COMPARING DEATHS PER 100,000 PEOPLE BY DISEASES IN SELECTED DEVELOPED AND DEVELOPING COUNTRIES

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1 Introduction

Economic status is one of the most important factors that determines the health level of different groups of people. In order to discern the effects that economic status plays in countries worldwide, this study compares health measures from some of the most developed countries and from some of the least developed countries, which will often be referred to as developing countries in this paper.

There are many disputes about the definition of developed and developing country. According to United Nations Conference on Trade and Development (UNCTAD), fifty countries were designated by the United Nations as least developed countries (LDCs) in 2004.(UNCTAD, 2004) This paper specifically uses this UNCTAD list from 2004 in order to determine which countries were developing countries. The list of LDCs is reviewed every three years by the Economic and Social Council of the United Nations. According to UNCTAD the criteria for being place in the list of LDCs are:

1. a low-income criterion, as measured by the gross national income (GNI) per capita
2. A weak human assets criterion, as measured by a composite index (the Human Assets Index) based on indicators of:
   (a) nutrition (per capita calorie intake as a percentage of the relevant requirement)
   (b) health (child mortality rate)
   (c) school enrollment (secondary school enrollment ratio)
   (d) literacy (adult literacy rate)
3. An economic vulnerability criterion, as measured by a composite index (the Economic Vulnerability Index) based on indicators of:
   (a) instability in agricultural production
   (b) instability in exports of goods and services
   (c) the economic importance of non-traditional activities (share of manufacturing and modern services in GDP)
   (d) economic concentration (UNCTADs merchandise export concentration index)
   (e) economic smallness (population in logarithm)

Developed countries were also selected using a list of developed countries from UNCTAD for 2004. Similar to LDCs, UNCTAD also utilized a GNI, the human assets index, and the economic vulnerability index in order to classify countries into the developed countries. The standards were just that the countries had to be above certain levels of these measures in order to qualify.

2 Methodology

We used simple random sampling to select countries from the lists by UNCTAD of least and most developed countries. In simple random sampling each individual is chosen randomly and entirely by chance, such that each individual has the same probability of being chosen at any stage during the sampling process. There are many ways to draw a simple random sample. We used random number generator to select ten of the countries from each list.

We decided to utilize estimated deaths per 100,000 people per disease as a measure of a country's health status. These estimates were created by the World Health Organization (WHO) in 2004 for each country. Although these counts are estimates, we can still assume that they are fairly close approximations to what the actual deaths per 100,000 people per disease were in 2004 in each country since various statistical techniques were utilized in order to create these estimates. Furthermore, these estimates can be treated as sort of samples from binomial random variables. Here the probability of success is that the person in the country died of a certain specified disease and the sample size is 100,000 people.By treating these counts as the outcomes of binomial random variables, we can utilize various tests that can compare the proportion of people who died from specified diseases in each country and determine differences between countries. We chose in a nonrandom fashion 18 disease categories from those listed by WHO for the counts as diseases for which we compare different countries.

For analysis we utilized the difference proportion test, Fishers Test and χ^2 goodness of fit test. Each of these three tests are based upon contingency tables. A contingency table is a manner of organizing data amongst two different categorical variables. By categorical variable, I mean random variables that only have two or more categories in which things can fit. One classic example of a categorical variable is gender. A given person is either male or female. Gender is the categorical variable and the categories or levels of gender is male and female. The simplest case of a contingency table is when data is distributed amongst 2 different binomial random variables, which is the case in this study. So, let us exam this simplest case. Here random variable Y can take on values 0 or 1, which represent the possible categories. The random variable X can also take on values 0 or 1, where 1 denotes success and 0 failure. There are different probabilities attributed to data falling into any given cell in the 2 by 2 contingency table. If you consider the conditional probabilities, that is the probability of Y=y given that X=0 or given that X=1, then you can denote the probability for the top left hand square to be π_1, which corresponds to $P(Y = 1/X = 1)$. Since this is a conditional probability, the square to the right must have conditional probability $1 - \pi_1$, which corresponds to $P(Y = 0/X = 1)$. Similarly for the second row, the probability that Y=1 given that X=0, $P(Y = 1/X = 0)$, is denoted π_2 and $P(Y = 0/X = 0)$ equals $1 - \pi_2$.

Example of Contingency Table

	Y=1	Y=0
X=1	π_1	$1 - \pi_1$
X=0	π_2	$1 - \pi_2$

For this study contingency tables were made where the X-variable represented the economic class of countries or simply two different countries. So the categories of X were either developed and developing or two different country names. The Y-variable represented affliction by a certain disease, such as meningitis. The y-variable categories were died by specified disease and didn't die by specified disease. Using this set up the counts were placed in their corresponding cells. Since the counts were per 100,000 people, the failure cells corresponding to Y=0 had 100,000 - count in Y=1.

One of the first questions that one may ask is whether or not the X variable is independent of the Y variable. This question, however simple, is very significant and has many important practical implications, such as in this study. If Y was independent of X then that would correspond to the proportions of people dying by a specified disease being the same across the different categories of X. For this study, independence would therefore mean that developed countries and developing countries had the same proportion of people who died of the disease. Since the two types have the same proportion, economic status of a given country must not have an effect on the proportion of people who die of that specific disease. If the two variables are dependent, then economic status does have some effect on the proportion of people who die of that specified disease. Moreover, dependence means that economic status affects a country's susceptibility to the specified disease. The logic is similar for comparison between two different countries. The difference proportion test, χ^2 test, and Fisher's test each use different methods to determine the probability of whether or not the two categorical variables in the contingency table are independent.

2.1 Difference Proportion Test

The difference proportion test is utilized to compare the probabilities of success between two binomial random variables. Here we treat the different conditional counts as the two binomial random variables, with probabilities of success π_1 and π_2 and sample size 100,000 for each. These probabilities of success will be estimated using sample proportions p_1 and p_2, which correspond to the maximum likelihood estimates for π_1 and π_2 respectively. If the Y variable is independent of the X variable, then these two probabilities of success should be the same. In order to test whether or not they are the same, and therefore whether or not the two categorical variables are independent, we perform a hypothesis test on the the difference proportion between them. The difference proportion is $\pi_1 - \pi_2$, which will be estimated by the difference of the sample proportions p_1-p_2 that corresponds to its maximum likelihood estimate. For this test the null hypothesis, or initial assumption, is that the difference proportion is equal to zero. When the difference proportion is equal to zero, the probability of success for the two binomial random variables is the same and the two categorical variables on the contingency table are independent. The alternative hypothesis is that the difference proportion is not equal to zero, which corresponds to the two categorical variables being dependent. Since the sample difference proportion is the maximum likelihood estimate, it is asymptotically normal. This means that we can treat this difference proportion as a normal random variable and that we can obtain a Z-score and an associated p-value for the hypothesis test. Under the null hypothesis, this normal random variable should have mean 0, since that is the assumed true difference proportion value. By assuming that the binomial samples are independent we can calculate the standard deviation to be $\sqrt{p(1-p)(\frac{1}{n_1}+\frac{1}{n_2})}$, where p is given by equation 2. In equation 2, X_1 and X_2 are both the number of successes for each sample and n_1 and n_2 are the sample populations for each sample. By using all this information we can transform the normal random variable we are using for the difference proportion into a standard normal random variable by dividing by the standard deviation. This standard normal random variable has mean 0 and standard deviation 1. This info provides the test statistic for the difference proportion test :

$$Z = \frac{p_1 - p_2}{\sqrt{p(1-p)(\frac{1}{n_1}+\frac{1}{n_2})}} \tag{1}$$

where p is equal to:

$$p = \frac{X_1 + X_2}{(1/n_1) + (1/n_2))} \tag{2}$$

Using the Z-score that our test statistic produces, we can create a p-value, which can then be used to determine whether or not to reject or accept the null hypothesis within a given level of confidence. For this study the level of confidence was 95 percent for each test. The p-value corresponds to the probability of observing data with a absolute value difference proportion as high or higher than the observed value given that the true difference proportion is equal to 0. If the p-value is less than a certain cut-off probability, α, we reject the null hypothesis. If the p-value is greater than or equal to α then we fail to reject the null hypothesis because it is still fairly probable to be true. Since several of the diseases had very small probabilities of success, we calculated p_1 and p_2 by taking the counts, adding one, and then by dividing by the 100,000 plus 1. This correction allows for faster convergence of Z to a standard normal random variable and increases the accuracy of the test.

