<u>EXTENDED ESSAY</u>

The Effect of The Human Development Index of Countries on

The Incidence of Lung Cancer in The Male Gender

'What is the relationship between the human development indices (HDI value)

of the randomly selected 38 countries and the occurrence of lung cancer in the

male gender?'

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INTRODUCTION

In a world that is constantly changing, some problems emerge because of the changes that occur. Various diseases that endanger human health are known to be among these issues. With time, it is possible to assert that, while most diseases can be cured, some diseases remain incurable. Cancer is one of these diseases. In 1500 BC, the world's first documented instance of cancer was discovered on ancient Egyptian papers. [1]Today, this disease, which is still incurable, kills many people.

Lung cancer is widely recognized as one of the most dangerous types of cancer. When looking at the global distribution of lung cancer, it does not have an equal distribution in each region. In this context, it is critical to discuss why the distribution of lung cancer among people carrying the same gene is not uniform around the world and what condition it is associated with.

While advancements in technology bring diseases, they also bring treatments for these diseases. In this context, there is a possibility that human development indices are related to the likelihood of lung cancer.

To examine the relationship between these two, it is necessary to first investigate what they depend on:

What is the HDI (Human Development Index)?

The Human Development Index (HDI) is a statistical tool for measuring a country's entire performance in its social and economic dimensions. The social and economic extents of a country are based on the health of its people, their grade of education and their standard of living. [2]

How exactly is HDI calculated?

The HDI is an index that estimates the main extent of human reconstruction. The components of the HDI are:

o   A (long) **healthy life** – life expectancy measures it.

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[1] *https://www.verywellhealth.com/the-history-of-cancer-514101*

[2] *UNITED NATIONS DEVELOPMENT PROGRAMME, Human Development Reports*

○ Accession to **education** - evaluated by the anticipated years of schooling of children and the average years of schooling of the grown-ups.

○ Adequate **standard of living** - evaluated by gross national income for each person, regulated to the country's price level.[3]

This introduction ensures an elementary conspectus of the Human Development Index using UNDP's standard HDI methodology over the past decades.

Components of the Human Development Index:

1. HEALTH

Life Expectancy: It is the most important metric for estimating population health. It is more comprehensive than the acute metric of child death rate, which centres exclusively on death rate at an adolescent age because life expectancy conquers death rate over the complete life course. It provides information on the mean age at death of a population.

Assessments recommend that life expectancy in a pre-modern, needy world was around 30 years in whole areas of the earth. Since 1900, the mean life anticipation global has more than duplicated and is presently over 70 years. The disparity in life anticipation between and within territories is still very large. Below is a chart with detailed information on life expectancy:
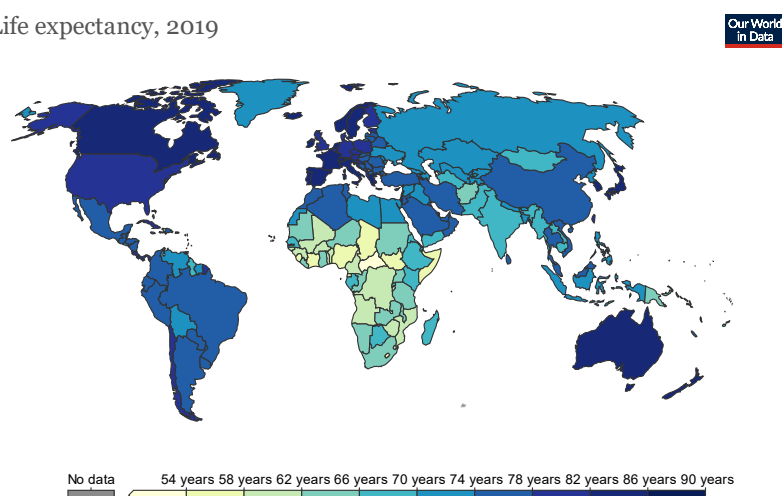
Life expectancy, 2019

No data 54 years 58 years 62 years 66 years 70 years 74 years 78 years 82 years 86 years 90 years

Chart 1: It shows the estimated life expectancy by country.

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[3] *https://ourworldindata.org/human-development-index*

2. EDUCATION

Expected and Average Years of Schooling: Education is one of the most important consequences of worldwide reconstruction. The provision of education is presently considered a fundamental right in most parts of the world - with repression on communities to provide standard education overall.

