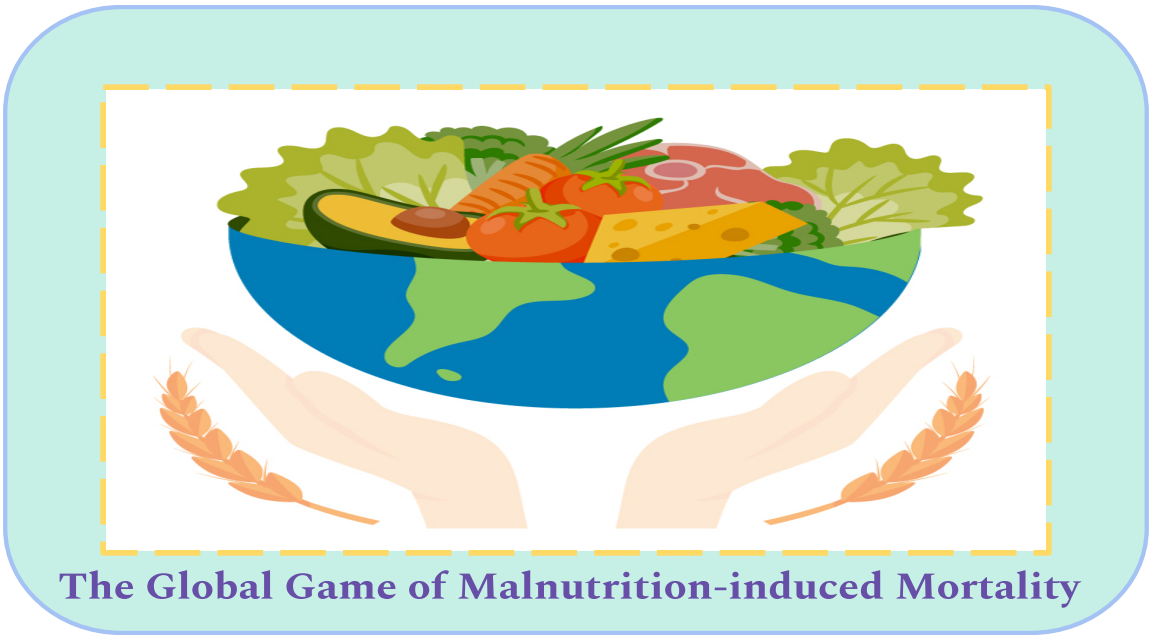


The Global Game of Malnutrition-induced Mortality

By Mayeesha Maliha for Data 101, March 2023

Hi, my name is Mayeesha, and I am a Cell Biology and Neuroscience major finishing up her last year at Rutgers. Over winter break, I traveled back to Bangladesh, where I was born, to visit my family before the post-graduation job search had me rethinking my entire life. While I was there, I noticed how much of the Western fast food culture had spread in Dhaka (the capital) - there were burger joints, pizzerias, and fried food stalls on every square foot of land anyone could possibly be standing on at any point in time. Everywhere, people were indulging in food that was oozing with oil; students coming back from school were positioned at street stalls selling pani puri (fried puff pastry balls stuffed with some version of potato filling), workers returning from their shifts were seated at burger joints biting into quarter pounder cheeseburgers, and families were choosing pizza as their form of fine dining.

I do not remember this culture of unhealthy eating being as prevalent in Bangladesh when I had gone back in 2017. The traditional platters I had enjoyed at restaurants with various vegetable dishes including ridge gourd, okra, and different leafy greens that were served with rice and often different proteins like chicken and beef curry had almost completely disappeared by 2019. I was especially alarmed to see the youth culture of eating out. Even my 15 year old cousins were frequently skipping a healthy breakfast at home to rush to food stalls stationed right under our flat to buy fried egg sandwiches before school. Truly, the street vendors and restaurants had taken over every street and alleyway to promote robust accessibility and consumption of fast food.

Bangladesh is classified as a lower middle income country by the World Bank,[1] and it has its fair share of poverty and malnutrition. As a result, the fact that fast food has become so accessible does not mean that people are any less malnourished. I was surprised when I was considered "tall" by my family members and other Bengali people when I went back because, on a good day, I stand at 5' 3," which is the most average a girl could be by American standards. However, kids and even adults in Bangladesh are particularly short for their age. In fact, according to the World Population Review, the average height for a man in Bangladesh is 5' 5" while the average man in the U.S. is 5' 10" tall.[2] While observing the surge of nutrition-deficient eating habits and the noticeably miniscule size of Bengali children, I started thinking about how despite the availability of food, there was an overwhelming absence of nutritious food. Naturally, this got me thinking about mortality (because that's completely normal) in low income countries like Bangladesh and how it could be affected by this huge deficit in adequate nutrition. Consequently, for this blog entry, I will be focusing on the number of deaths in different countries due to health risk factors identified by the **2019 Global Burden of Disease study** conducted by the Institute for Health Metrics and Evaluation (IHME).

