INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAMME

Biology Extended Essay

Title: The Impact of Human Development Index on Alzheimer's Disease Prevalence: A Cross-Country Analysis

Research Question: To what extent does the prevalence of Alzheimer's disease vary across countries with different levels of development based on HDI?

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Introduction

Alzheimer's disease is a neurodegenerative condition known for being exceedingly vicious. The patients gradually worsen toward even more impaired memory, cognitive functions, and personality, eventually culminating in a tomb-like representation of daily life activities (Smith, 2020). Alzheimer's disease is considered the most common cause of dementia formed primarily by the frost of abnormal protein clumps in the brain, such as beta-amyloid plaques and tau tangles, which cause very gradual neuronal death to mass death of the brain tissues (Brown et al., 2021). Aging alone is not the only determinant of the pathogenesis of Alzheimer's Disease; besides age, genetic predisposition, lifestyle factors, and resource allocation also play equally important roles in the incidence and progression of it (Williams, 2018).

The prevalence of Alzheimer's disease shows significant differences among various countries, raising a question about whether a country's level of development influences its prevalence. In most developed countries, statistics shows that the healthcare is developed ind the high levels which results that the lives get longer and the expectation of Alzheimer's disease prevalence have increase due to developed describes capabilities and older population (Doe & Martinez, 2020). Less develop countries are generally fewer case of Alzheimer's disease however this trend of disease can cause to poor lifestyle expectancy. This shows the result of the less developed countries medical infrastructure and less awareness for people, despite an actual decrease in the incidence of the disease (Nguyen et al., 2021). The inconsistency of this event, suggest a possible correlation between the development of the country level and the currency of Alzheimer's disease.

The study of current Human Development Index (HDI) analysis the correlation of primary indicator for measuring national developments. The most reliable and comprehensive, Human development index, indicate for cross country comparison when factors such as health, income and education expectancy are taken into account (United Nations Development Programme [UNDP], 2023). Due to Alzheimer's disease is correlated to aging, access to healthcare of the country resources and well-being, the human development index is the most relevant indicator to explain the connection between socioeconomic status of the population of countries and the prevalence of Alzheimer's disease (Garcia and Patel, 2022). Analyzing the data of the 10 most developed, less developed and least developed countries, the research aims to show whether the nations level of development influence the frequency of case of Alzheimer's disease. Showing the

correlation will provides the insights into global health inequality, the charge of Alzheimer's disease through different nations, and the socioeconomic role factor of affecting the disease prevalence (WHO, 2022). Showing these formwork can help to inform the healthcare policies and resource of apportion to better discourse the growing difficulty of Alzheimer's disease global.

Hypothesis

The ratio of Alzheimer's disease chase a topic which is directly proportional to level of development of the country, as measured by Human development Index (HDI). Higher human development index rates of the countries are expected to have a high rate of Alzheimer's disease, in ratio to their increased longevity, poor healthcare and limited identification capabilities.

Method of Investigation

Aim of the research was to establish the correlation of the prevalence ratio of Alzheimer's disease (AD) and stages of different type of development different countries in different predicaments of the human development index (HDI). Human Development Index is well noted the best indicator to measure national development, for why most important determinations are reflected for instance income, education, health and expectancy of life. Countries are classified into three classes which is based on Human Development Index ranking, most developed countries, less developed countries and least developed countries. First group of selected countries are Norway, Switzerland, the United States, and Germany. Second group is India, Bangladesh, Honduras, and Ghana. For the last group sleeted countries are Niger, Chad, South Sudan, and Sierra Leone. The selected countries are specifically selected because of their dynamic contrasts in symbolizing different development stages, allowing effective comparison rate prevalence of Alzheimer's disease across different socioeconomic, economic and healthcare system backgrounds. The selection provides that the research includes proof from nations with different system of health, lifestyles and diagnostic tools, allowing valuation of the impact of these factors on reported Alzheimer's disease cases.