The visualisations below show the two metrics that the HDI receives:

o Average Years of Schooling anticipates the mean number of years of education completed by individuals aged 25 or more. This information goes back to 1870 and is based on a combination of information from Lee and Lee (2016), Barro-Lee (2018) and the UN development programme.[4]

Average years of schooling, 2017
Average number of years the population older than 25 participated in formal education.

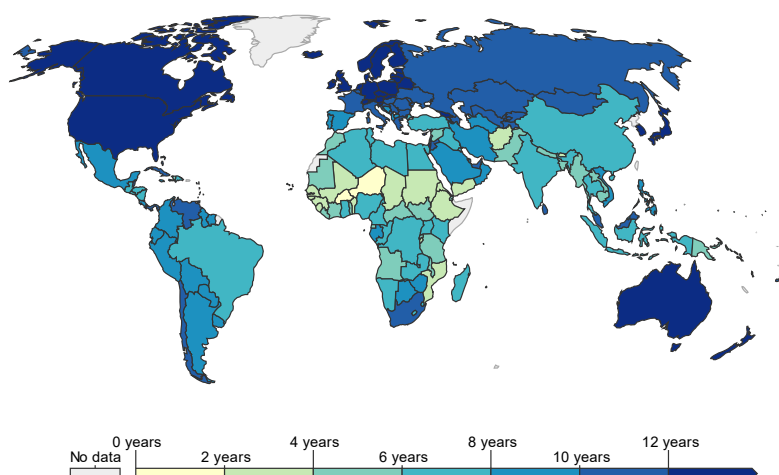**Chart 2:** This shows the average number of years the population older than 25 participated in formal education.

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[4] *https://ourworldindata.org/human-development-index*

School life expectancy, 2017
This measure tell us how many years of education a child of school entrance age can expect to receive if the
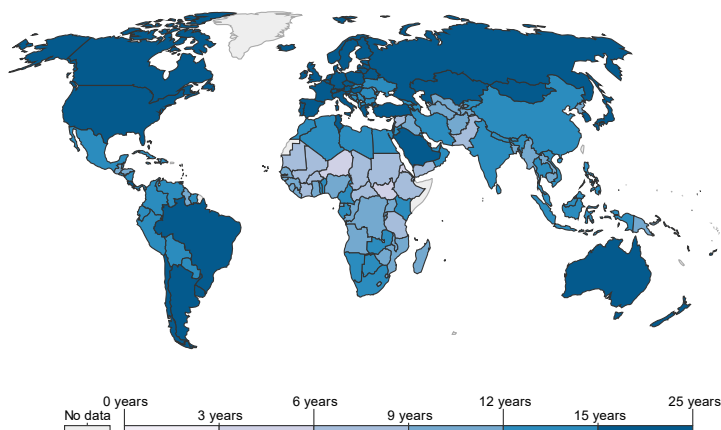current age-specific enrolment rates persist throughout the child's years of schooling.

Our World
in Data

Chart 3: Displays anticipated years of education, which assesses the number of years of education a child of school enrolment age is expected to complete if current age-specific registration proportions remain along with the child's life by territory.

3. STANDARD OF LIVING

GNI (Gross National Income) Per Capita: For mainly of human history, previous people lived in a world of weak sanitarian, starvation, and little attainment to regular education. Economic growth - especially in recent centuries - has facilitated some of the world's population to exchange these circumstances.

This metric is regulated for price alterations over time and for price variations between territories - it is evaluated in international dollars in 2011 prices.[5]

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[5] *https://ourworldindata.org/human-development-index*

The chart shows the GNI per capita - this is the key figure on which the HDI is based:

Gross National Income per capita, 2020
Gross National Income (GNI) per capita is adjusted for price changes over time (inflation) and price differences between countries – it is measured in constant international $.
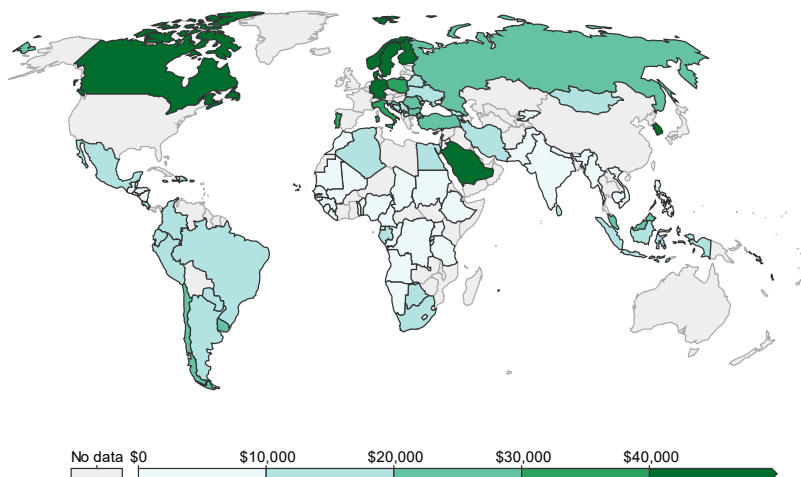