2.2 χ^2 Independence test

This test determines whether or not a certain table or distribution of data came from a distribution where the categorical variables are independent. The null hypothesis of this test is that the actual distribution of the data is comes from a distribution where the two categorical variables are independent. The alternative hypothesis is that the data did not come from a distribution where the the two categorical variables are independent. The different counts for the table constructed under the assumption that the two binomial random variables have the same probability of success are denoted μ_{ij} where i denotes the row and j denotes the column. It is important to note that the μ_{ij}'s are assumed to be unbiased estimators of the actual counts. The actual counts are denoted n_{ij} where again i denotes the row and j denotes the column. If we examine the variance of the difference between the expected counts and the actual counts over the square root of the associated expected counts we obtain the test statistic listed in equation 3. Fisher proved that this test statistic has a probability density function that converges asymptotically to a χ^2 distribution with (I-1)(J-1) degrees of freedom, where I is the total number of rows of the table and J is the total number of columns for the table. Here all the tables are 2 by 2 since we are dealing with two different binomial random variables that each have success counts and failure counts.

$$\chi^2 = \frac{(\mu_{ij} - n_{ij})^2}{\mu_{ij}} \tag{3}$$

Utilizing the fact that the test statistic from equation 3 converges to a χ^2 distribution, we can find the probability of observing data with a χ^2 value as high or higher than that observed by the data. This p-value can then be used to determine whether to reject or fail to reject the null hypothesis given a certain level of confidence. Since the counts for many of the diseases were very small, one-half was added to each count before doing the test in order to increase the rate of convergence of the statistic to a χ^2 distribution. For all the tests we utilized a 95 percent level of confidence.

2.3 Fisher's Exact test

For 2 by 2 contingency tables the Fisher Exact test works by assuming that the two categorical variables are independent and therefore that the odds ratio must be 1. The odds correspond to the probability of an event occurring over the probability of that event not occurring. In the case of our contingency tables an example would be $\frac{\pi_1}{1-\pi_1}$, which denotes the odds of Y=1 given X=1. The odds ratio is the ratio of two different odds. For our contingency tables again the odds ratio is the odds of Y=1 given X=1 over the odds of Y=1 given X=0. If Y and X are independent then the odds ratio is equal to one, since the odds of success should be the same across the X categories. Additionally, some of the marginal counts of the table must be fixed. Given these conditions, all the cell counts can be determined from the count given in a single cell. Also, the cell counts can be said to have a hyper-geometric distribution. which can then be utilized to predict the probability of observing the count actually observed in that cell. This probability is given by the formula below:

$$P(n_{11}) = \frac{\binom{n_{1+}}{n_{11}}\binom{n_{2+}}{n_{+1}-n_{11}}}{\binom{n}{n_{+1}}} \tag{4}$$

In the equation above n_{11} is the count for the cell in row one and column one. n_{1+} is the total for row 1. n_{2+} is the total for row 2. n_{+1} is the total for column one and n is the total over all the cells for the table. This test statistic comes from viewing the contingency table as the result of a random drawing experiment. This experiment assumes there are a fixed number of objects of two different types. Utilizing this probability we can find a p-value for the cell count straying as far or farther from the expected cell count. This p-value can then be utilized to determine whether to reject or fail to reject the null hypothesis given a certain level of confidence. For this paper, all the tests were done at a 95 percent level of confidence.

3 Results/Discussion

Table 1: Comparing Developed vs. Developing Countries

Disease	Dif. Prop	Fisher	χ^2	Comments	Which Higher Prop
Comm., Mat., Per., and Nutr.	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Infectious and Parasitic	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
STDs excluding HIV	$1.02 * 10^{-11}$	$4.6 * 10^{-14}$	$1.02 * 10^{-11}$	Reject	Developing
HIV/AIDs	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Diarrhoeal Diseases	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Meningitis	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Hepatitis B	$5.04 * 10^{-4}$	$5.34 * 10^{-4}$	$5.04 * 10^{-4}$	Reject	Developing
Respiratory Infections	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Maternal Conditions	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Perinatal Conditions	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Nutritional Deficiencies	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developing
Noncommunicable Diseases	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developed
Malignant Neoplasms	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developed
Diabetes Mellitus	.1644	.1671	.1644	Fail Reject	Developing
Endocrine Disorder	$4.74 * 10^{-3}$	$3.94 * 10^{-3}$	$4.74 * 10^{-3}$	Reject	Developing
Neuropsychiatric Conditions	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developed
Cardiovascular Diseases	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	$2.2 * 10^{-16}$	Reject	Developed
Respiratory Diseases	$1.60 * 10^{-4}$	$1.39 * 10^{-4}$	$1.60 * 10^{-4}$	Reject	Developed

Comm., Mat., Per., and Nutr. means Communicable, Maternal, Perinatal, and Nutritional conditions. Under the Dif. Prop, Fisher, and χ^2 tests are the associated p-values of each test. Comments describes whether the end decision was to reject or fail to reject the null hypothesis that the proportions for the two categories were the same.

Several patterns can be observed from table 1. First developed countries and developing countries were extremely dissimilar from each other. For every disease except diabetes mellitus the null hypothesis was rejected and the associated p-values were incredibly small and not even close to .05. This pattern makes sense given that developed countries have much better economies than developing countries. Better economic status allows the developed countries to have improved quality of life for their citizens and to provide them with excellent medical care and food supply. Therefore, economic status of a country plays a tremendous role in determining how susceptible its citizens are to specific diseases. This theory also explains why developed countries have lower counts than developing countries for communicable diseases. Communicable diseases tend to be the medical disorders that are most responsive to excellent medical care and increased quality of life like sterile running water and a steady food supply. Developed countries having lower endocrine counts can be explained by their better quality of medicine, since endocrine disorders often require hormone supplements in order to allow the afflicted to function and survive for extended periods of time.

Another pattern is that the developing countries had lower counts for most of the noncommunicable diseases. There are several possible explanations for this pattern. One explanation is that the citizens of developing countries tend to have less sedentary lifestyles. Most of the noncommunicable diseases are very responsive to exercise and so lack of exercise for the citizens of developed countries could have made their counts higher. Another possible explanation is that the citizens of developing countries have different diets than the citizens of developed countries. Developed countries have more fast food restaurants which serve unhealthy food that promotes obesity and a variety of health problems. A third possible explanation is that noncommunicable diseases tend to take longer to develop and kill the afflicted much slower than communicable diseases. Additionally, the noncommunicable diseases make their victims more susceptible to disease in general. So, people in developing countries suffering from noncommunicable diseases may have a much higher probability of being killed by a communicable disease before the noncommunicable disease afflicting them has a chance to become deadly.

Diabetes mellitus was the only disease for which developed and developing countries proved similar. This may be due to the two different types of diabetes. Type one diabetes results from the body's lack of ability to produce enough insulin which causes blood sugar levels to rise out of control. The individuals that have type one diabetes tend to have had the disease since their birth. Type one diabetes must be treated with regular insulin injections, usually after every meal. These regular injections of insulin mean that people suffering form this type of diabetes require medical care to be available, since insulin is not something available outside of a medical setting. This idea suggests that developed countries would have less deaths by type one diabetes than developing countries. Type two diabetes results from the lack of responsiveness of cell to insulin. People with type two diabetes usually obtained the disease later in life. Additionally, type two diabetes is associated with lack of exercise and obesity. The treatment for type two diabetes includes diet and regular exercise and may or may not include insulin injections. Due to both the cause of type two diabetes and its treatment, citizens of developed countries with more sedentary lifestyles are probably much more susceptible to it than those in developing countries. The fact that developed countries probably have lower counts for type one diabetes and that developing countries probably have lower counts for type two diabetes may have caused a cancellation, which resulted in them being similar.

Since we have examined the overall difference between developed and developing countries, it is important to examine the degree of variation of the countries within each of these categories for each disease. This information will provide insight into how similar the countries within the categories are and also reveal various patterns amongst the different diseases. These patterns may reveal clues to what factors affect country disease counts, which is important for medical studies. However, in this paper we will focus more on the patterns themselves and less on the possible explanations for the patterns. Below is a table displaying the numerical assignment of each of the 20 countries. These numerical assignments are utilized in each of the figures below and in the tables located in the appendix. It is important to note that each disease has a figure associated with it for each category of country, unless specified. The actual disease counts for countries can be located in figure 1a and figure 2a in the appendix.