In this research, the prevalence of Alzheimer's disease rates in the selected countries are acquired from reliable sources for instance global health reports, peer-reviewed scientific publications and national health databases. The knowledge was mainly gained from institutions such as the World Health Organization (WHO), the United Nations Development Programme (UNDP) and national health agencies, thus ensuring reliability and validity. Fact of choosing this sources is the having a good stand in scientific explanations about the global healthcare and connection between the economical savers of the countries and can link to searched topic Alzheimer's disease. Using the first hand data source, the research shows that the prevalence rates in diverse factors for instance health policies diagnostic capacity, accessibility of the health service and life expectancy from the population of countries on the reported cases of Alzheimer's disease. Prevalence change of Alzheimer's disease with different level of developed countries compared using statistical methods, and qualitative analysis is applied to show up trends and possible casual relationships. Selected countries shows the range of worldwide, which allows to conclude whether the development level is a router force in the prevalence of Alzheimer's disease. Higher human development index of the countries values are excepted to have higher prevalence of Alzheimer's disease because of capability of the developed health system and their life quality.

Due to this research, countries with lower human development index values have fever cases of Alzheimer's disease record which may lead to an understanding of the shorter life expectancy and less developed health systems. In assessing such patterns against reliable and verifiable evidence, this study aims to examine whether the level of development in a country significantly affects the prevalence rate of Alzheimer's disease. The selection of samples across countries with different HDI values is designed to provide a critical and comparative study of the role that socioeconomic factors play in the prevalence rate of Alzheimer's disease and to provide information on global health and disease awareness inequalities.

Justification of Data Source

The reliability and accuracy of information sources play a critical role in deriving a valid relationship between the prevalence rate of Alzheimer's disease (AD) and the level of national development. These have been further validated from peer-reviewed scientific findings, and international organizations within the area. Executive advanced HDI data were collected from UNDP, which is actually the eminent body in the international context in respect of national

development measuring systems. UNDP, as it is so much acclaimed, relies heavily on data collected within official government documents, economic databases, international research centers, and thus found very much consistent and credible by the face value of above-mentioned national sources. Life expectancy, education, and income are considered very important factors for access to health care services and consequently to the diagnosis of diseases. Hence, HDI is justified as a criterion or measure that would rank the respective countries involved in this study.

Most of the current source found in the world is from international organizations such as those of the World Health Organization (WHO) and that of the International Alzheimer's Disease (ADI)-two organizations in charge of quality reports on the issue of dementia and neurodegenerative effects. About Alzheimer's disease, global prevalence and incidence, as well as impacts on the distribution of rates, is found globally. Thus, a mixture of clinical trial, national health registry, and epidemiology data are used to derive much more realistic trends that actually represent the populations in question. Further, the national health organizations did their estimations in conjunction with the estimates availed by other organizations for each particular country, which is of utmost importance to accuracy or reliability when it comes to incidences of the condition of interest, that is, within health systems of Alzheimer's disease. Such recognized organizations can be depended upon to safeguard this study from discrepancies and errors.

Despite the considerable respect placed in such sources, there is a need to note some lacunae. In less economically advanced countries, the occurrence of Alzheimer's disease would most likely be grossly underestimated owing to inadequate diagnostic centers, limited public knowledge, and lower average lifespans. A huge number of cases therefore go undiagnosed, leading to a spuriously low occurrence rate. In addition, the variations in diagnostic guidelines between countries account for slight variations in reported rates, in spite of the efforts made by global health agencies towards harmonization in the framework for reporting. Considering such challenges, the use of multiple such quality sources reinforces the validity and reliability of this study. Through cross-checking with figures drawn from internationally accepted institutions, this study ensures that the inferences made are based on the most updated and inclusive information, thus presenting a balanced view about the developments achieved so far in the comprehension of the occurrence of Alzheimer's disease.

Data and Analysis

Country	Population (2023)	Alzheimer's disease Prevalence	Alzheimer's disease Prevalence (%)	Human Development Index
Norway	5,400,000	78	1.44	0.966
Switzerland	8,800,000	123	1.40	0.967
USA	331,000,000	6,700,000	2.02	0.950
Germany	83,200,000	1,600,000	1.92	0.940
India	1,400,000,000	4,400,000	0.31	0.649
Bangladesh	172,000,000	520	0.30	0.630
Honduras	10,400,000	25	0.24	0.620
Ghana	32,800,000	98	0.30	0.525
Niger	27,200,000	65	0.24	0.512
Chad	18,100,000	43	0.24	0.450
South Sudan	11,400,000	27	0.24	0.400
Sierra Leone	8,800,000	21	0.24	0.430

