Analysis of Factors that increase Lifespan in Japan, Switzerland and Central African Republic

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ABSTRACT

Can humans live forever? Will humans achieve immortality by 2050? These are the questions humans have wanted to hear for centuries. This analytical research will analyze and assess the factors that allow humans to increase their lifespan. Three countries were chosen: the greatest quality of life (Switzerland), the country with the most extended lifespan (Japan), and the country with the lowest quality of life (Central African Republic). All these countries were on different continents to remove any bias. The theories were tested by comparing charts and using ANOVA tests.

Introduction

"Can humans live forever? Will humans achieve immortality by 2050? These are questions that the masses have wanted to hear dating back to the Classical Period of Plato and Ancient Greece (Keach, 2020) So, what exactly is getting in the way of increasing our lifespans? If anything, what is a lifespan? A Lifespan is the average number of years a newborn should anticipate to survive if exposed to the sex- and age-specific death rates in effect at the time of his or her birth, for a given year, in a particular country, territory, or geographic area (Longevity: Extending Life Span Expectancy, 2019).

For centuries, researchers have been trying to figure out what affects life expectancy and how the people on earth can increase the mean global life expectancy, 72.81. (World Life Expectancy 1950-2021). Since 1800, Life expectancy has increased by over 240%, going from a global average of 25 years to 71 years (Roser,2015). The objective of this analysis is to determine if specific factors (ex., Wealth, Wage Gap, Healthcare Quality) can affect or at least have an association with Life expectancy or answer the question of "Can the average lifespan increase by looking at patterns from other countries? The hypothesis can be tested by looking at the countries with the highest and lowest life expectancy (Tier 1-Life expectancy, 2019). In Addition to that, a few more factors allow us to get a better idea or perspective on increasing lifespan, including nutrition, Median Income, Access to Healthcare, Quality and Price of Healthcare, and Cause of Deaths (Life Expectancy of the World Population).

All on different continents, three countries were chosen to remove any bias. In Japan, the leading causes of death are Stroke, Alzheimer's disease, and ischemic heart disease. Most diseases were non-communicable diseases. There is also one injury (self-harm) and nutritional disease (Lower Respiratory Infect). In Switzerland, the leading causes of death are Ischemic heart disease, stroke, Alzheimer's, and lung cancer. Most were non-communicable or transmissible diseases; one injury (falls) and one transmittable, nutritional disease (Lower Respiratory Infect). In the Central African Republic, the leading causes of death are: HIV/AIDS Tuberculosis Diarrheal diseases Lower respiratory infect Malaria Neonatal disorders Road injuries Stroke Ischemic heart disease Protein-energy malnutrition Congenital disabilities, 7/11 of those diseases were transmissible, communicable and nutritional diseases, three non-communicable diseases being Stroke Ischemic heart disease and congenital defects and one injury being road injuries (Figure One)
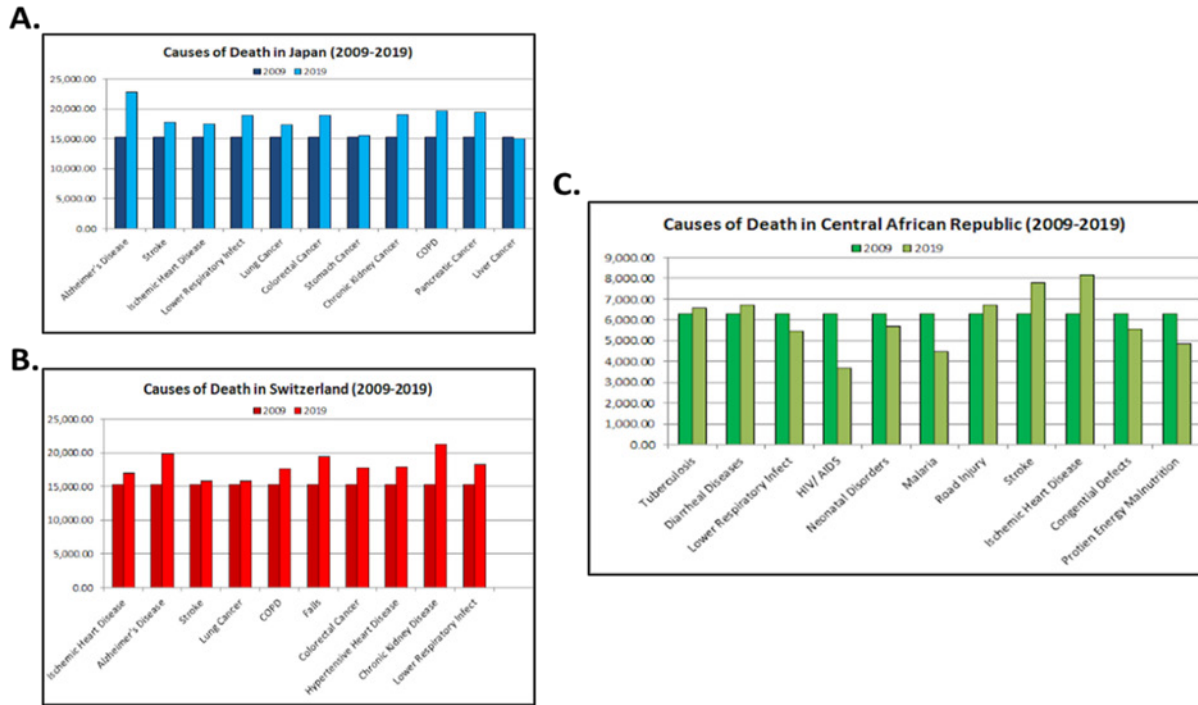
Figure 1. Bar Chart of Cause of Deaths per Country, from 2009 to 2019

