov et al., 2006; Bulled et al., 2010; Khang et al., 2010). Kabir (2008) concluded that most of explanatory variables turned out to be statistically insignificant, which imply that relevant socio-economic factors like per capita income, education, health expenditure, access to safe water, and urbanization cannot always be considered to be influential in determining life expectancy in developing countries. With the same objective, to explore the socioeconomic factors associated with life expectancy, Lei et al. (2009) identified a model with four factors associated with life expectancy in Beijing. Inequalities in income and education have recently been identified to account for regional inequalities in life expectancy as well as in other health indicators (Hoi et al., 2009). Camargos et al. (2007) observed the relationships between education and life expectancy. Longer life expectancy was associated with low infant mortality rates and high literacy rates and when the risk of mortality are high, the populations are expected to reproduce frequently, to increase the probability of some offspring surviving to maturity, and early, to ensure reproduction before death (Lin et al., 2003,Koons et al. (2008).The healthcare services such as increased number of physicians, hospital deliveries, and prenatal examination could increase life expectancy (Rattanamongkolgul et al., 2004; Seubsman et al., 2011). Singariya (2013) studied that, demographic variable had negative association with life expectancy. In another study by Hussain (2002) carried out determinants of life expectancy, using cross country data of 91 developing countries. He found per capita GNP, fertility rate, adult illiteracy rate, per capita calorie intake, and dummy variable for sub-Saharan Africa to be significant variables in both linear and log linear models. There are many researches on relationships of demographic, social and health factors with life expectancy. In this paper little research has been taken in case of least developed country to fill the gap in the previous studies. The objective of this study is Identifying and exploring the relationships between socio-economic, educational, demographic and health factors with life expectancy at birth on the basis of recent information of 49 least developed countries.

**2. Data and Methods**

In this study, some variables were selected that have shown effects on life expectancy in the previous studies (Mondal et al., 2014,Khang et al., 2010, Lin et al., 2012; Chan et al., 2012; Robine, 2003; Tang et al., 2009;Anderson, 2010). Data and necessary information were obtained from the World Health Organization (WHO, 2013), United Nations Development Programs (UNDP) (UNDP, 2012), and World Population Data Sheet, Population Reference Bureau (PRB) (PRB, 2013). Country list is taken from The Least Developed Countries Report (2012) by UNCTAD. A list of these countries is shown in Appendix B and all the variables, their sources and descriptions are included in a table of the Appendix A. It was investigated the effects of some demographic, socioeconomic status, and the availability of health factors on Life expectancy. In this study, life expectancy is dependent variable. Other variables are taken from three determinants: demographic variables, socioeconomic factors and health factors. Demographic variables include total fertility rate (TFR), adolescent fertility rate, infant fertility rate (IMR), deaths per 1000 population, population density (PD); socioeconomic variables include gross national income (GNI) per capita, education index (EI); health related variables include physician density, HIV prevalence, using Sanitation. There are 48 least developed countries in the world according to UNCTAD. Data and necessary information were obtained from these 48 countries. The data were used for univariate analysis to carry out the description of the variables through maximum, minimum, mean, median, standard error of mean (SE mean), and standard deviation (SD). The bivariate analysis, Pearson’s correlation analysis was used to find the relationships among the variables; and finally forward multiple linear regression analysis was used to examine the average relationship between LE and socio-health factors and find out the most prominent affecting factors on LE. The multiple linear regression analysis examined each independent variable with LE as the dependent variable. The underlying multiple linear regression model is:

y = β0+ β1X1+ β2X2+ β3X3+………..+ βnXn+ε (1)

where *Y* is the response variable (LE), *Xi* (*i* =1, 2, 3,. . ., *n*) are the predictors, β0 is the intercept term, β1, β2, β3,……, βn  are the unknown regression coefficients, and ε is the error term with a N(0,σ2) distribution. The variance inflation factor (VIF) was used to check multi-collinearity problem among the predictors. The variance inflation for independent variables *Xj* is:

,j=1,2,….,p (2)

Where, *p* is the number of predictors and Rj2 is the square of the multiple correlation coefficient of the *j th* variable with the remaining (*p-*1) variables, where:

1. if 0<VIF<5, there is no evidence of a multi-collinearity problem;
2. if 5<VIF<10, there is a moderate multi-collinearity problem; and
3. if VIF>10, there is a serious multi-collinearity problem of those variables.

The Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc, Chicago, IL, USA) was used for statistical analysis.