Chart 4: Shows the gross national income (GNI) per capita is adjusted for price changes over time (inflation) and price differences between countries.[6]

TWO STEPS OF CALCULATING THE HDI

1. Formation of Indices for Each of The Four Metrics

The worth of each of the four metrics is first normalised to an index worth from 0 to 1. For this purpose, "goalposts" are set by UNDP for the maximum and minimum limits of each metric, as shown in **Table1**.

 Table 1: Shows the goalposts which are set up by UNDP for the maximum and minimum limits of each metric[7]

Dimension	Indicator	Minimum	Maximum
Health	Life anticipation (years)	20	85
Education	Expected years of schooling	0	18
	Mean years of Schooling (years)	0	15
Standard of Living	Gross national income per capita (2011 PPP $)	100	75,000

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[6] *https://ourworldindata.org/human-development-index*

[7] *https://ourworldindata.org/uploads/2018/05/Screen-Shot-2018-05-08-at-13.55.26.png*

Using the actual value for a given country and the global maximum and minimum, the dimension value (index) for each metric is calculated as follows:

$$\text{Dimension Index} = \frac{\text{Exact Worth} - \text{Minumum Worth}}{\text{Maximum Worth} - \text{Minumum Worth}}$$

So, the dimension index is 1 in a territory that reaches the maximum worth, and it is 0 for a territory that reaches the minimum worth.[8]

2. Aggregate the Four Metrics to Create The HDI

Once each of the unique indices has been computed, they are aggregated to compute the HDI. The HDI is computed as the geometric average (equally weighted) of life anticipation, education and GNI for each individual as follows:

$$\text{HDI} = (I_{\text{Health}} \times I_{\text{Education}} \times I_{\text{Income}})^{1/3}$$

The education extent is the arithmetic average of the two education indices (average years of schooling and anticipated years of education).[9]

WHAT ARE LUNG CANCER AND ITS CAUSE?

Malignant tumour formations caused by an unbalanced proliferation of cells in the lungs are called lung cancer. The cancer cells initially multiply where they are and form a mass. In advanced stages, it spreads to surrounding tissues and organs. Lung cancer is one of the most extensive cancers with serious consequences. Because it usually causes no symptoms in its early stages, the disease is often far advanced by the time it is diagnosed. For this reason, people at risk need to have regular medical check-ups.

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[9] *https://ourworldindata.org/human-development-index*

Several environmental/hereditary factors are involved in the development of lung cancer:

1. Cigarette smoke: smoking produces about 90% of lung cancer situations. Moreover, it is not only a venture for the smoker. Second-hand smoke, the smoke you breathe in from a lit cigarette or a smoker, can also lead to this disease.

2. Vaporise: These are also called electronic cigarettes or e-cigarettes. The fluids in a vape include nicotine, flavourings, and other poisonous substances that you inhale.

3. Radon: This gas cannot be seen, smelled, or tasted. It exists in soil and rock and gives off radiation. Radon gets into homes, schools, and other structures across small fractures in the foundation. It is the second-largest risk agent for lung cancer after cigarettes.

4. Particulate pollution: This is a mixture of tiny acid particles, chemicals, dust, and metals in the air. Each particle is much smaller than a grain of sand. They can get trapped in your lungs if you breathe them in.

5. Genes: In families, genes are passed from one generation to the other. These include mutated genes that make your cells incapable to repair harmed DNA and others that make your body incapable to extract cancer-causing chemicals from your system.[10]

Research Question:

'What is the relationship between the human development indices (HDI value) of the randomly selected 38 countries and the occurrence of lung cancer in the male gender?'