Note: Y-axis is deaths per disease and X-axis are the Diseases. A) Japan, B) Switzerland, C) the Central African Republic. If data in 2009 > data in 2019, then data has decreased over time. If data in 2009 < data in 2019, then data has increased over time. Data from the graphs are collected from "[The Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019]" by The Lancet. (https://doi.org/10.1016/S0140-6736(20)30925-9). Copyright © 2020 The Author(s). Published by Elsevier Ltd

Data

According to U.S News, Japan is ranked #10 for *Best Public Health System*, #13 for Quality of Life, and #2 for best countries overall, while Switzerland is ranked # 5 for *Best Public Health System*, and #4 for best countries overall (Davis, n.d). In general, health care is provided free of charge to Japanese nationals, immigrants, and foreigners in Japan. The government's universal health care system covers Medical treatment in Japan. This system is open to all nationals and non-Japanese citizens who have lived in Japan for more than a year (Healthcare in Japan, n.d). In 2018, Japan spent $4,267 on healthcare, up 3.53 percent from 2017 (Figure 2).

Anyone living in Switzerland can use the healthcare system as long as they have health insurance. Both residents and non-residents must have basic health insurance. This plan covers approximately 80% to 90% of healthcare costs. Basic, private doctors, and private healthcare are the three categories of healthcare available to citizens. Adults must pay a one-time cost of CHF 300 ($ 329), followed by a visiting fee of CHF 15 ($ 16.44) (Healthcare in Switzerland, 2021). In 2018, Switzerland spent $9,871 on health care, up 2.75 percent from 2017 (Figure 2).

The Central African Republic has 4.7 million people, with around 75% living in poverty. Half of the population is malnourished, and a fourth of the population is homeless. Mbassade adds that most people do not have access to healthcare. "Many health personnel left rural areas for healthcare." For example, for the 90,000 people at the prefecture where Mbassade works, there are only 46 medical workers left. There is no room for many medical facilities.