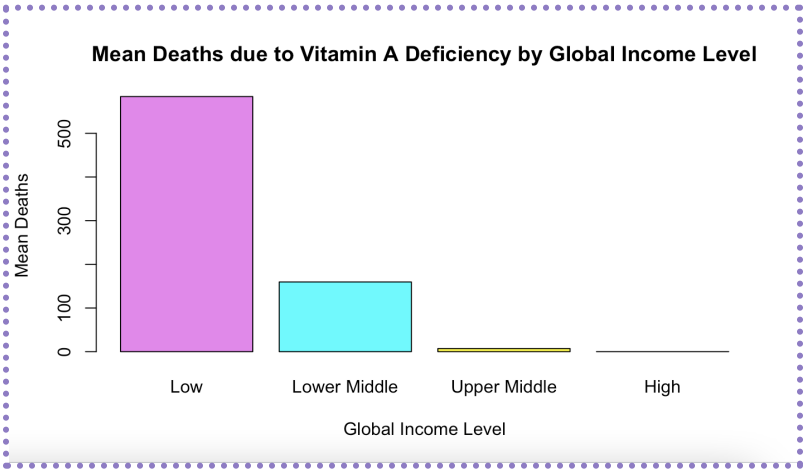
The Data

The dataset was obtained from **Our World in Data**, an organization which provides free, open source datasets and articles regarding the world's most pressing problems. While the data was obtained from an article about Air Pollution, the dataset itself includes deaths from many risk factors. The data originally had 30 columns corresponding to the names of countries and deaths due to risk factors, such as outdoor air pollution, high systolic blood pressure, high BMI, diets high in sodium and low in fruits and vegetables, smoking, vitamin A and iron deficiencies, child stunting, and many more. I added an additional column containing the Gross National Income (GNI) per capita in U.S. dollars for each country (as reported by the World Bank) to get an idea of its economic status in relation to deaths. I also cleaned up the data a bit and renamed the columns so the column titles were easier to read. Since all of the attributes in the dataset were numerical except for the country attribute, I created another categorical attribute called Income Level from the numerical attribute of GNI per capita in USD. I used the World Bank's GNI per capita estimates for low, lower middle, upper middle, and high income countries to create intervals for categorical values titled Low, Lower Middle, Upper Middle, and High.[3] The code for this is shown below.

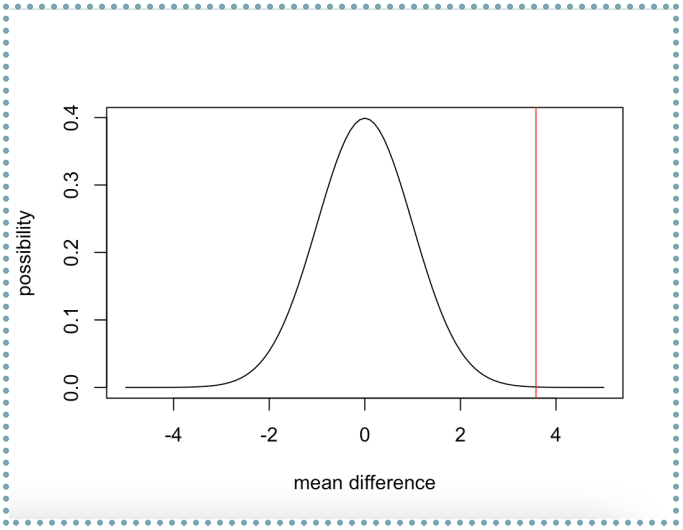
```
number_of_deaths_by_risk_factor<-read.csv("number_of_deaths_by_risk_factor.csv")

#cutting the GNI.per.capita.in.USD column into 4 intervals to create a new categorical variable, IncomeLevel
number_of_deaths_by_risk_factor$IncomeLevel<-cut(number_of_deaths_by_risk_factor$GNI.per.capita.in.USD,breaks=c(0,1045,4095,12695,100000),labels=c('Low','Lower Middle','Upper Middle','High'))
```