To answer this question, two cases that are mentioned were studied to do the preliminary work:

o   Detailed information about the **development index of the countries (the human development index)** is collected and converted into graphics.

o   Data on the **incidence of lung cancer by each country** is collected and graphically presented.

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[10] *https://www.mayoclinic.org/diseases-conditions/lung-cancer/symptoms-causes/syc-20374620#*

This study was conducted to establish the connection between these concepts.

For the research to be conducted, 38 countries were selected randomly -so that there is no specified situation- to obtain more concise and precise information:

1. Bulgaria	15. India	29. Norway
2. Belarus	16. Australia	30. Poland
3. Canada	17. Iceland	31. Slovenia
4. Chile	18. Ireland	32. Sweden
5. China	19. Israel	33. Switzerland
6. Colombia	20. Italy	34. Brazil
7. Croatia	21. The Republic of Korea	35. Thailand
8. Czechia	22. Kuwait	36. Turkey
9. Denmark	23. Latvia	37. Uganda
10. Ecuador	24. Lithuania	38. Ukraine
11. Estonia	25. The UK	
12. France	26. Malta	
13. Germany	27. The Netherlands	
14. The US	28. New Zealand	

HYPOTHESIS

From past to present, what makes a society a society is the human power of that society. A healthy society means that people are mentally and physically healthy. Looking at examples from the past, we can see how any disease that threatens human health has negatively affected human history, for example, the plague epidemic. This disease emerged towards the middle of the 1300s and caused the death of approximately 75-200 million people. However, nowadays plague has fewer than 5000 cases worldwide[11]. Of course, the reason for this is that the treatment has been found. But why was the cure

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[11] *https://www.who.int/news-room/fact-sheets/detail/plague*

found much later? It is possible to say that this is related to the developing world standards and technology. It would not be appropriate to compare the health technology of the 1300s with the health technology of today. Thanks to new medicines, new treatment devices, and many more innovations that make the work of doctors easier, we can defeat the plague and many other diseases. However, today, compared to many countries, some countries lag in these areas of development. In this case, we can say that some diseases still result in death, just as in the past. In this context, it is possible to say that the level of development of countries is quite effective in the treatment of a disease.

In this case, the hypothesis was set as follows:

There is a regular proportion between the country's level of development (the HDI value) and the incidence of lung cancer in men as the human development index increases, treatment conditions may improve.

<u>Method Development</u>

In creating my research question, I had great difficulty in selecting data with high precision. Before the research question 'What is the relationship between the human development indices (HDI value) of the randomly selected 38 countries and the incidence of lung cancer in the male gender?', I had considered studying many different situations, but most of them did not produce the expected results. I wanted to study the relationship between HDI and one of the factors that cause lung cancer, regardless of gender, but the data in the sources I used were different. In this case, I created a research topic based on gender by evaluating this research site.

<u>METHODOLOGY</u>

Based on the hypothesis, I compared the human development levels of 38 countries and obtained ranked data from these levels. Then, I decided to investigate how the incidence of lung cancer, a very common disease among cancer types and causes the death of approximately 2 million people annually, depends on the level of human development of countries. As part of this research, to obtain more exact and specific data, I decided to concentrate on one gender: men.

Given this information, I will first combine the two data I will use for the correlation (the HDI and the lung cancer incidence in the male sex) into a single graph. Next, I will run a linear regression to find the line that fits best. This way, I can use the properties of linear regression with the help of the correlation method. (By determining the correlation coefficient, I have obtained the data that allows me to interpret the relationship between these two data).

Using the correlation method, I decided to examine the relationship between these two investigated cases.

Correlation: This is a statistical procedure of determining if there is a linear relation among two quantitative estimations, and if so, in what way and how strong that relationship is.

The computed correlation coefficient also takes a value between -1 and +1. If the correlation coefficient (r) is negative, there is a reverse relation among the two variables, that is, it is said that "when one variable increases, the other decreases". When the correlation coefficient (r) is positive, it is expounded to mean that "when one of the variables increases, the other also increases".[12]

Explication of the correlation coefficient (r):

If r < |±0.2|, there is no correlation.

A weak correlation among |±0.2-0.4|

A moderate correlation among |±0.4-0.6|

A high correlation among |±0.6-0.8|

If |±0.8| < r, this is interpreted as a very high correlation.