In many other areas, adds Mbassade, the shortage of medication has had a negative impact: "Maternal and newborn mortality is increasing progressively due to the absence of medical care (Ministry of Foreign Affairs, 2021). Health spending was $54 in the Central African Republic in 2018, up 79% from 2017 (Central African Republic-2021, n.d.) (Figure 2).
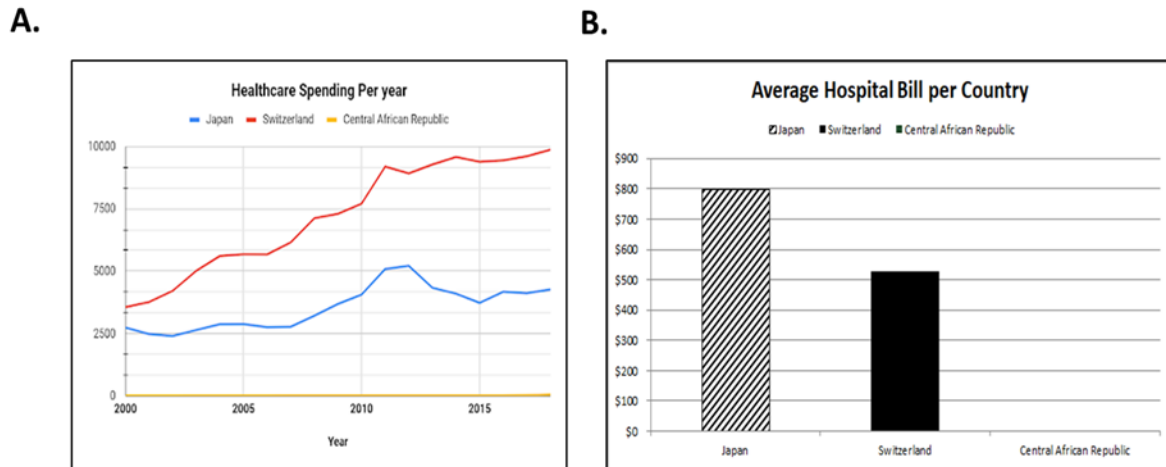
Figure 2 A-line chart of Healthcare Capita per year,(B) Column Chart with Average Hospital Bill Per Year according to the *International Student Insurance, Expatica and Macro Trends (Central African Republic-2021, n.d. Healthcare in Switzerland, 2021; Healthcare in Japan, n.d)*
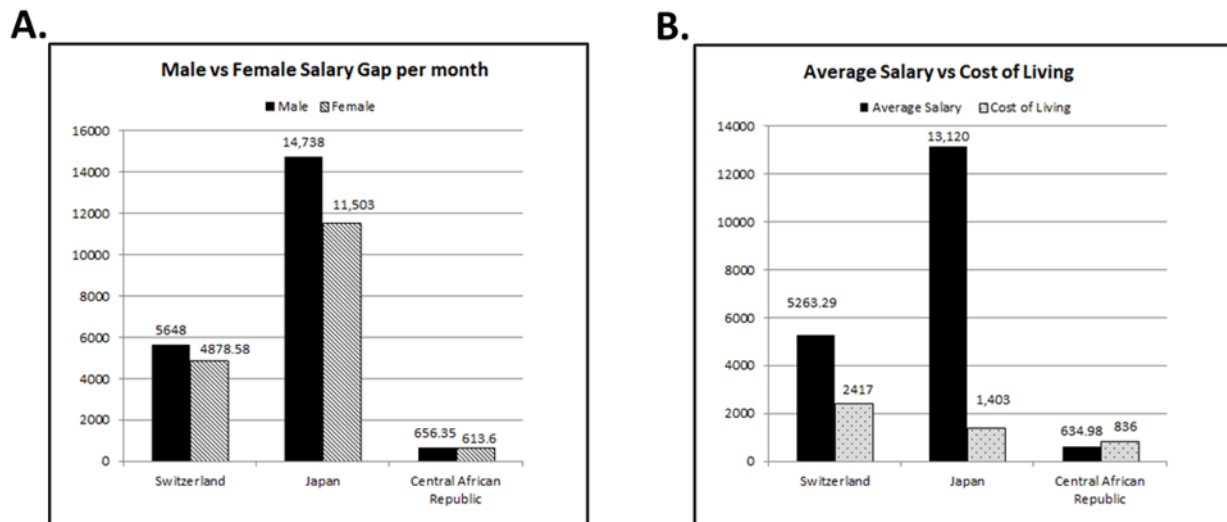
Note: Data of Central African Republic retrieved from "[Central African Republic -2021]" by MacroTrends (http://www.macrotrends.net/countries/CAF/central-african-republic/healthcare-spending) Copyright © 2021 The World Bank Group. Data of Healthcare Spending in Switzerland is from "[Health care in Switzerland: a guide for expats]" by Expatica 2021: (http://www.expatica.com/ch/healthcare/healthcare-basics/healthcare-in-switzerland-103130/#Costs.). Copyright and Published © 2021 Expatica. Data of Healthcare Spending in Japan from "[Healthcare in Japan]" by International Student Insurance. (https://www.internationalstudentinsurance.com/japan-student-insurance/healthcare-in-japan.php). Copyright and Published © 2021 – Envisage International Corporation