**3. Results**

In this study, 48 least developed countries were included. Univariate, bivariate and forward multiple regression approaches have been applied as the statistical tools.

**3.1 Univariate Analysis**

Background statistics of predictor and response variables are explained in Table 1. It explains the maximum and minimum values for all variables as well as their means, medians, standard error means (SE means) and standard deviations (SD) to explore the main features of data of these countries under study. This analysis is useful because different variables are often measured in different units, and have very different ranges.

Table 1 provides most important information and significant results of the study countries regarding life expectancy and its determinants are discussed here. Of these countries, the LE of Sierra Leone is the lowest (45 years), the LE of Samoa is the highest (73 years) and mean, median, SE means and SD are 59.44, 60.00, 0.95,and 6.56 respectively. In case of GNI, the GNI of Democratic Republic of the Congo is the lowest (370.00) and the GNI of Equatorial Guinea is the highest (18900.00) and mean, median, SE means and SD are 2315.90, 1505.00, 441.88, and2931.08 respectively. In case of EI, the EI of Niger is the lowest (0.18) and the Samoa is the highest (0.77) and mean, median, SE means and SD are 0.39, 0.37, 0.02, and0.12respectively. In case of AFR, the AFR of Myanmar is the lowest (12.00) and the AFR of Niger is the highest (192.00) and mean, median, SE means and SD are 83.70, 69.50, 6.43 and 43.61respectively. In case of TFR, the TFR of Myanmar is the lowest (2.00) and the TFR of Niger is the highest (7.60) and mean, median, SE means and SD are 4.83, 4.90, 0.18 and 1.28 respectively. In case of PHD, the PHD of United Republic of Tanzania is the lowest (0.10) and the PHD of Tuvalu is the highest (10.90) and mean, median, SE means and SD are 1.65, 1.00, 0.33 and 2.00 respectively. In case of HIV prevalence, the HIV prevalence of Bangladesh is the lowest (5.10) and the HIV prevalence of Lesotho is the highest (14600.00) and mean, median, SE means and SD are 1716.10, 707, 417.85, and 2675.54 respectively. In case of IMR, the IMR of Tuvalu is the lowest (17.00) and the IMR of Sierra Leone is the highest (128.00) and mean, median, SE means and SD are 63.19, 61.00, 3.47 and 24.02 respectively. In case of deaths, the deaths of Samoa and Vanuatu is the lowest (5.00) and the deaths of Sierra Leone is the highest (18.00) and mean, median, SE means and SD are 10.06, 9.00, 0.49 and 3.39 respectively. In case of PD, the PD of Mauritania is the lowest (4.00) and the PD of Bangladesh is the highest (1087.00) and mean, median, SE means and SD are 116.40, 50.50, 26.25 and181.88 respectively. In case of using sanitation, the using sanitation of Niger is the lowest (10.00) and the using sanitation of Samoa is the highest (92.00) and mean, median, SE means and SD are 36.49, 33.00, 3.13, and21.00 respectively.

**3.2 Bivariate analysis**

The correlation coefficients (*r*) were derived to examine direction, strength and significance of linear relationships between the variables (Table 2)