Vitamin A Deficiency



Often, people living in lower income countries experience multiple micronutrient deficiencies; micronutrients are vitamins and minerals that are essential even if consumed in low quantities. According to Our World in Data, another term for micronutrient deficiency is "hidden hunger" because the short term impacts of lacking micronutrients in one's diet tends to be "hidden" in comparison to those resulting from macronutrient (protein, fat, and energy) deficiencies.[4] Since there was a column for vitamin A deficiency induced deaths in the dataset, I decided to first look at how a country's income level correlated with the number of deaths due to the lack of sufficient intake of vitamin A. To do this, I used the tapply function and a barplot to look at the mean deaths due to vitamin A deficiency according to different global income levels. Immediately, I saw that low income countries had the highest average number of deaths due to vitamin A deficiencies than countries at any other income level, and high income countries had the lowest number of deaths for that same risk factor. From tapply, the mean number of vitamin A deficiency-induced deaths for the low income level was about 584.222, which was higher than the mean number of vitamin A deficiency-induced deaths for the high income level, which was 0.0518. From this, I formed my **alternative hypothesis:** Countries at the low global income level have more mean deaths for vitamin A deficiencies than countries at the high global income level. The **null hypothesis** was that countries at the low global income level have the same number of mean deaths for vitamin A deficiencies as countries at the high global income level.

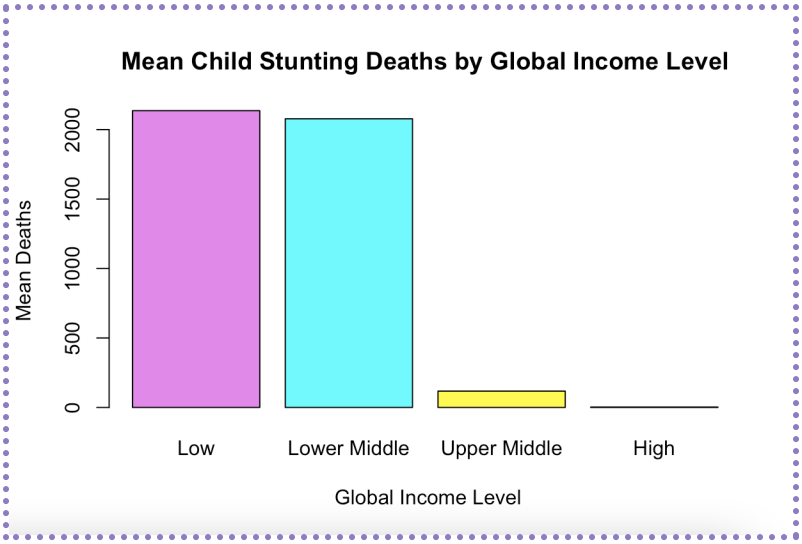


To test this first hypothesis, I made a subset defined by vitamin A deficiency deaths (column 27) and income level (column 32) from

the main dataset. Then, I performed the Z test to see whether the difference in mean deaths due to the lack of vitamin A for low income and high income level countries was significant. The red line was far to the right and the p value was about 0.000171, which is lower than the critical value of 0.05. Thus, we can reject the null hypothesis. It is safe to say that lower income countries have more deaths resulting from vitamin A deficiencies than high income countries.

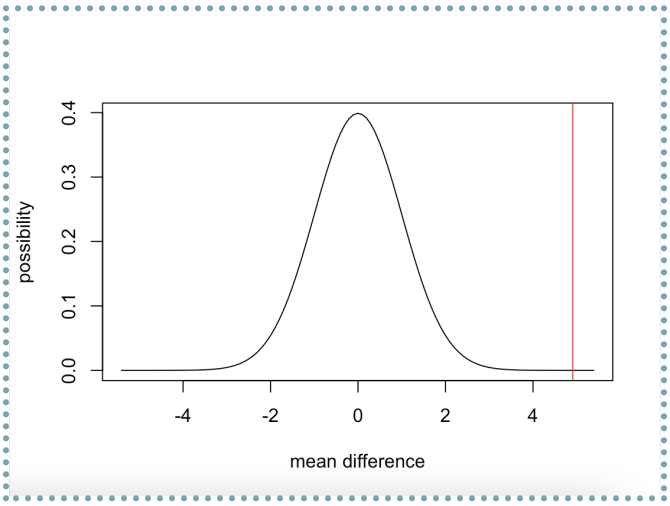
Child Stunting

Since vitamin A has significant impacts on growth and development, and deficiencies can also cause blindness in women and children, I was also curious about how a country's income level correlated with child stunting deaths. As explained by the World Health Organization, child stunting is the insufficient growth of children due to chronic malnutrition, often from not obtaining sufficient vitamins and minerals, and disease.[5] Given the amount of children I saw in Bangladesh who seemed to be extremely short for their age, I felt that the mortality due to child stunting in low income nations would be appropriate to test. To look into this, I again used tapply and a barplot to look at the mean deaths due to child stunting according to different global income levels. Again, there was a huge difference in child stunting-related deaths in low income countries as opposed to high income countries. From tapply, the mean number of child stunting deaths for the low income level was about 2136.407, which was higher than the mean number of child stunting deaths for the high income level, which was 2.661. From this, I formed my **alternative hypothesis**: Countries at the low global income level have more mean child stunting deaths than countries at the high global income level. The **null hypothesis** was that countries at the low global income level have the same number of mean child stunting deaths as countries at the high global income level.