According to *The Wall Street Journal*, Japanese men earn an average of $329,600 (¥ 36,568,296) compared to $238,000 (¥26,405,505) for Japanese women. To infer, women earn approximately 72.2 percent of what males earn, the greatest percentage since comparable figures were first available in 1976 (Hongo, 2015). Salary after tax for men is $176,858 (¥19,622,000) which is 14,738 per month while for women it is around $138,036.46 (¥15,314,800) which is around $11,503 per month (3.7 Overview of individual tax systemジェトロ, n.d.). The average Cost of living for one person, including rent, is $1403 (Prices in Japan, 2020), while the average salary per month regardless of gender is $13,120.50.

In 2019, Male full-time employees in Switzerland earned an average of $86,000 per year, while Female Full-time employees in Switzerland earned $ 72,800 per year (Statistique, n.d). Salaries change drastically after-tax, with an annual salary of $67,776 for men and $58,543.60. Around $5648 per month for men and $4878.58 for women (Zurich- Salary After Tax, n.d). The average salary for both genders is $5263.29. The average Cost of living, with rent, is $2417 per month (Cost of Living in Switzerland, 2020).

On average, in the Central African Republic, men get paid 445,000 XAF per month ($ 810.35) per month before tax, while females get paid 416,000 XAF per month ($757.54) before tax (Salary in the Central African Republic, n.d). With the tax rate at 19% (Central African Republic Sales Tax, n.d.), the salary after tax would be, respectively, $656.35 for men and $613.60 for women. The average Cost of living for both genders is $634.98. According

to Living Cost.org, the Average Cost of living per month in the Central African Republic is $736 per month (Cost of Living in the Central African Republic, 2020)

Figure 3. *Two bar graphs (3A & 3B) 3A shows the salary gap between Males and Females in Switzerland, Japan and the Central African Republic*

Note:

Data of the Central African Republic Salary retrieved from "[Average Salary in Central African Republic 2021, The Complete Guide.]" by Salary Explorer. (http://www.salaryexplorer.com/salary-survey.php?loc=41&loc-type=1). Copyright © Salary Explorer 2021.

Data of the Central African Republic Cost of Living retrieved from "[Cost of Living in the Central African Republic]" by Livingcost.org (https://livingcost.org/cost/central-african-republic). Copyright © 2020 Livingcost.org. Data of the Average Switzerland Salary retrieved from "[Income Tax Calculator 2021 - Zurich- Salary After Tax]" by Talent.com 2021. (ch.talent.com/en/tax-calculator?salary=66866&from=year®ion=Zurich). Copyright © 2021 Talent.com.

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Data of the Japanese Average Salary retrieved from "[Overview of individual tax system: Section 3. Taxes in Japan - Setting Up Business - Investing in Japan]" by the Japan External Trade Organization ジェトロ . (http://www.jetro.go.jp/en/invest/setting_up/section3/page7.html). Copyright © 1995-2021 Japan External Trade Organization(JETRO). All rights reserved..

Data of the Japan Cost of Living retrieved from "[Cost of Living; Prices in Japan]" by Living Cost. (https://livingcost.org/cost/japan). Copyright © 2020 Livingcost.org .