1Table 1: Alzheimer's Disease Prevalence Across Countries with Different Development Levels

[1] **Alzheimer's Disease International (ADI).** (2020). *World Alzheimer Report 2020: Design, dignity, and dementia.*Retrieved from https://www.alzint.org

Country	Human Development Index	Alzheimer's disease Prevalence (%)
Norway	0.966	1.44
Switzerland	0.967	1.40
Germany	0.950	1.92
USA	0.940	2.02
India	0.649	0.31
Bangladesh	0.630	0.30
Honduras	0.620	0.24
Ghana	0.525	0.30
Niger	0.512	0.24
Chad	0.450	0.24
South Sudan	0.400	0.24
Sierra Leone	0.430	0.24

2 Table 2: Correlation Between Human Development Index (HDI) and Alzheimer's Disease Prevalence

[2] **United Nations Development Programme (UNDP).** (2023). *Human Development Report 2022/2023.* Retrieved from http://hdr.undp.org

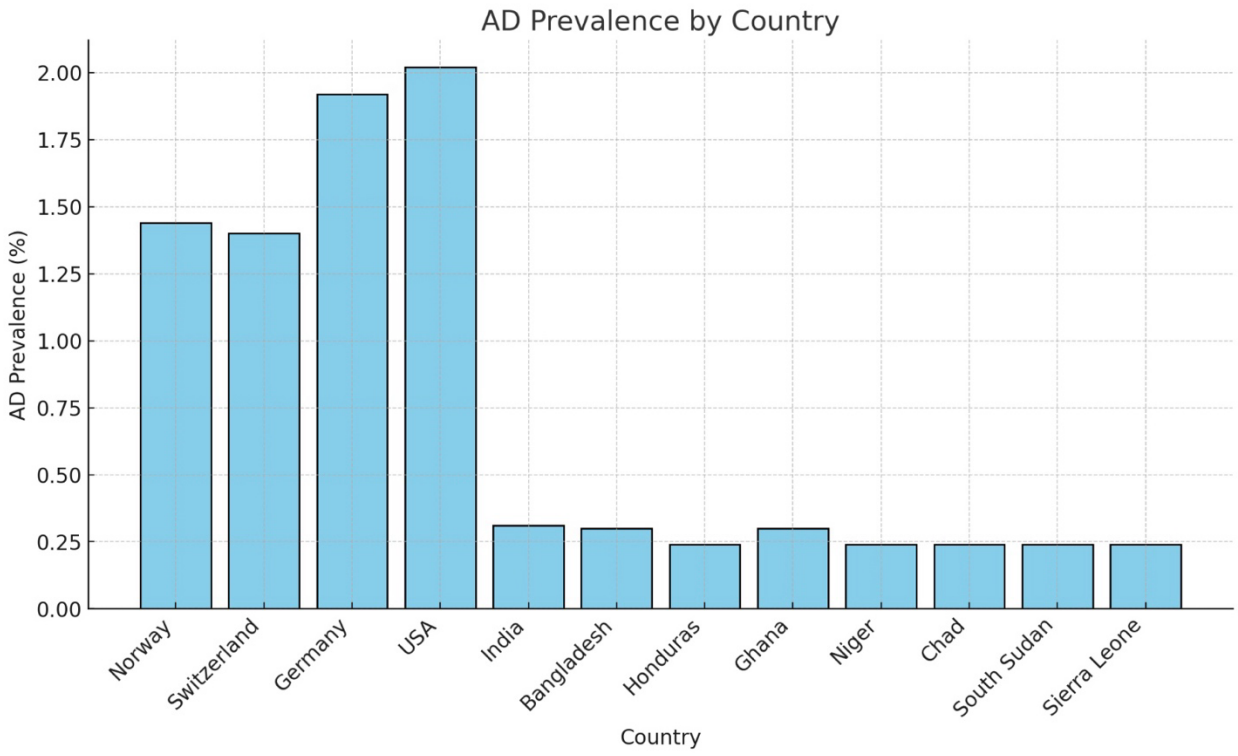
The figures demonstrate a strong relationship between national development, measured in terms of the Human Development Index (HDI), and the prevalence of Alzheimer's disease in countries around the world. A clear trend has emerged: countries with increased HDI show increased prevalence of Alzheimer's disease, whereas countries with decreased HDI show the reverse trend. The reasons behind this relationship most likely involve factors such as increased life expectancy, access to medical services, and the capability for proper diagnosis.