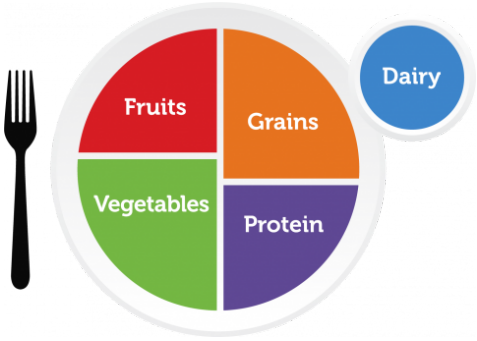
To test the hypothesis, I made a subset defined by child stunting deaths (column 28) and income level (column 32) from the main dataset. Then, I performed the Z test to see whether

the difference in mean deaths due to child stunting for low income and high income level countries was significant. The red line was far to the right and the p value was 4.592852e-07 (or 4.592852×10^{-7}), which is lower than the critical value of 0.05. Thus, we can reject the null hypothesis. It seems that low income countries do have a significantly higher mean number of child stunting deaths than their high income counterparts.



Evaluating the Data

Indeed, the economic instability and poverty in low income countries exacerbate the issues of fast food consumption, as many people are not able to afford healthy foods rich in vitamins and minerals to maintain sufficient nutrition. Global risk factors leading to deaths is a complex issue simply for the reason that there are many countries, cultures, and historical effects that must be considered. As a result, there are numerous hidden variables that may have also affected the number of deaths in low income countries besides the risk factors I have studied here. The **hidden variables** include (but are not limited to): the differences in population sizes for different countries, the lack of affordable access to healthy food, the lack of timely and affordable healthcare to treat health issues before they worsen and lead to death, and low rates of health education and literacy about how to maintain a nutritional diet. While American schools may teach the youth about the MyPlate nutrition guide, depicting a plate with equal amounts of fruit, grains, protein, vegetables, and dairy, many lower income countries may not provide children with such lessons in school. While various hidden variables are present due to the complexity and global scope of the issue, the data has been obtained from a controlled, standardized population-based study examining significant health-related deaths from over 170 countries (huge sample size of hundreds of thousands of people), and the study was conducted by the IHME which is an independent research organization focusing on population health. The study was published in The Lancet,[6] a peer reviewed medical journal. Thus, the data comes from an



unbiased, credible source, indicating that it is reliable. With regards to whether we may be fooled by the data, it is important to recognize that not all countries have efficient tracking capabilities with regards to recording the number of deaths and their causes. From my own experiences in Bangladesh, I have seen how overcrowded and understaffed hospitals can be, and it may be a common occurrence for deaths to go unrecorded. As a result, the number of deaths from different risk factors in low income countries might actually be underrepresented in the dataset due to lack of efficient mortality reporting services; there may actually be more health-related deaths in lower income nations. However, the data does not seem to be purposely fooling us.

Why should we care?

While the prevalence of malnutrition-related deaths in low income countries might not seem extremely important for people living in high income countries like the U.S., fast food culture and eating empty calories with no nutritional value are issues which have been plaguing the West for much longer than lower income countries in Africa and Asia. While the lack of economic stability and prosperity has made the nutritional deficits more fatal for low income nations, it is important to recognize that when there are health issues, no one is really spared. The lack of affordable healthcare in the U.S. should also be considered when wondering how the observations I have shared in this entry are applicable to those living in high income countries. Healthcare is increasingly becoming a profit-driven enterprise around the world, and the lack of accessibility and affordability of individualized medical care, the high attrition and burnout rates of healthcare professionals, and prevalence of understaffed hospitals should make everyone, regardless of their nation's income level, be more cautious of what types of food they are implementing into their daily diets. Moreover, we live in an age of globalization, with almost all countries importing and exporting goods across borders and relying on each other

for different commodities and services - so is any global issue really ever “someone else’s problem”? We could all benefit from being more conscious about what is happening around the world and also more aware of our own diets and lifestyles for a better tomorrow, not just for ourselves, but for humanity as a whole.

Sources:

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