In order to test the researchers' three data subjects by one variable, a One Way ANOVA Test is needed (Analysis of Variance). An ANOVA Test is a hypothesis test that provides information on the connection between the dependent and independent variables for three or more sets of data (Kenton, 2021). The one-way ANOVA test was

used three times between the difference of each disease that showed up in all three countries between 2009 and 2019, Net salary vs. Cost of healthcare, and the wage gap to determine if those factors affected lifespan. The Equation of the F-statistic:

$$F = \frac{MSbetween\ (MSb)}{MSwithin\ (MSw)} \text{ or } F = \frac{MSb}{MSw}\ , \text{(p-value)} = 0.05, \text{ Bonferroni Corrected } \alpha = \frac{\alpha p}{k}$$

Anova: Single Factor	(Epidemiology) Differences in Causes of Death					
Summary						
Groups	Count	Sum	Average	Variance		
Switzerland	3	3163.92	1054.64	330183.9808		
Japan	3	8320.4	2773.466667	484194.39573		
Central African Republic	3	2555.96	851.986666666	2168218.06293		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F-critic
Between Groups	6687518.87	2	3343759.43	3.36328	0.1047	
Within Groups	5965192.87	6	994198.81			
Total	12652711.75	8				

Anova: Two Factor	Anova: Two-Factor Without Replication: Net Salary vs Hospital Bill per Country					
Summary						
Groups	Count	Sum	Average	Variance		
Hospital Bill	3	1326.52	442.173	165335.71		
Net Salary	3	14764.31	4921.43	36384124.11		
Japan	2	12517	6258.2	59590444.5		
Switzerland	2	3372.81	1686.405			
Central African Republic	2	201.02	100.51			
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F-critic
Rows		1	30095700.0133	1.8689722	0.30497	18.51282051
Columns		2	20446652.16	1.269756959	0.440576	19
Error		2	16102807.72			
Total		5				

Anova: Two Factor	Anova: Two-Factor Without Replication: Wage Gap					
Summary						
Groups	Count	Sum	Average	Variance		
Male	3	21042.35	7014.11666	50972922.74		
Female	3	16995.18	5665.06	30108671.18		
Japan	2	26241	13120.5	5232612.5		
Switzerland	2	10526.58	5263.29	296003.5682		
Central African Republic	2	1269.95	634.975	913.78125		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F-critic
Rows	2729930.834	1	2729930.834	1.950229887	0.297361862	18.51282051
Columns	159363588.8	2	79681794.42	56.92371943	0.017264085	19
Error	2799599.0	2	1399799.50			
Total	164893118.68	5				

Table One: *ANOVA Test between Switzerland, Japan and the Central African Republic over the differences in causes of death B) Anova Test between Net Salary and Hospital Bill per county and Anova test between Male and Female Wage Gap and C) Anova Test over the Wage Gap between Men and Women in all three countries*

Note:

Data of the Central African Republic Salary retrieved from "[Average Salary in Central African Republic 2021, The Complete Guide.]" by Salary Explorer. (http://www.salaryexplorer.com/salary-survey.php?loc=41&loc-type=1). Copyright © Salary Explorer 2021. Data of the Central African Republic Cost of Living retrieved from "[Cost of Living in the Central African Republic]" by Livingcost.org (https://livingcost.org/cost/central-african-republic). Copyright © 2020 Livingcost.org. Data of the Average Switzerland Salary retrieved from "[Income Tax Calculator 2021 - Zurich- Salary After Tax]" by Talent.com 2021. (ch.talent.com/en/tax-calculator?salary=66866&from=year&region=Zurich). Copyright © 2021 Talent.com. Data of the Switzerland Cost of Living retrieved from "[Cost of Living in Switzerland]" by Livingcost.org 2020. (https://livingcost.org/cost/switzerland). Copyright © 2020 Livingcost.org . Data of the Japanese Average Salary retrieved from "[Overview of individual tax system: Section 3. Taxes in Japan - Setting Up Business - Investing in Japan]" by the Japan External Trade Organization ジェトロ. (http://www.jetro.go.jp/en/invest/setting_up/section3/page7.html). Copyright © 1995-2021 Japan External Trade Organization(JETRO). All rights reserved. Data of the Japan Cost of Living retrieved from "[Cost of Living; Prices in Japan]" by Living Cost. (https://livingcost.org/cost/japan). Copyright © 2020 Livingcost.org .Data from the graphs are collected from "[The Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019]" by The Lancet. (https://doi.org/10.1016/S0140-6736(20)30925-9). Copyright © 2020 The Author(s). Published by Elsevier Ltd