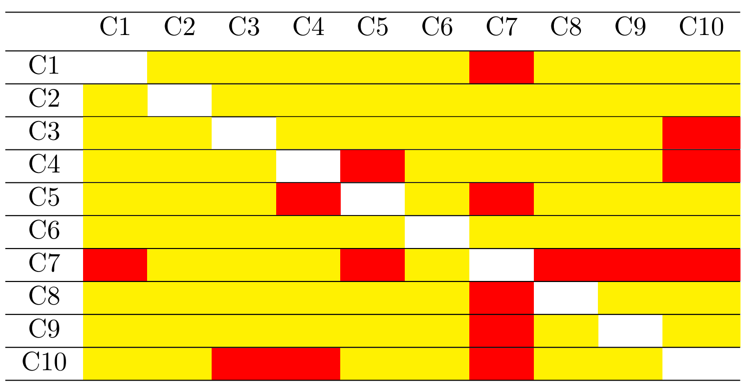
Table 1: Listing Country type and Numerical Assignment

Country	Country Type	Numerical Assignment
Belgium	Developed	C1
Canada	Developed	C2
Denmark	Developed	C3
Iceland	Developed	C4
Japan	Developed	C5
Netherlands	Developed	C6
New Zealand	Developed	C7
Norway	Developed	C8
Sweden	Developed	C9
United States	Developed	C10
Bangladesh	Developing	D11
Central African Republic	Developing	D12
Djibouti	Developing	D13
Guinea-Bissau	Developing	D14
Kiribati	Developing	D15
Lao People's Dem Republic	Developing	D16
Liberia	Developing	D17
Malawi	Developing	D18
Solomon Islands	Developing	D19
Vanuata	Developing	D20

Amongst the communicable diseases, the developed countries were surprisingly similar. In fact for many of the diseases all the countries failed to reject the difference of proportions test, which means that the differences between the observed country proportions of people dying of those diseases in each developed country were the statistically insignificant. The diseases for which the developed countries showed no difference were for STDs excluding HIV, HIV, Diarrhoeal diseases, Meningitis, Hepatitis B, Maternal Conditions, Perinatal conditions, nutritional conditions, and Endocrine disorders. Since these diseases showed no dissimilarity between the various developed countries, their associated tables were excluded from this paper. There are many good reasons why the developed countries would all be fairly similar with respect to these diseases. In fact, developed countries have a lot of things in common that would directly affect the health of their citizens. For example, developed countries all have similar standards for medical care and for education about disease prevention. In particular they have educational systems that emphasize the need for safe sex. Additionally, condoms tend to be very available in these countries. This fact helps to explain why they are similar with respect to the diseases that can be transmitted sexually, which includes the categories STDs excluding HIV, HIV, and Hepatitis B. Developed countries tend to have excellent sewage systems and clean running water available to everyone in the public, which helps to combat diseases that spread via contaminated water such as Diarrhoeal diseases. The public in developed countries tend to have access to a great variety of antibiotics that fight infections, which may explain why the meningitis counts are similar. Developed countries tend to have great food supplies and therefore nutritional problems tend to be very rare in these countries, which would explain the similar low counts for each of the developed countries. In developed countries medical care tends to be easily accessible and hospitals are common, which may explain the similar maternal, perinatal disease counts, and endocrine disorder counts.

It is interesting to note that most of the diseases for which the developed countries' counts are similar are communicable. This fact makes sense given that the commonality between developed countries is made up of traits that would all directly affect communicable diseases, such as sanitation and the availability of medical care, food, and antibiotics.

Figure 1: Results of Difference Proportion tests for Infectious and Parasitic Diseases

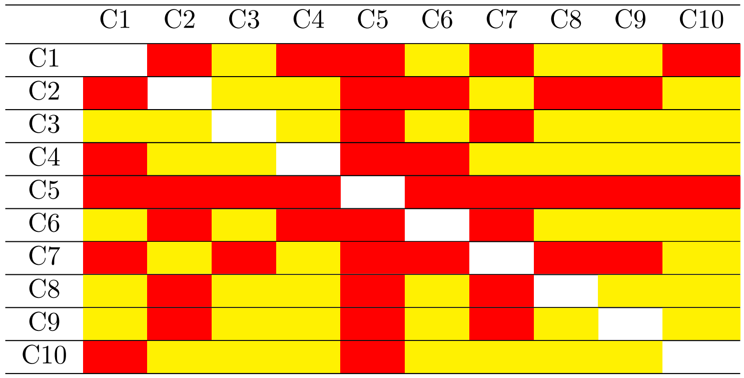


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For Infectious and parasitic diseases the developed countries follow a certain pattern where the countries can be loosely put into 2 categories where one category has high counts and the other category has lower counts. These categories are distinguished by whether their difference proportion tests with the highest and lowest count countries.The country with the highest count was the US with 23.0 per 100,000 people. The country with the lowest count was New Zealand with 4.1 per 100,000 people. There is one country, which is Canada (C2) with a count of 11.6 per 100,000, that falls into both categories and the difference proportion test failed to reject for Canada compared to any of the other developed countries. The countries that belong in the low count category are Denmark (C3), Iceland (C4), and New Zealand (C7). Belgium (C1), Japan

(C5), the Netherlands (C6), Norway (C8), Sweden (C9), and US (C10) all belong to the high count category.

Figure 2: Results of Difference Proportion Tests for Developed Country Proportions for Respiratory Infections

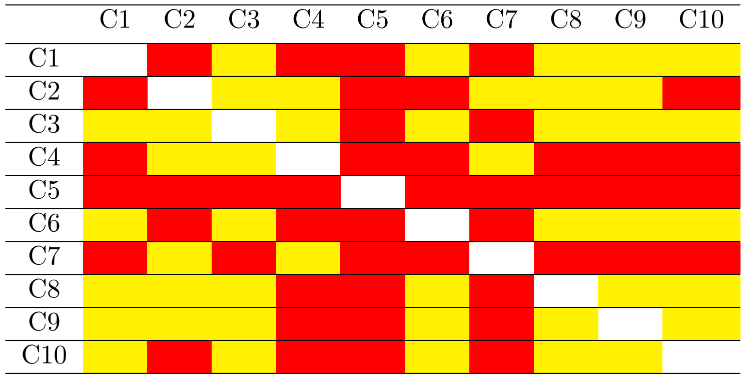


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

The developed country counts for Respiratory diseases were fairly varied, as can be seen from table . Japan (C5) had much higher counts than any of the other developed countries with 78.0 per 100,000. Every difference proportion test with Japan resulted in rejecting the null hypothesis, which shows that the counts for Japan were very different from the counts of the other developed countries. Both the US (C10) and Denmark (C3) were fairly in the middle range of the counts with counts of 21.3 and 25.5 per 100,000 respectively. Each of these countries only rejected the null hypothesis for two countries. For the US, they were Japan and Belgium (C1) which were both higher count countries. For Denmark, Japan and New Zealand (C7) were rejected, where New Zealand was the country with the lowest count. Belgium(C1), the Netherlands (C6), Norway (C8), and Sweden (C9) were all countries with higher counts. The highest amongst these high count countries, excluding Japan, was Belgium with a count of 37.9 per 100,000. The lower count countries were Canada (C2), Iceland (C3), and New Zealand (C7). The only explanation that I can offer for explaining this pattern is that the higher count countries are all geographically close to one another. Indeed, the countries share a common border. Due to the fact that respiratory diseases travel through the air, it is possible that the heavy traffic between these neighboring countries caused them to sync. So, these countries may represent one large area where the respiratory count is the same. It may also be that since these countries are neighbors, they may have more in common than any of the other developed countries. Sweden and Norway are good candidates for this explanation. Not only are their counts almost identical for respiratory diseases, but also for all the other communicable diseases.