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[12] https://www.statisticshowto.com/probability-and-statistics/correlation-coefficient-formula/

DATA

The United Nations Development Programme (UNDP) collects the development index of 189 territories in its yearly Human Development Index (HDI) report. The index takes into account health, education, and income in each country to ensure a dimension of human development that is comparable among territories and over time. The data used to calculate the HDI comes mainly from the United Nations and international institutions such as "the United Nations Educational", "Scientific and Cultural Organisation (UNESCO)", "the United Nations Department of Economic and Social Affairs", "the World Bank", "the International Monetary Fund and the Organisation for Economic Cooperation and Development (OECD)".

Table 2 shows the countries' HDI values and Chart 5 shows the distribution on the world map of the HDI values:

Table 2: Shows the Human Development Indexes of the countries:[13]

Rank	Country	HDI Value (2019)
1.	Norway	0.957
2.	Ireland	0.955
3.	Switzerland	0.955
4.	Iceland	0.949
5.	Germany	0.947
6.	Sweden	0.945
7.	Australia	0.944
8.	Netherlands	0.944
9.	Denmark	0.940
10.	United Kingdom	0.932
11.	New Zealand	0.931
12.	Canada	0.929
13.	United States	0.926
14.	Israel	0.919
15.	Slovenia	0.917
16.	Republic of Korea	0.916
17.	France	0.901
18.	Czechia	0.900
19.	Malta	0.895
20.	Estonia	0.892
21.	Italy	0.892
22.	Lithuania	0.882

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[13] *Human Development Report Office*

23.	Poland	0.880
24.	Latvia	0.866
25.	Chile	0.851
26.	Croatia	0.851
27.	Belarus	0.823
28.	Turkey	0.820
29.	Bulgaria	0.816
30.	Kuwait	0.806
31.	Ukraine	0.779
32.	Thailand	0.777
33.	Colombia	0.767
34.	Brazil	0.765
35.	China	0.761
36.	Ecuador	0.759
37.	India	0.645
38.	Uganda	0.544

Human Development Index, 2017

The Human Development Index (HDI) is a summary measure of key dimensions of human development: a long and healthy life, a good education, and having a decent standard of living.
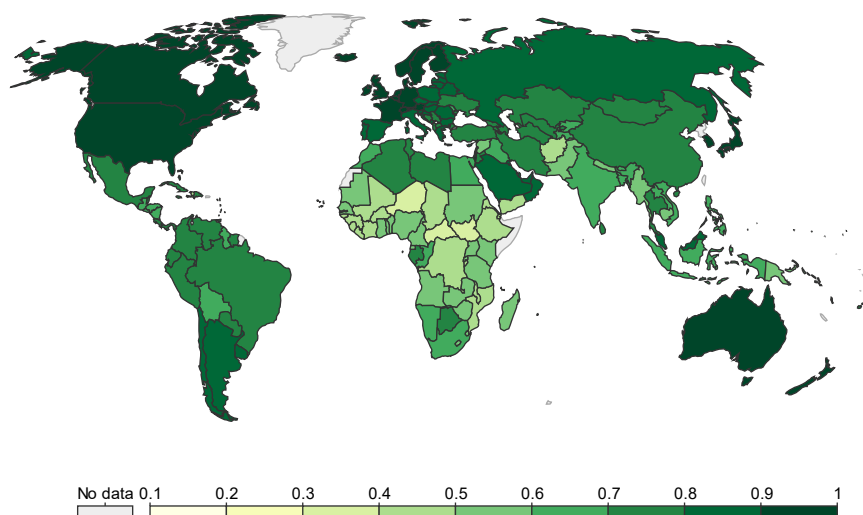
Our World in Data

No data 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Chart 5: Shows the values of the human development index values according to the countries.[14]

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[14] *https://ourworldindata.org/human-development-index*

In addition to the information about the factors that trigger lung cancer (see page 9), the studies also show that 90-95% of lung cancers are not inherited, apart from a few cases. So, in this case, the person probably does not have these mutations at birth, and they are not passed on to their children. It is possible to interpret that environmental factors and the individual's standard of living play the biggest role in the development of lung cancer. Also, the most common cause of lung cancer is inhaling harmful substances, so lung cancer can improve many years after you have breathed the harmful smoke.