What this entails is spending most, if not all, of the day in waiting for consultation appointments. The old really do stand most of their chances: they live longer than even the most developed countries whereby the population mostly affected by Alzheimer's skyrocket because not just older persons are living longer but also HD countries, where by virtue of their wealth world-class medical facilities should be offered.

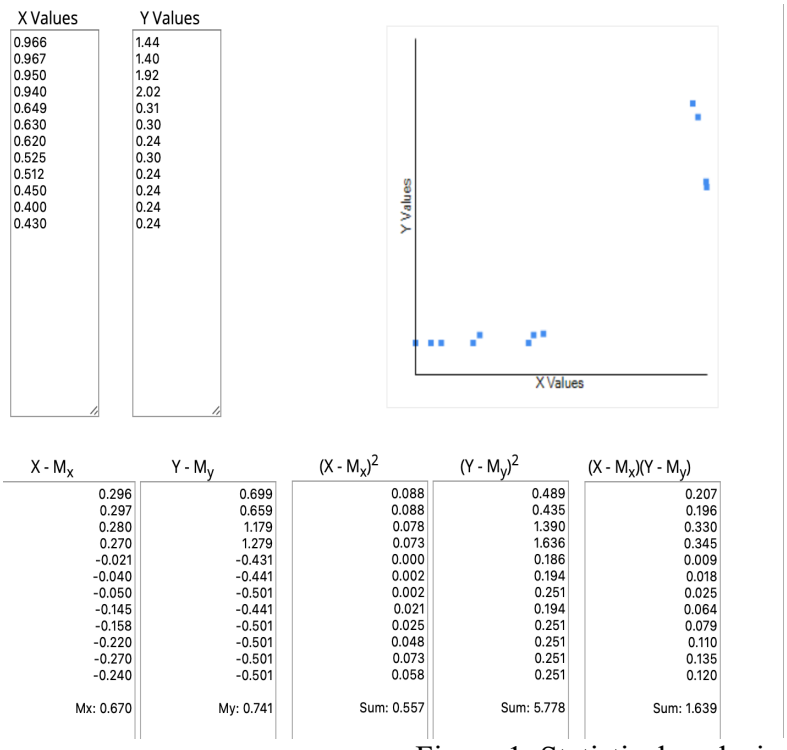
Such impairments to healthcare services in their respective low HDI countries would render Alzheimer's cases to be underdiagnosed and underreported; not because these areas have lower incidence but because their medical infrastructure itself along with public awareness and diagnostic capacities are never on par with those in high HD countries.

Statistical analysis of this relationship was quantified using the Pearson coefficient value, as the relationship was either directly or inversely linear with respect to the variables involved. The Pearson correlation coefficient ranges from -1 to 1; a value close to 1 indicates a positive correlation. Thus, it clearly implies that in statistical analysis there is a strong positive correlation between the prevalence of Alzheimer's disease and HDI and thus further reinforces the general understanding that accrues to a certain extent, that higher national development relates to a higher prevalence of Alzheimer's cases being reported. The contention would be on the economic and health stakeholders on setting up that disease diagnosis and reporting scenario.

In conclusion, it is recommended for action to narrow the gap in healthcare access and diagnostic capacity in low HDI countries. Accordingly, future studies could also investigate genetic makeup, lifestyle factors, and public health policies to help explain global variations in Alzheimer's incidence.