The communicable, maternal, perinatal, and nutritional counts are all sums of the various diseases in each of the four categories for each country. Therefore, all the trends visible in this table can be explained by counts of diseases in each of the categories. Since the developed country counts were significantly different only for the infectious and parasitic diseases and the respiratory diseases, then all deviation of the counts result from these two tables. Since Japan (C5) had abnormally high respiratory disease counts, the counts for this table was abnormally high for the developed countries. In fact, just like the respiratory disease counts Japan compared with any other developed country resulted in rejection of the null hypothesis. Additionally, New Zealand had the lowest counts for both these categories, which caused its counts in to be much lower than those of the other developed countries. In fact, its counts were only similar to Canada (C2) and Iceland (C4), which were both countries with low counts for both respiratory diseases and infectious and parasitic diseases. Additionally, there appears to be a group of countries that all had high counts for both the infectious and parasitic diseases and for respiratory diseases. These countries were Belgium (C1), Sweden (C9), Norway (C8), Netherlands (C6), and the US (C10). These five high count countries all failed to reject

Figure 3: Results of Difference Proportion tests for Communicable, maternal, perinatal, and nutritional conditions for developed countries

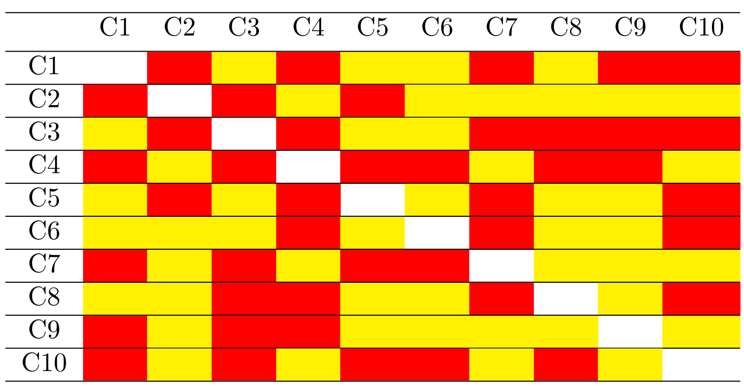


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

the null hypothesis for every country in this category. So, these countries are all effectively have the same counts. Denmark (C3) was a sort of middle country since it was similar to both some low count countries like Canada and Iceland and all the high count countries. Denmark also was the country that failed to reject the null hypothesis the most out of all the developed countries, which further illustrates its position as a sort of median count country.

It is also interesting to note that the developed countries tend to be disimilar with respect to counts of noncommunicable diseases. Factors that tend to affect noncommunicable diseases tend to be related to the lifestyle, such as level of exercise. This difference amongst the developed countries may then reflect that even though developed countries are very similar by means of medical care and sanitation, the people in these countries tend to have fairly different lifestyles.

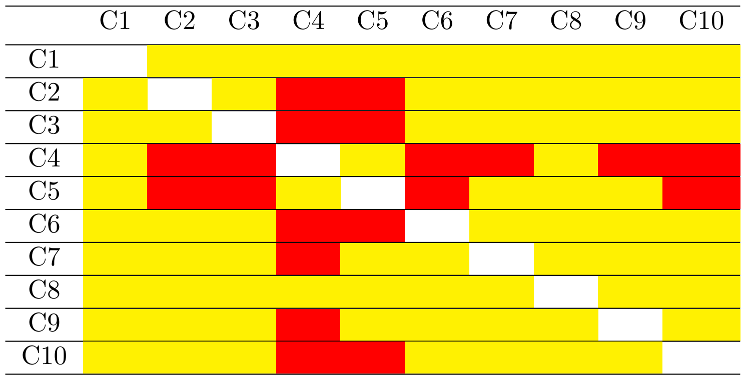
Figure 4: Results of Difference Proportions test for Malignant Neoplasms



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For Malignant Neoplasms the data fall into several categories. The first category contains the low count countries, which are Iceland (C4), New Zealand (C7), and the US (C10). Iceland (C4) had the lowest count at 179.1 deaths per 100,000 people. Each of these three countries only failed to reject the null hypothesis for other countries in the category or for the three medium count countries. The three medium count countries were Sweden (C9), Norway (C8), and Canada (C2). Both of these countries failed to reject the null hypothesis for countries from both the low count and the high count categories. Norway had the highest count out of the three. Canada had the smallest count out of the three. The high count countries were Belgium (C1), Denmark (C3), Japan (C5) and the Netherlands (C6). Denmark had the highest count at 292.8 deaths per 100,000 people.

Figure 5: Results of Difference Proportions test for Diabetes Mellitus for Developed Countries



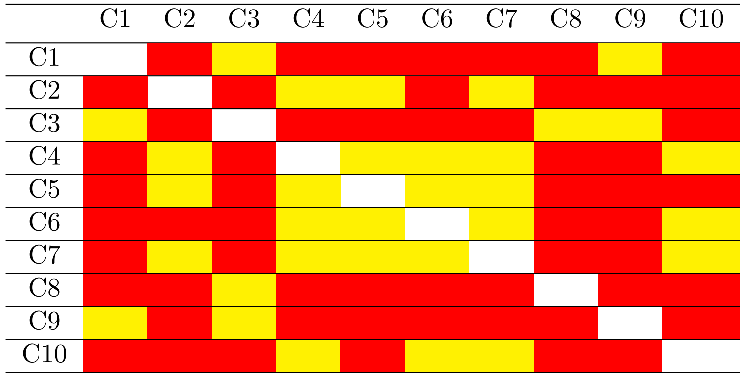
Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For Diabetes Mellitus, the countries fell into 4 categories. The two low count countries were Iceland (C4) and Japan (C5). The country with the lowest count was Iceland (C4) with a count of 6.9 deaths per 100,000 people. The medium count countries were Belgium (C1) and Norway (C8). Both of these countries failed to reject the null hypothesis for any country and so represent the average developed country. This fact shows that the developed countries were still fairly close even though some of the country counts were distinct. New Zealand(C7) and Sweden (C9) were both countries with slightly elevated counts. They were both dissimilar from the lowest country Iceland. But they were similar to every other country. The countries Canada (C2), Denmark (C3), Netherlands (C6), and US (C10) were all high count countries since they were dissimilar from both the low count countries. Denmark had the highest count at 26.4 deaths per 100,000 people.

For neuropsychiatric conditions most of the countries were similar. For this reason and the simplicity of the data, no figure was made for this specific data. Only Japan and New Zealand had counts that were dissimilar from the rest. Japan with a count of 12.4 deaths per 100,000 people had a very low count compared to the other developed countries. When compared with any other developed country the null hypothesis for the difference proportion test was rejected. This extremely low count for Japan may be explained by Japanese culture. Culture often shapes the attitudes and thought processes of people. Culture also determines how different kinds of people get treated within society. Since Japanese culture is distinct from the western culture seen in the other nine developed countries, it is a fairly reasonable explanation that its culture caused the Japanese to suffer less from neuropsychiatric conditions. New Zealand had the second lowest count and was dissimilar only for Sweden, the US, and Denmark, which were the countries with the top three highest counts. Sweden had the highest count with 75.1 deaths per 100,000 people. Other than Japan and New Zealand, all the developed countries had similar counts and failed to reject the null hypothesis when compared to any country other than Japan and New Zealand.

For cardiovascular diseases the developed countries appear to be in two distinct groups that do not overlap at all. The lack of overlap between the two groups indicates that the developed countries vary greater with respect to cardiovascular disease than for any other disease in this project. The group with the higher counts are Sweden (C9), Belgium (C1), Denmark (C3), and Norway (C8). The country with the highest count was Sweden with 446.8 deaths per 100,000 people. Sweden and Belgium both were similar to every country in

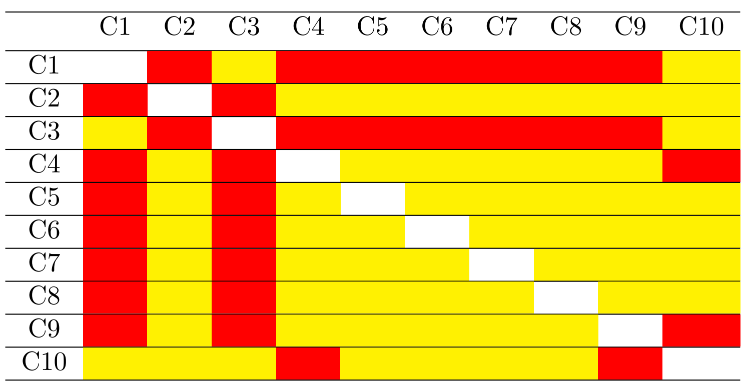
Figure 6: Results of Difference Proportions test for Cardiovascular Diseases for Developed Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

this category except for Norway. Norway was only similar to Denmark, but Denmark was similar to every country in this high count category. The fact that these four countries are neighbors geographically may again explain why their counts are similar for cardiovascular diseases. Since they are neighbors, these four countries most likely have very similar cultures. Culture could affect both the diet and the average level of exercise for the citizens of these countries, which would cause these four countries to be similar. This theory does have a problem in that it fails to explain why the Netherlands is not in the high count category however. The second group contained the countries with lower counts. These countries were Canada (C2), Iceland (C4), Japan (C5), Netherlands (C6), New Zealand (C7), and the US (C10). The country with the lowest count was Canada with 234.7 deaths per 100,000 people. Canada and Japan were the two lowest counts in this group and they were both dissimilar to the Netherlands and the US, which were the two highest count for the lower group. Both Iceland and New Zealand were similar to every other country in the lower group category and so represent sort of the middle or average country for this group.