Table 3 shows lung cancer in men as a percentage by country:

Table 3: Shows the incidence of lung cancer in men by country [15] (shown as a percentage)

Rank	Country	Cumulative risk in per cent
1.	Turkey	12.4
2.	Estonia	11.8
3.	Croatia	11.6
4.	Latvia	11.6
5.	Poland	10.8
6.	Belarus	10.6
7.	Republic of Korea	10.3
8.	Netherlands	10.2
9.	Slovenia	10.2
10.	Denmark	10.1
11.	Czechia	10.1
12.	France	10.0
13.	Lithuania	10.0
14.	Germany	9.7
15.	Italy	9.5
16.	China	9.4
17.	Ireland	9.3
18.	Malta	9.0
19.	United Kingdom	8.9
20.	Canada	8.8
21.	Bulgaria	8.7
22.	Norway	8.5
23.	Ukraine	8.5
24.	United States	8.4
25.	Australia	7.9
26.	Switzerland	7.7
27.	Iceland	7.4
28.	Israel	7.0
29.	New Zealand	6.8
30.	Thailand	6.2
31.	Sweden	4.6

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[15] *https://gco.iarc.fr/*

32.	Brazil	3.6
33.	Colombia	3.2
34.	Kuwait	2.6
35.	Chile	2.2
36.	India	2.2
37.	Ecuador	1.7
38.	Uganda	1.0

ANALYSIS

CORRELATION: To investigate the impact of countries' level of development on the rate of lung cancer in men, I ranked these two values (the HDI values and the incidence of lung cancer) by country. To make a comparison between these data based on statistical data, I will use the correlation method.

The graph created to make the correlation is shown in Graph 1:
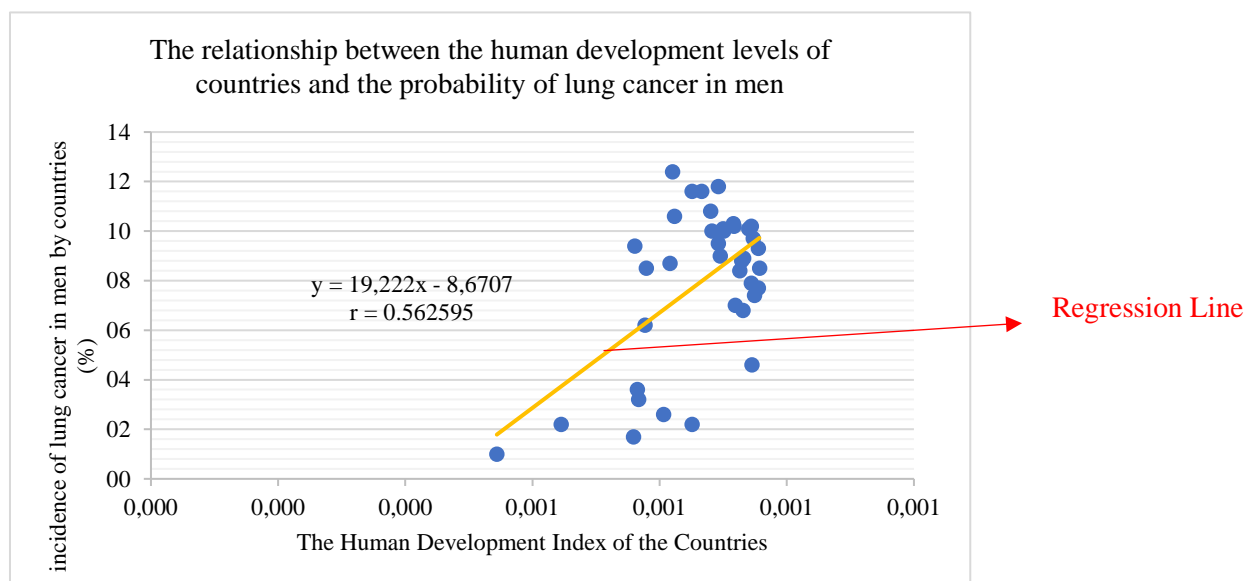
Graph 1: Shows the relationship between the human development levels of countries and the probability of lung cancer in men.

Regression line: In statistics, a regression line is a line that best defines the attitude of a set of data.[16]

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[16] *https://www.myaccountingcourse.com/accounting-dictionary/regression-line*

Determining Correlation Coefficient

I get the "r" value of the correlation graph I created. This "r" value indicates the degree of closeness of the correlation. As stated on page 12, the range of numbers for the "r" value gives information about the success of the correlation.

As the value "r" (correlation coefficient) gets closer to +1.00, the connection between two variables in the same direction increases. As one variable increases, the other increases.