The significant similar relationships were found between LE with education index (*r* = 0.39, *P*<0.01), physician density (*r* = 0.49, *P*<0.01), population density (*r* = 0.29, *P*<0.05) and using sanitation (r = 0.49, *P*<0.01). On the other hand, significant opposite relations were found between LE with adolescent fertility rate (*r* = -0.54, *P*<0.01), TFR (*r* = -0.58, *P*<0.01), HIV prevalence (*r* = -0.48, *P*<0.01), IMR (*r* = -0.08, *P*<0.01), deaths (*r* = -0.95, *P*<0.01). Again GNI (*r* = 0.07) is positively correlated with LE. Again, GNI is positively correlated with educational index (r = 0.26), physician density (*r* = 0.43), HIV prevalence (r = 0.03),using sanitation (*r* = 0.49, *P*<0.01) and adolescent fertility rate (*r* = -0.07) and TFR (*r* = -0.13), IMR (*r* = -0.16), Deaths (*r* = -0.02), PD (*r* = -0.12) were negatively correlated. Again, educational index is positively correlated with physician density (r = 0.56, *P*<0.01), HIV prevalence (r = 0.29), PD (*r* = 0.11), using sanitation (*r* = 0.44, *P*<0.01) and adolescent fertility rate (*r* = -0.33, *P*<0.05) and TFR (*r* = -0.35, *P*<0.05), IMR (*r* = -0.38, *P*<0.05), deaths (*r* = -0.37, *P*<0.05), were negatively correlated. Again, adolescent fertility rate is positively correlated with TFR (r = 0.60, *P*<0.01), HIV prevalence (*r* = 0.13), IMR (0.34, *P*<0.05), deaths (*r* = 0.54, *P*<0.01) and physician density (*r* = -0.51, *P*<0.01), PD (*r* = -0.27), using sanitation (*r* = -0.56, *P*<0.01) were negatively correlated. Again, TFR is positively correlated with HIV prevalence (*r* = 0.05), IMR (0.52, *P*<0.01), deaths (*r* = 0.51, *P*<0.01) and physician density (*r* = -0.55, *P*<0.01), PD (*r* = -0.37, *P*<0.01), using sanitation (*r* = -0.39, *P*<0.01) were negatively correlated. Again, physician density is positively correlated with PD (r = 0.39, *P*<0.05), using sanitation (*r* = 0.62, *P*<0.01) and HIV prevalence (*r* = -0.42, p<0.05), IMR (-0.52, *P*<0.01), deaths (*r* = -0.37, *P*<0.05) were negatively correlated. Again, HIV prevalence is positively correlated with IMR (r = 0.11), deaths (*r* = 0.43, *P*<0.01) and PD (*r* = -0.11), using sanitation (*r* = -0.08) were negatively correlated. Again IMR is positively correlated with deaths (r = 0.77, *p*<.001) and PD (*r* = -0.28) and using sanitation (*r* = -0.36, *P*<0.01) were negatively correlated. Deaths is negatively correlated with PD (*r* = -0.23) and using sanitation (*r* = -0.42, *P*<0.001). Population density (PD) is positively correlated with using sanitation.

**3.3 Forward multiple regression analysis**

An impact analysis helps to standardize the effect of each independent variable on the dependent variable, and allows one to determine reasonably, which independent variable affects the dependent variable the most. In this analysis, LE was the dependent variable and GNI per capita, educational index, adolescent fertility rate, TFR, physicians’ density, HIV prevalence rate, IMR, deaths, population density, using sanitation were the predictors. The results are presented in the following table (Table 3). Since, the VIF for the case of all predictors were less than five, so there is no evidence of a multi-collinearity problem. In this analysis four models (Model 1, Model 2, Model 3, model 4) are taken. In Model 1, only deaths were included which is indicated negative associations with LE. The adjusted R2 is 0.91. In model 2, deaths and IMR were included where both indicated negative associations with LE. The adjusted R2 is 0.93. In model 3, deaths, IMR and PD were included where deaths and IMR indicated negative associations with LE and PD indicated positive associations with LE. The adjusted R2 is 0.94. In model 4, deaths, IMR, PD and GNI were included where deaths and IMR indicated negative associations with LE and PD and GNI indicated positive associations with LE. The adjusted R2 is 0.95. At every model the predictors are significantly associated with LE.

**4. Discussion**

Life Expectancy at birth is widely accepted as a useful indicator of the health status of a country's population and beyond that, is extensively used by international agencies as a general indicator of national development. For LDCs life expectancy is not only important but also essential for development.

The study revealed that number of deaths, infant mortality rate, population density and gross national income has significant relation with life expectancy. Number of deaths and infant mortality rate were the negative significant predictors of life expectancy at all regression models. These variables have good impact on life expectancy in LDCs. The infant mortality rate is the most influential variable on life expectancy (Sufian, 2013). In the bivariate analysis infant mortality rate has negative significant association with life expectancy. Socioeconomic determinants have good impact on life expectancy. In this study, GNI has strong relationship with LE. GNI showed positive significant impact on life expectancy. Our results show that higher income increases life expectancy, in accordance with the findings of previous studies (Karlsson et al., 2010; Tang and Griffiths, 2009). Income per capita had a positive effect on health (Martinez-Sanchez E et al., 2001, Bayatiet al., 2013, Schoder et al., 2011). From the bivariate analysis, GNI has significantly positive correlation with using sanitation which is the one of the most important factor of health status. In fact, high level income can increase using sanitation. Another important predictors of life expectancy is education index. In this study, education index has significantly positive relation with life expectancy. Also found that, education index is significantly positively correlated with physician density. Thus it is conducted that as education index increase, life expectancy will increase.