Figure 7: Results of Difference Proportions test for Respiratory Diseases for Developed Countries

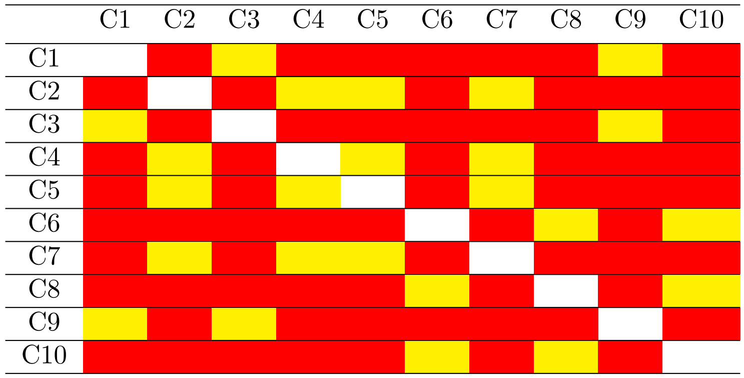


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For respiratory diseases, there were three countries with counts that were distinctly high. The two countries Belgium (C1) and Denmark (C3) both had very high counts and were dissimilar from every country outside of the high count group. Denmark had the highest count at 76.3 deaths per 100,000 people. The

US was similar to every country except the two lowest count countries, which were Iceland (C4) and Sweden (C9). Iceland had the lowest count at 31.7 deaths per 100,000 people. The seven low count countries were all similar to each other and so had counts that were all fairly close.

Figure 8: Results of Difference Proportions test for Noncommunicable Diseases for Developed Countries

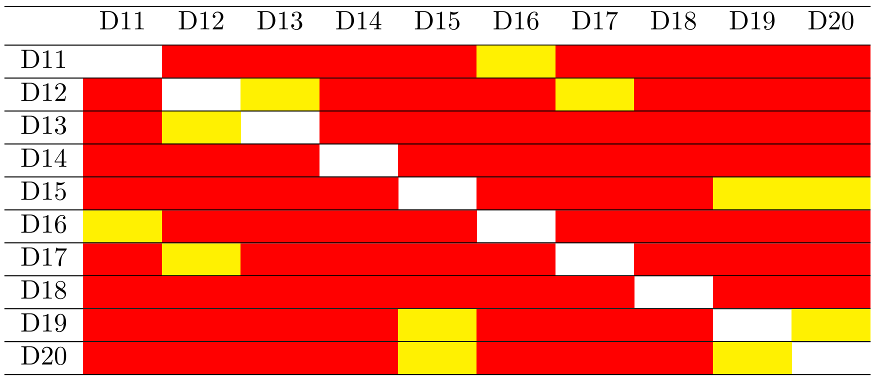


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

The noncommunicable disease counts were made from the sum of counts that included the categories discussed above. Since there was much greater deviation amongst the counts for noncommunicable diseases than for communicable diseases, most of the countries proved to be dissimilar from one another. Additionally, it is more difficult to explain the results for this category using the information from the diseases already discussed because there are more diseases contributing variation to the death counts for the different countries. The developed countries can be placed into several groups. One group contains Belgium (C1), Denmark (C3), and Sweden (C9). This first group is made up of the countries with the highest counts. Denmark had the highest count with 954.7 deaths per 100,000 people. Each of these three countries are similar only to each other and not to any country outside the group. So, this group is distinct and separate from the rest of the developed countries. Interestingly, these three countries were similar for both cardiovascular diseases and respiratory disease. This fact dictates that there must be some commonality that makes these three countries more similar to each other than any other developed country. A second group contained Canada (C2), Iceland (C4), Japan (C5), and New Zealand (C7). This second group was also distinct in that its members were only similar to countries in the group and no others. This second group had the four lowest counts for noncommunicable diseases. The country with the lowest count was Iceland with 585.6 deaths per 100,000. These four countries were also had similar counts for respiratory and cardiovascular diseases which indicates that they all have some commonality making their counts low. The final group contains the Netherlands (C6), USA (C10), and Norway(C8). Just like the other two groups, these three countries were only similar to countries within the group. These countries had more moderate counts that were in the 700s. There must be some commonalities or set of characteristics that define each of the three distinct and non-overlapping groups.

Developing countries proved to be more diverse than the developed countries. In fact the only diseases for which the developed countries were all similar were neuropsychiatric conditions, hepatitis B, and respiratory infections. This fact makes sense given that the developing countries tend to differ greatly with respect to level of sanitation, accessibility of medical care, and access to a stable food supply. Additionally, the developing countries are much more spread out geographically than the developed countries, since the developed countries were concentrated mostly in western and northern Europe. This large geographical divide means that developing countries will differ greatly with respect to environmental conditions and culture. These substantial differences were not observed in the developed countries where the environmental conditions were all similar and the culture was predominantly western. Furthermore, due to the greater differences between the developing countries, it will often prove difficult to place all the countries within different groups and these groups will be much less likely to have overlapping parts.

Figure 9: Results of Difference Proportions test for Infectious and Parasitic Diseases for Developing Countries



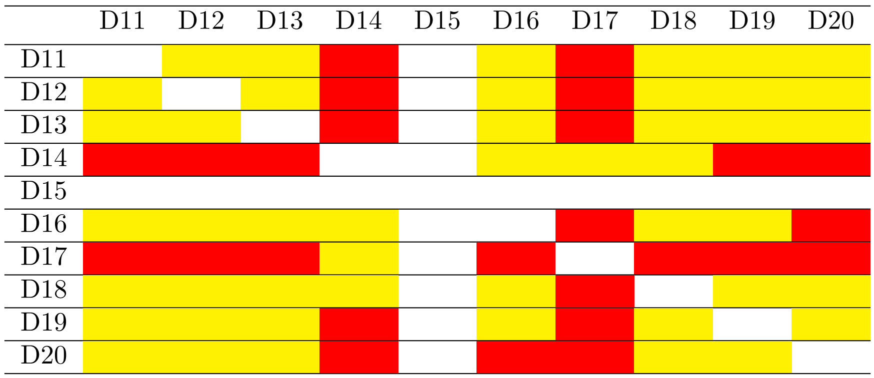
Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For infectious and parasitic diseases the Solomon islands (D19) had the lowest count at 103.4 deaths per 100,000 people and Malawi (D18) had the highest count at 948.1 deaths per 100,000 people. It can be discerned from the figure above that the Solomon islands (D19), Vanuatu (D20), and Kiribati (D15) all form one distinct group. One explanation for why these three countries are all similar is geography. These three countries are all South Pacific islands. Since they share geographical location these three countries most likely encounter the same infectious diseases and parasites associated with islands of the South Pacific. These three countries all have the lowest counts for the developing countries. The countries in this low count group all are only similar to other countries in this group and no others. A second group contains the Central African Republic (D12), Liberia (D17), and Djibouti (D13). These three countries all have counts which are fairly high, although not as high as Malawi's. The Central African Republic is similar to all members of this group, but the other two members are not similar to each other. This observation is interesting since all three of these countries exist in Africa along the same latitude and the Central African Republic lies in the middle of the countries. So, perhaps commonalities in environment explain the similar counts for these three countries for infectious and parasitic diseases. A third group contains Bangladesh (D11) and Lao People's Democratic Republic (D16). This group both had lower counts that were closer to the first group's. The countries Guinea-Bissau (D14) and Malawi (D18) both had counts that were radically different from those of any other country.

For STDs excluding HIV one country, Kiribati (D15) had no count given so it was left blank. There were two countries whose counts were distinctly higher than any other country. These two countries were Guinea-Bissau (D14) and Liberia (D17). The country with the highest count was Liberia with 19.6 deaths per 100,000 people. Liberia was only similar to Guinea-Bissau, but Guinea-Bissau was similar to both Lao People's Democratic Republic (D16) and to Malawi (D18). These two countries constituted a sort of middle count group and were similar to the most countries. The third group contains Bangladesh (D11), Central African Republic (D12), Djibouti (D13), Solomon islands (D19), and Vanuatu (D20). This third group consisted of countries with low counts. The country with the lowest proportion was Vanuatu with 0.0 deaths per 100,000 people. The overlap between the different groups suggests that the developing countries were fairly similar with respect to their deaths by STDs excluding HIV/AIDs.