As the value "r" gets closer to -1.00, the reverse relationship between the two variables increases. As one variable increases, the other decreases. As it approaches 0.00, the relationship between the two variables decreases.

So, in the light of the pieces of information above, a (-) correlation coefficient is called "negative correlation", while a (+) value is called "positive correlation". In this case, since r (correlation coefficient) = (+)0.562595 we found, it is possible to say that there is a positive correlation between the Human Development Index and the Percentage of Lung cancer Incidence in the Male Gender.

In this case, the result we obtained from this correlation confirms the direct proportion between the Human Development Index and the Percentage of lung cancer incidence in the male gender, but we can also say that "r" values in the range of 0.4-0.6 indicate a moderate correlation. In this case, I could not confirm my hypothesis 100% because I said that according to the hypothesis, the HDI values of the countries greatly affect the incidence of Lung Cancer in men.

As a result of the correlation, Turkey was the country that remained the farthest from the regression line and showed that there is no connection between the development level of the countries in the formation of lung cancer, which is seen in men. Thailand was the country that was on the exact regression line and showed us that the level of development of its country is highly or even completely related to the lung cancer seen in men. So, we can see that there is a moderate relationship between the countries' human development levels and the prevalence of lung cancer in men, but because the "r" value we obtained is 0.562595, we cannot say that there is a very strong relationship between the HDI value and the prevalence of lung cancer in men.

CONCLUSION

Within the scope of the selected research question 'How does the level of development of countries affect the incidence of lung cancer in the male gender?', the development level of the countries and the incidence of lung cancer in men were investigated and the relationship between these two was researched. In this context, firstly, studies on HDI and Lung Cancer were carried out and the percentages of HDI and lung cancer seen in men in the selected countries were determined and tabulated (for each country). Then, a correlation technique was used to observe the connection between these two and the correlation coefficient (r) was determined as (+)0.562595 so it means there is a positive correlation between concepts. In this case, the correlation between these two values turned out to be moderate as the value (+)0.562595 (r-value) is between the range (+)0.4-0.6, and, while confirming the hypothesis in one respect, it also showed that the hypothesis was not correct in another. The countries close to the regression line (such as Thailand), which was mentioned before, supported my hypothesis, while the countries far from the regression line (such as Turkey) remained far from my hypothesis.

As a result, although the correlation coefficient "r" value we obtained because of our correlation was a positive value, the effect of HDI on lung cancer seen in men was determined as moderate since it remained in the range of 0.4-0.6. So, I could not confirm my hypothesis 100%, but although there is a moderate correlation between HDI values of countries and lung cancer in men, we cannot say that they are completely independent of each other.

However, as stated in a previous study on HDI and lung cancer, *"Studies have shown that HDI is associated with the incidence and distribution of cancer types. Lung cancer is the most common cancer in all communities with different HDI. In communities with high HDI, the incidence of lung cancer is rising in women."*[17], we can say that there is a relationship between the countries where lung cancer is

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[17]

https://tlcr.amegroups.com/article/view/6148/5865#:~:text=Studies%20have%20shown%20that%20HDI,rising%20in%20women%20(9).

seen in women and the HDI values of the countries. Of course, it would not be appropriate to say this based on only one study, but this hypothesis can be supported by future research.

DISCUSSION

Within the study's scope, the data on HDI and lung cancer in men, especially mentioned in the "Introduction" section, differ according to many sources. For this reason, when calculating the HDI and lung cancer risk values of the countries, the information of many different sources was used in common. In this case, it is unlikely that the data obtained will be 100% real. However, although the accuracy of the information is not 100%, the data obtained is very close to being correct since it is the common data of the sources. For this reason, if the data shared by the sources had absolute accuracy, the research could be considered 100% correct. Another factor that may affect the research is the fact that the graph used for correlation will not be able to obtain 100% appropriate data. Unfortunately, since this is not possible, it is possible to encounter deficiencies in the processing of data in the correlation calculation part. In this case, in general, the use of data in future studies should be very meticulous and precise. In future studies to be carried out within the scope of this research, it is recommended to use very precise and accurate information and besides, the use of the most up-to-date data is required. Although the study was limited to the only male gender, it gave more comprehensive data because it narrowed the study area, but since this study aims to investigate the relationship between the development indexes of countries and lung cancer seen in humans, including women in the study will increase the applicability of the results obtained.

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