Graph 1:Alzheimer's Disease Prevalence by Country



X Values	Y Values
0.966	1.44
0.967	1.40
0.950	1.92
0.940	2.02
0.649	0.31
0.630	0.30
0.620	0.24
0.525	0.30
0.512	0.24
0.450	0.24
0.400	0.24
0.430	0.24

$X - M_x$	$Y - M_y$	$(X - M_x)^2$	$(Y - M_y)^2$	$(X - M_x)(Y - M_y)$
0.296	0.699	0.088	0.489	0.207
0.297	0.659	0.088	0.435	0.196
0.280	1.179	0.078	1.390	0.330
0.270	1.279	0.073	1.636	0.345
-0.021	-0.431	0.000	0.186	0.009
-0.040	-0.441	0.002	0.194	0.018
-0.050	-0.501	0.002	0.251	0.025
-0.145	-0.441	0.021	0.194	0.064
-0.158	-0.501	0.025	0.251	0.079
-0.220	-0.501	0.048	0.251	0.110
-0.270	-0.501	0.073	0.251	0.135
-0.240	-0.501	0.058	0.251	0.120
Mx: 0.670	My: 0.741	Sum: 0.557	Sum: 5.778	Sum: 1.639

Result Details & Calculation

X Values
$\sum = 8.039$
Mean = 0.67
$\sum(X - M_x)^2 = SS_x = 0.557$

Y Values
$\sum = 8.89$
Mean = 0.741
$\sum(Y - M_y)^2 = SS_y = 5.778$

X and Y Combined
$N = 12$
$\sum(X - M_x)(Y - M_y) = 1.639$

R Calculation
$r = \sum((X - M_y)(Y - M_x)) / \sqrt{((SS_x)(SS_y))}$

$r = 1.639 / \sqrt{((0.557)(5.778))} = 0.9137$

Meta Numerics (cross-check)
r = 0.9137

Figure 1: Statistical analysis of the data

A study using the Pearson correlation coefficient does demonstrate a strong positive connection, thus supporting the hypothesis that advanced stages of development, with increased lifespans and advanced healthcare, account for increased reported cases of Alzheimer's disease. However, it is important to note that the lower prevalence rate in developing countries could be the result of decreased reporting instead of a real decline in the prevalence rate. In addition, factors like differences in the level of reporting and how societies view age-related diseases could be influencing these findings.

Conclusion

Aim of the study was to show differences in the prevalence of Alzheimer's disease (AD) among countries with levels of different developments of progress, using the Human Development Index (HDI) as a measure of global progress. The findings show a strong positive correlation between a country's position on the Human Development Index and the observed prevalence rates of Alzheimer's disease. Countries with better positions on the Human Development Index, such as Norway, Switzerland, the United States, and Germany, have increasing prevalence rates of Alzheimer's disease (1.40% to 2.02%). This can be explained by higher longevity, improved health services, and developed diagnostic capabilities. In contrast, countries with lower HDI rankings, such as Niger, Chad, South Sudan, and Sierra Leone, have lower prevalence rates of Alzheimer's disease (around 0.24%). This is likely a result of decreasing life expectancy, poor healthcare, and underdiagnosis, rather than a true decline in disease prevalence.

The above tables offer additional proof for this trend by specifically illustrating the connection between prevalence rates and stages of advancement. The first table reveals that more advanced countries consistently record higher percentages of Alzheimer's disease prevalence, while less developing and least developing countries record lower percentages, which is likely a result of lower life expectancy and limited awareness. The following table, which equates Human Development Index values with percentages of Alzheimer's disease prevalence, highlights that as the Human Development Index decreases, so does Alzheimer's disease prevalence, thus supporting the idea that health care access and socioeconomic status play important contributing factors in reported rates of Alzheimer's disease.

At the end of the research and analysis, the findings support the hypothesis that higher levels of development lead to higher reported prevalence of Alzheimer's disease, it is important to acknowledge potential limitations in data accuracy. Deficient reporting and limited diagnostic resources in low Human Development Index countries may lead to synthetic low prevalence rates. Besides, cultural differences in health care seeking behavior and disease awareness may contribute to disparities in reported cases due to the global sources. In conclusion, the current research supports the claim that the prevalence rate of Alzheimer's disease is strongly correlated with a country's level of development. High Human Development Index countries, characterized by longer life expectancies and well-developed health systems, have increased prevalence rates of Alzheimer's disease and their healthcare. However, low Human Development Index countries with limited health care and diagnostic services have lower prevalence rates. These findings highlight the importance of healthcare, public health programs, and early detection methods in reducing the global burden of Alzheimer's disease.

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