The developing countries were very distinct when it came to their counts for HIV/AIDs. Because this fact made the patterns easy to discern from the counts and table 14a, no figure was made for this data. Despite this there were several groups in which the countries could be classified. The first group contained the countries with the lowest counts. This group consisted of Bangladesh (D11), Laos (D16), Solomon Islands

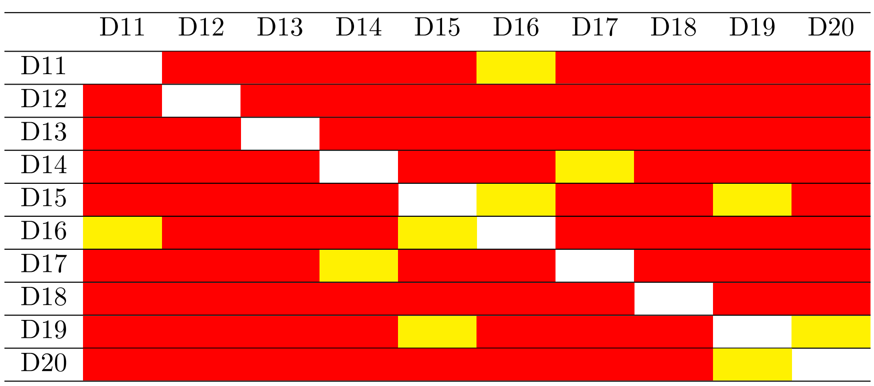
Figure 10: Results of Difference Proportions test for STDs excluding HIV for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

(D19), and Vanuatu (D20). Bangladesh and Vanuatu both had the lowest count at .1 deaths per 100,000 people. Each of the four countries in the category had counts that were incredibly small compared to those of the other developing countries, in fact they all were less than .5 deaths per 100,000. The only other group contained Guinea-Bissau (D14) and Liberia (D17), which both had moderate counts in the 50s. Kiribati (D15) did not have a count for HIV/AIDs so it was excluded from the data. The remaining three countries Central African Republic (D12), Djibouti (D13), and Malawi (D18) all had high counts that were dissimilar from any other developing country. Malawi had the highest count with 506.3 deaths per 100,000 people.

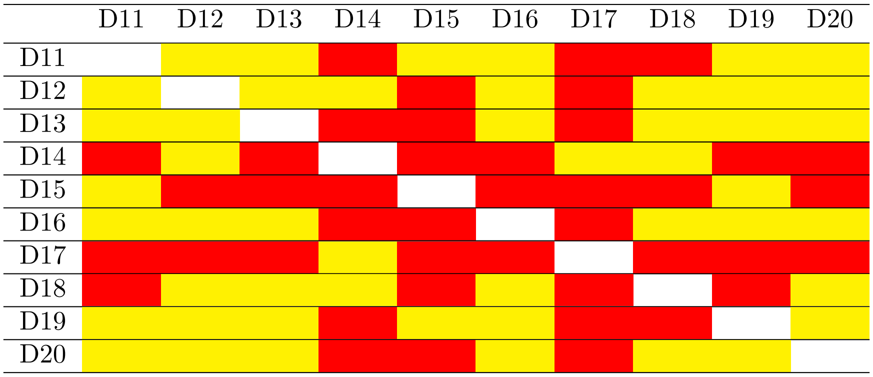
Figure 11: Results of Difference Proportions test for Diarrhoeal Diseases for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For diarrhoeal diseases Vanuatu (D20) had the lowest count at 8.5 deaths per 100,000 people. Liberia (D17) had the highest count at 220.1 deaths per 100,000 people. The countries could be split into several groups. The high count group included Liberia and Guinea-Bissau (D14). Each country in the high group was similar only to the other country in the high count group. The low count group contained the Solomon islands (D19) and Vanuatu. This group was as distinct as the high count group since the Solomon islands was also similar to Kiribati (D15). The medium count group contained Kiribati, Laos (D16), and Bangladesh (D11). The medium count group is only loosely associated via Laos which is similar to each country in the category. The remaining countries all had counts which were dissimilar from any other country.

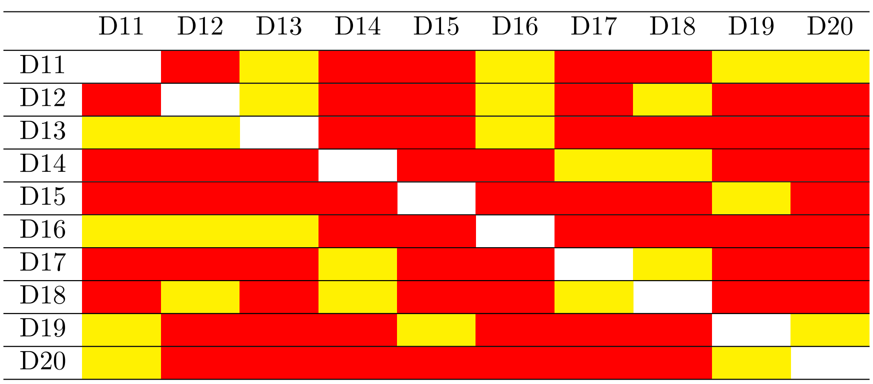
Figure 12: Results of Difference Proportions test for Meningitis for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For Meningitis the developing countries all are part of one group. However, this group is fairly spread out so that countries in the middle are similar to most of the other countries, but countries with extreme counts are dissimilar to countries at the other end. Kiribati (D15) had the lowest count with 1.6 deaths per 100,000 people. Liberia (D17) had the highest count at 35.8 deaths per 100,000 people. Bangladesh (D11) and Solomon islands (D19) both were lower count countries in that they were the only countries that Kiribati was similar to. However, both of these countries were similar to all the other countries except Guinea-Bissau (D14), Liberia, and Malawi (D18). Guinea-Bissau and Malawi were both higher count countries, where Guinea-Bissau was the only country that was similar to Liberia and Malawi was the only country with a lower count similar to Guinea-Bissau. Malawi was similar to a wide range of countries, which illustrates its position in the middle of the data. The rest of the countries lie in the middle of the range of counts.

Figure 13: Results of Difference Proportions test for Maternal Conditions for Developing Countries

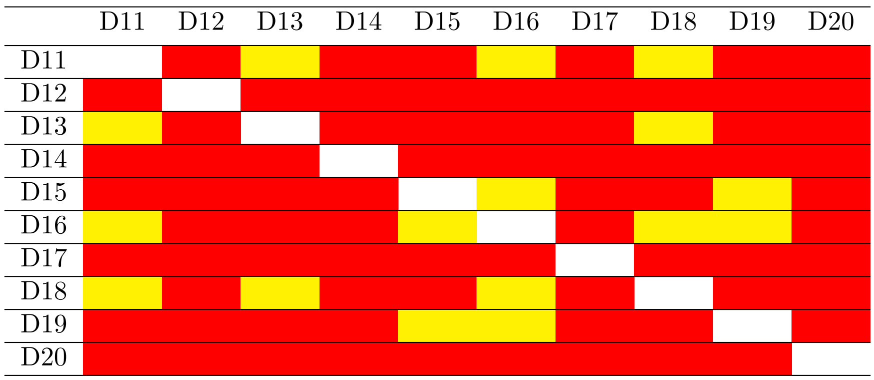


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For maternal conditions the country with the highest count was Liberia (D17) at 63.1 deaths per 100,000 people. The country with the lowest count was Kiribati (D15) at 1.8 deaths per 100,000 people. The developing countries form one large and very spread out group. The only country that Kiribati was similar to was Solomon islands (D19). However, Solomon islands was similar to Bangladesh (D11), and Vanuatu (D20), which were countries closer to the middle of the low count group. Liberia was only similar to Guinea-

Bissau (D14) and Malawi (D18). Guinea-Bissau was only similar to these higher end countries, but Malawi was similar also to Central African Republic (D12). The remaining countries were all in the middle of the group.