High fertility may also have a negative effect on life expectancy, as high-fertility families have limited resources per child and because a short period between births may decease breast-feeding and endanger the nutritional status of infants (Mondal et al., 2014). In the present study, TFR and adolescent fertility rate were significantly inversely correlated with income and education. Adolescents who anticipate a shorter lifespan reproduce at an earlier age than adolescents who expect to live longer (Brumbach et al, 2009; Geronimus, 2004; Wilson, 1997).Physician density and using sanitation was significantly inversely correlated with TFR and adolescent fertility rate. That is indicating that as physician density and using sanitation decrease reproduction will increase.

Mortality is another important predictor of life expectancy. In this study, the number of deaths per 1000 population is significantly inversely correlated with life expectancy. That is representing that as number of deaths per 1000 population decrease life expectancy will increase. Number of deaths per 1000 population has significantly positively correlated with HIV prevalence rate. The present study reveals that, HIV prevalence rate has also adverse significant relation with life expectancy which indicates that life expectancy will increase if HIV prevalence decreases.

In this present study, every variable has strong relationship with life expectancy. They have also a strong interrelation among them. Finally this study indicating that, GNI, education index, physician density, using sanitation need to increase life expectancy and adolescent fertility rate, TFR, IMR, HIV prevalence rate need to decrease to increase life expectancy.

1. **Conclusions**

A basic indicator of well-being is life expectancy. Increasing life expectancy has been one of the wonders of the last century. But the level of life expectancy remains low in many countries of LDC. Socio-economic, demographic and health factors have good contact on life expectancy. How socio-economic, demographic and health factor affect life expectancy in LDCs are analyzed in this study. In the present analysis, it was revealed that socio-economic, demographic and health factors are correlated with LE. The analysis indicates that should be increased GNI and decreased deaths, infant mortality rate and population density to increase LE. This also suggested that international efforts should paid attention to increasing LE in LDCs by improving the situation of GNI, deaths, IMR, PD. In this study, 48LDCs and measured the effects of ten different determinants from socio-economic, demographic and health factors. Further the research with data sets that are more expansible and a wide range of factors would enhance policymakers’ understanding of which factors influence life expectancy most.

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**Table 1:** Descriptive statistics of the dependent and independent variables of all countries (N=48)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | N | Minimum | Maximum | Mean | Median | SE Mean | SD |
| Life Expectancy (Y) | 48 | 45 | 73 | 59.44 | 60.00 | 0.95 | 6.56 |
| Gross national income (X1) | 44 | 370 | 18900 | 2315.90 | 1505 | 441.88 | 2931.08 |
| Educational index (X2) | 44 | 0.18 | 0.77 | 0.39 | 0.37 | 0.02 | 0.12 |
| Adolescent fertility rate (X3) | 46 | 12 | 192 | 83.70 | 69.50 | 6.43 | 43.61 |
| Total fertility rate (X4) | 48 | 2.00 | 7.60 | 4.83 | 4.90 | 0.18 | 1.28 |
| Physician density (X5) | 37 | 0.10 | 10.90 | 1.65 | 1.00 | 0.33 | 2.00 |
| HIV prevalence rate (X6) | 41 | 5.10 | 14600 | 1716.10 | 707 | 417.85 | 2675.54 |
| Infant mortality rate (X7) | 48 | 17 | 128 | 63.19 | 61.00 | 3.47 | 24.02 |
| Deaths (X8) | 48 | 5.00 | 18.00 | 10.06 | 9.00 | 0.49 | 3.39 |
| Population density (X9) | 48 | 4.00 | 1087.00 | 116.40 | 50.50 | 26.25 | 181.88 |
| Using sanitation (X10) | 45 | 10.00 | 92.00 | 36.49 | 33.00 | 3.13 | 21.00 |