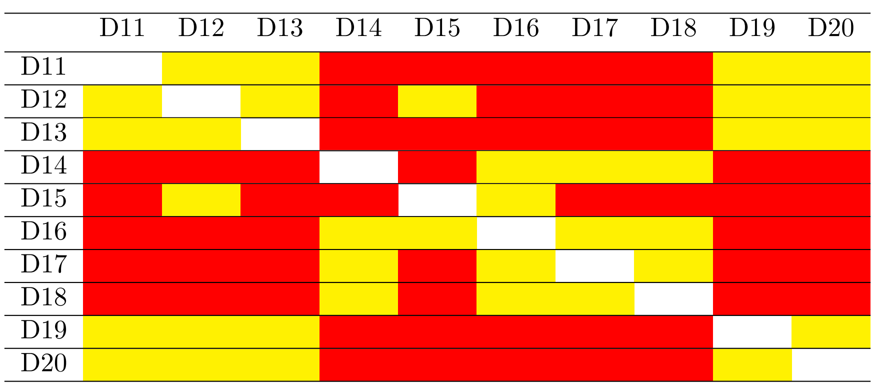
Figure 14: Results of Difference Proportions test for Perinatal Conditions for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

Vanuatu(D20) had the lowest count for perinatal conditions at 20.6 deaths per 100,000 people. Liberia (D17) had the highest count at 264.3 deaths per 100,000 people. Both of these countries were dissimilar from every other country. Guinea-Bissau (D14) and Central African Republic (D12) were the second and third highest countries for perinatal counts. They both were dissimilar to every other country as well. The rest of the countries can all be fit into one fairly spread out group. By spread out I mean that the ends of the group are not similar to each other, but they are connected by means of intermediate countries to the countries at the other extreme. The higher end of this group was Djibouti (D13) and the lower end of the group was Solomon islands (D19). The remaining countries were in the middle of this group.

Figure 15: Results of Difference Proportions test for Nutritional Deficiencies for Developing Countries



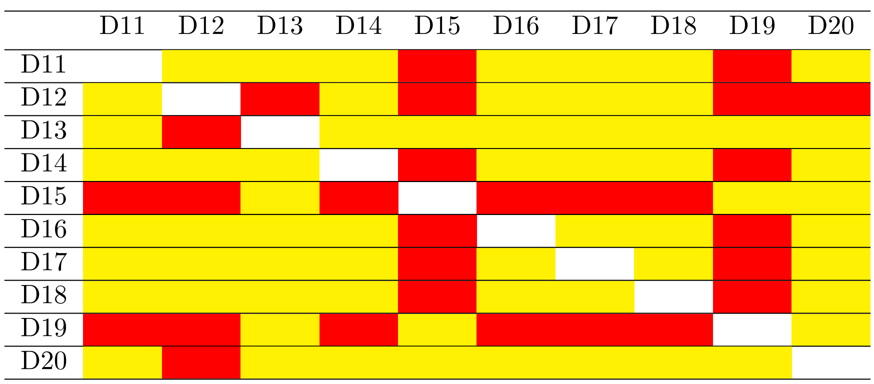
Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For nutritional deficiencies the developing countries can be split roughly into 2 different groups with one country in between joining them. The first group contains the lower count countries. These are Bangladesh (D11), Djibouti (D13), Solomon islands (D19), and Vanuatu (D20). The country with the lowest count was Vanuatu at 6.6 deaths per 100,000 people. The other group contains the high count countries which are

Guinea-Bissau (D14), Kiribati (D15), Laos (D16), Liberia (D17), and Malawi (D18). The country with the highest count was Liberia with 47.4 deaths per 100,000 people. The country that connects the two groups is the Central African Republic (D12). The Central African Republic was similar to all the low count countries and to Kiribati.

The communicable, maternal, perinatal, and nutritional conditions counts were made from a sum that included all the diseases previously discussed for developing countries. Since developing countries had very diverse counts for each of these diseases, their counts for this category were all incredibly dissimilar and far apart. In fact there were only two cases where the difference proportion test failed to reject the null hypothesis. These cases were Bangladesh (D11) compared with Laos (D16) and Kiribati (D15) compared with the Solomon islands (D19). Since most of the counts were rejected a figure was not created for this category. The counts for Laos and Bangladesh being similar makes sense since both these countries are located fairly close to each other in Southeastern Asia. Their similarity in environment and perhaps culture may have caused them to have to have similar counts.It should also be noted that these two countries had similar counts for all the communicable diseases except for nutritional conditions. The similarity between Kiribati and the Solomon islands is harder to explain. Both of these countries are island countries in the South Pacific, which does give them inherent similarities in environment. However, Vanuatu (D19) is also an island country in the South Pacific. Yet, its counts were different from both those of Kiribati and of the Solomon islands. Indeed, Vanuatu is even closer geographically to the Solomon islands than Kiribati. So, similar environmental conditions is a poor explanation for their similarity. Although it must be admitted that the counts for Vanuatu were rejected with a p-value of .04094, which is fairly close to the boundary point for rejection. It is interesting to note that Kiribati and the Solomon islands both had similar counts for all the diseases except for nutritional conditions and for the diseases where Kiribati had no counts.

Figure 16: Results of Difference Proportions test for Malignant Neoplasms for Developing Countries

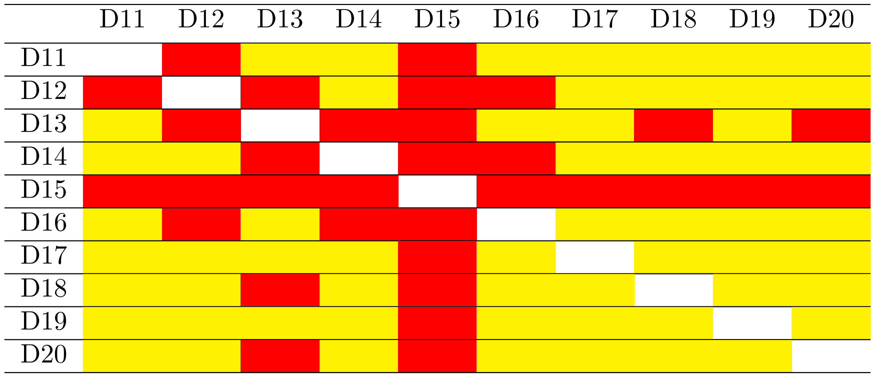


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For malignant neoplasms the developing countries formed one somewhat spread out group. By spread out, I mean that the countries with extreme counts were not similar to each other, but they were similar to several countries with intermediate counts that connect them. Kiribati (D15) had the lowest count at 34.5 deaths per 100,000 people. Central African Republic (D12) had the highest count at 77.6 deaths per 100,000 people. Kiribati was similar only to Djibouti (D13), Solomon islands (D19), and Vanuatu (D20). The Central African Republic was similar to every country except these four that were either Kiribati or similar to Kiribati. The large degree of interconnectedness amongst the group suggests that the developing countries were not as varied as they were for the past with the exception of perhaps STDs excluding HIV and HIV/AIDs.

For diabetes mellitus Kiribati (D15) had the highest count at 58.8 deaths per 100,000 people. Kiribati's was so high that it was dissimilar from all the other developing countries. The rest of the countries all fit

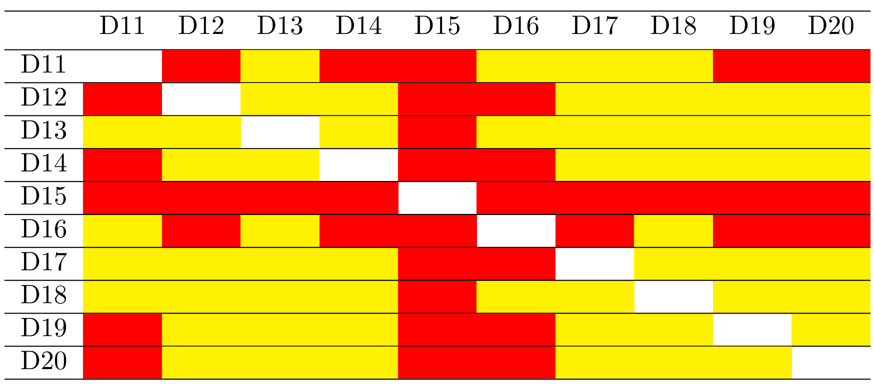
Figure 17: Results of Difference Proportions test for Diabetes Mellitus for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

into one somewhat spread out group in that the extreme count countries were dissimilar from each other, but they were both similar to countries connecting them. The country with the lowest count was Djibouti (D13) with 8.3 deaths per 100,000 people. Djibouti was similar to Laos (D16), Liberia (D17) and Solomon islands. The country that had the highest count in the group was Central African Republic (D12) with 27.5 deaths per 100,000 people. So the counts for diabetes mellitus were fairly close together, with the exception of Kiribati. This fact can also be observed by the high degree of similarity between countries in the main group.

Figure 18: Results of Difference Proportions test for Endocrine Disorder for Developing Countries

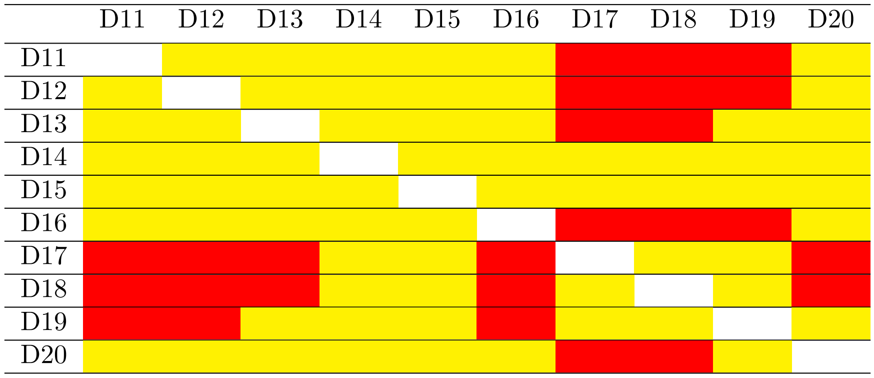


Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

The developing countries displayed a pattern for endocrine disorders similar to the patter observed by them for diabetes mellitus. Kiribati again (D15) had the highest count at 31.7 deaths per 100,000 people and its count was also so high that it was dissimilar from all the other developing countries. Additionally, the rest of the countries all could be loosely placed in one spread out group where the extreme countries were dissimilar but were similar to other countries that connected them. Laos (D16) had the lowest count at 1.6 deaths per 100,000 people. The high end of the group was Vanuatu (D20) with 14.4 deaths per 100,000 people. All of the countries in the group were similar to a high proportion of other countries in the group with the exception of Laos. Laos was only similar to three out of the nine countries which were Bangladesh

(D11), Djibouti (D13), and Solomon Islands (D18).

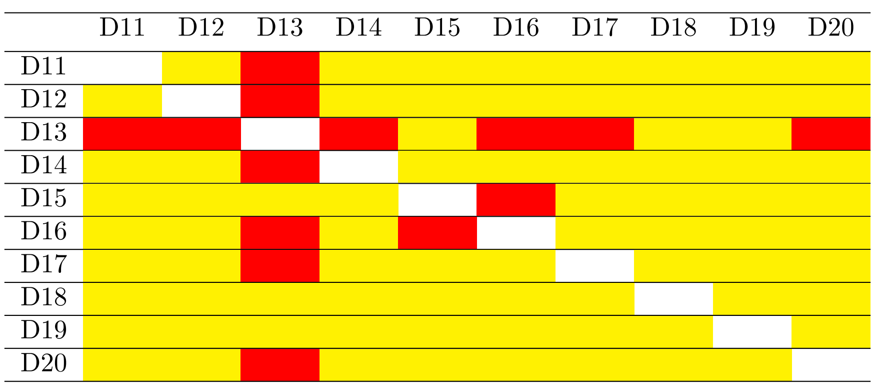
Figure 19: Results of Difference Proportions test for Cardiovascular Disorders for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

For cardiovascular disorders the developing countries formed one spread out group where the countries with extreme counts were dissimilar but they were similar to countries with moderate counts which link them. However, it is also possible to subdivide the developing countries loosely into subgroups. The low count subgroup is made up of Liberia (D17), Malawi (D18), and Solomon islands (D19). Each of these countries were dissimilar to the three highest count countries. All the countries in the low count subgroup were similar to each other and to some of the medium count countries. The country with the lowest count was Liberia with 134.0 deaths per 100,000. The three medium count countries were Guinea-Bissau (D14) and Kiribati (D15). Guinea-Bissau and Kiribati were similar to every other developing country and so represent the sort of average for the developing countries with respect ot cardiovascular disorder counts. The third subgroup contained Vanuatu (D20) and Djibouti (D13). Both these countries were similar to every country except Liberia and Malawi, which indicates that they had slightly higher counts than the medium count countries. Bangladesh (D11), Central African Republic (D12), and Laos (D16) make up the high count subgroup. Central African Republic had the highest count at 193.2 deaths per 100,000 people, but the other two high count countries were only lower by .3 deaths per 100,000 people.

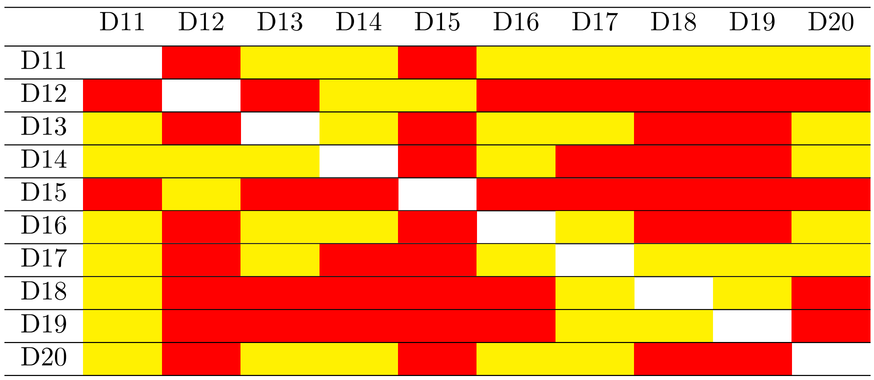
Figure 20: Results of Difference Proportions test for Respiratory Diseases for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

Most of the developing countries were similar with respect to respiratory disease counts. Djibouti (D13) was the only country that really stood out from the rest of the countries. Djibouti had the lowest count at 20.3 deaths per 100,000 people and in fact its count was so low that it was similar only to Kiribati (D15), Malawi (D18), and Solomon islands (D19). The only other dissimilarity came from Kiribati compared with Laos (D16). Laos had the highest count at 52.0 deaths per 100,000 people and Kiribati had the second lowest count. The rest of the countries were all similar to each other. Malawi and Solomon islands were the only two countries who were similar to every other country, however.

Figure 21: Results of Difference Proportions test for Noncommunicable Diseases for Developing Countries



Red means that the null hypothesis for the difference proportion test was rejected. Yellow means fail to reject. White means that no test was made.

The noncommunicable disease counts represent a sum of counts for other diseases that include malignant neoplasms, diabetes mellitus, endocrine disorders, cardiovascular disorder, and respiratory disorder. Due to this fact some of the variation seen amongst the noncommunicable disease counts can be explained using the variations seen for these diseases. For noncommunicable diseases Kiribati (D15) had the highest count at 496.0 deaths per 100,000 people. Solomon islands (D19) had the lowest count at 316.0 deaths per 100,000 people. The developing countries form one group where the extreme count countries are dissimilar from each other, but are similar to medium count countries that link them. Within this subgroup there are some loose categories in which the developing countries can be placed. One subgroup is the low count subgroup which includes Liberia (D17), Malawi (D18), and Solomon islands. Each of the countries in this subgroup were similar to each other and to Bangladesh (D11). Bangladesh, Djibouti (D13), Laos (D16) and Vanuatu (D20) make us a middle count subgroup. These countries have counts at the higher end of the 300s and link the high count subgroups and the low count subgroups. Central African Republic (D12), Guinea-Bissau (D14), and Kiribati (D15) make up the high count subgroup. Guinea-Bissau has the lowest count out of the three. The Central African Republic is similar only to the countries in the high count subgroup. Guinea-Bissau and Kiribati are not similar to each other, so this subgroup is fairly spread out. One important observation is that the developing countries were much closer in their counts for the noncommunicable diseases than they were for the communicable diseases. So there must exist some common factors between these countries that make their counts for noncommunicable diseases similar.

In summary, economic status of a country had a major impact on a country's susceptibility to disease in general. Developed countries,which had stronger economies, tended to better manage communicable diseases, while countries with worse economies tended to better manage noncommunicable diseases. These trends indicate that economic status dramatically alters the effects of disease on a given country. Additionally, the spread of the counts for the various diseases were different for the two economic categories. Countries with better economies tended to have very similar counts for communicable diseases, which indicates that having a higher economic status describes many factors that affect the susceptibility of a country to communicable diseases. Developing countries had fairly similar counts with respect to noncommunicable diseases. This fact indicates that having a low economic status must affect several factors that determine susceptibility of a country to noncommunicable diseases. These patterns indicate that economic status is likely a very important variable in assessing the overall health of a given country. Further data needs to be gathered in order to discern what factors economic status directly affects that alters the counts for these various diseases.

4 References

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