**Table 2: Correlation between the variables that were examined**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Y | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 |
| Y | 1 |  |  |  |  |  |  |  |  |  |  |
| X1 | .065 | 1 |  |  |  |  |  |  |  |  |  |
| X2 | 0.39\*\* | 0.26 | 1 |  |  |  |  |  |  |  |  |
| X3 | -0.54\*\* | -0.07 | -0.33\* | 1 |  |  |  |  |  |  |  |
| X4 | -0.58\*\* | -0.13 | -0.35\* | 0.60\*\* | 1 |  |  |  |  |  |  |
| X5 | 0.49\*\* | 0.43\* | 0.56\*\* | -0.51\*\* | -0.55\*\* | 1 |  |  |  |  |  |
| X6 | -0.48\*\* | 0.03 | 0.29 | 0.13 | 0.05 | -0.42\* | 1 |  |  |  |  |
| X7 | -.083\*\* | -0.16 | -0.38\* | 0.34\* | 0.52\*\* | -0.52\*\* | 0.11 | 1 |  |  |  |
| X8 | -0.95\*\* | -0.02 | -0.37\* | 0.54\*\* | 0.51\*\* | -0.37\* | 0.43\*\* | 0.77\*\* | 1 |  |  |
| X9 | 0.29\* | -0.12 | 0.11 | -0.27 | -0.37\*\* | 0.39\* | -0.11 | -0.28 | -0.23 | 1 |  |
| X10 | 0.49\*\* | 0.49\*\* | 0.44\*\* | -0.56\*\* | -0.39\*\* | 0.62\*\* | -0.08 | -0.36\* | -0.42\*\* | 0.31\* | 1 |

Note: \*Significant at p<0.05 level and \*\* Significant at p<0.01 level

Y= Life Expectancy, X1= Gross national income,X2= Educational index, X3= Adolescent fertility rate, X4= Total fertility rate, X5= Physician density, X6= HIV prevalence rate, X7= Infant mortality rate, X8= Deaths, X9= Population density, X10= Using sanitation

**Table 3:** Forward multiple linear regression models explaining the life expectancy

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 | VIF | Model 2 | VIF | Model 3 | VIF | Model 4 | VIF |
| Deaths (X8) | -0.96\*\* | 1.00 | -0.79\*\* | 2.41 | -0.78\*\* | 2.44 | -0.730\*\* | 2.67 |
| IMR (X7) |  |  | -0.21\* | 2.41 | -0.19\* | 2.46 | -0.21\* | 2.48 |
| PD (X9) |  |  |  |  | 0.11\* | 1.13 | 0.12\* | 1.15 |
| GNI (X1) |  |  |  |  |  |  | 0.11\* | 1.12 |
| Adjusted R2 | 0.91 |  | 0.93 |  | 0.94 |  | 0.95 |  |

**Appendix A:** Variables, their descriptions and sources

|  |  |  |
| --- | --- | --- |
| Variables | Descriptions | Sources |
| Life expectancy ( Y) | The average number of years a newborn infant can expect to live under current mortality levels | PRB, 2013 |
| Gross National Income (GNI)  per capita (X1) | GNI PPP per capita is gross national income in purchasing power parity (PPP) divided by mid-year population. GNIPPP refers to gross national income converted to “international” dollars using a purchasing power parity Conversion factor. International dollars indicate the amount of goods and services one could buy in the USA with a given amount of money. | PRB, 2013 |
| Educational Index (X2) | The Education Index is calculated from the Mean years of schooling index and the Expected years of schooling index | UNDP, 2012 |
| Adolescent fertility rate (X3) | Number of births to women ages 15-19 per 1000 women ages 15-19. | PRB, 2013 |
| Total fertility rate (TFR) (X4) | The average number of children a woman would have assuming that current age-specific birth rates remain constant throughout her childbearing years (ages 15- 49). | PRB, 2013 |
| Physicians density (X5) | Number of physicians per ten thousand populations | WHO, 2013 |
| Prevalence of HIV (X6) | The estimated percentage of adults, ages 15 to 49, living with HIV/AIDS per 100000 populations. | WHO-2013 |
| Infant Mortality Rate (X7) | The annual number of deaths of infants under age 1 per1,000 live births | PRB, 2013 |
| Deaths (X8) | Number of deaths per 1000 populations | PRB, 2013 |
| Population density (X9) | Number of population per square kilometers | PRB, 2013 |
| Using sanitation (X10) | Percentage of population using sanitation | WHO, 2013 |

**Appendix B:** Least developed countries

|  |  |  |
| --- | --- | --- |
| **Regions** | **N** | **Country** |
| Africa | 33 | Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone,  Somalia, Sudan, Togo, Uganda, United Republic of Tanzania, Zambia. |
| Asia | 09 | Afghanistan, Bangladesh, Bhutan, Cambodia, Lao People’s Democratic Republic, Myanmar, Nepal,  Timor-Leste, Yemen. |
| Americas | 01 | Haiti |
| Pacific | 05 | Kiribati, Samoa, Solomon Islands, Tuvalu, Vanuatu. |

**Source:** The Least Developed Countries Report 2012, United Nations Conference on Trade and Development