Results

Looking at the three different ANOVA tests, the data showed no statistical significance in the first ANOVA test (Common Causes of Death in All Three Countries) since the p-value from the test (≈ 0.104) is less than the alpha 0.05. The reason why the alpha is 0.05 is that the confidence level is around 95%. In order for the results to be statistically significant (to reject the null hypothesis), p either needs to be less than 0.05 or F needs to be greater than F critical, the null hypothesis for ANOVA tests is that "there is no difference in means" (Sullivan). In the second test (Net Salary vs. Hospital Bill), the results are also statistically significant for the same reasons. In the third test (Wage Gap), there is no statistical significance between the same genders in each country (ex: comparing Men in Switzerland to Men in Japan or comparing Women in Japan to Women in the Central African Republic).

However, there is a statistical significance between the men and women of their respective countries (wage gap between men and women in Japan) since $p \approx 0.01$, which is less than 0.05. Since there is a statistical difference between the two countries, there also needs to be a place to differentiate which two data points are statistically significant. To be specific about what two or three data points are statistically significant, a Post-Hoc test needs to be run. The word "Post-Hoc" is a Latin term that means "after this." There are many different types of post hocs, ex: Bonferroni Procedure, Duncan's new multiple range test (MRT), Dunn's Multiple Comparison Test, Fisher's Least Significant Difference (LSD), Holm-Bonferroni Procedure) However, Bonferroni's Procedure will be used since it is the easiest (Post Hoc Definition and Types of Tests, 2021).

The Initial value was changed to the new Bonferroni Corrected p-value, which is equal to = in which **αp =** 0.05 and k, is equal to how many groups that are being tested (in this case, three, so k=3) in which the new Bonferroni constant turned out to be p = 0.0166666. The post hoc test was made up of three separate, two-tailed, two-sample equal variance T-tests between Japan and Switzerland, one between Switzerland and the Central African Republic, and another between the Central African Republic and Japan. The data from the researchers are significant to this paper as all three countries are diverse in socioeconomic factors, all from different countries, and have significant gaps in government spending, which makes it easier to analyze and find a pattern between all three countries. The p-value being greater than 0.05 rules out common occurrences between all three data sets, which does not make the researcher's studies invalid, but It just will not be a typical pattern between all three countries.

Table Two. *Bonferroni Post Hoc T-test Results*

POST HOC TEST		
Groups	p-value (T-test)	Significant?
Japan vs Switzerland	0.041977217	No
Switzerland vs Central African Republic	0.006859199	Yes
Japan vs Central African Republic	0.016374964	Yes

ALPHA	
Test	Alpha
ANOVA	0.05
Post-Hoc test (Bonferroni Corrected)	0.016666667

Note: Table 2A) Shows the statistically significant values and the adjusted p-value from the separate t-tests. 2B) Shows the original ANOVA p-value ≈ 0.05 and the Bonferroni Corrected p-value $\alpha = \frac{\alpha p}{k}$ or 0.01666667 since (0.05/3) ≈ 0.01667

The Bonferroni Corrected Post Hoc Analysis revealed that the wage gap in Japan (average 13120, $p < 0.0166 \approx 0.016374964$) and Switzerland (average 5263.29, $p < 0.0166 \approx 0.006859199$) is greater than the wage gap in the Central African Republic (average 913.78). On top of that, the post hoc test also revealed that the wage gap is a significant factor in increasing lifespan. The Wage Gap was insignificant in Japan vs Switzerland (countries with high lifespans) over the countries compared to the Central African Republic (comparing a country with a high lifespan to a low lifespan).

Google Sheets set up the ANOVA Test, Post-Hoc Tests and Figures in Microsoft Excel 2010, excluding the "Healthcare Spending per Year." The results from the data show that only the wage gap has an association with longer lifespans and not healthcare vs salary or the one that was specifically expected to have an association (Common Causes of Death in All Three Countries). In the Central African Republic, the cost of living was higher than both salaries hence why the majorities of people living there either are homeless, below the poverty line or cannot afford the necessities like healthcare and food.

Conclusion

This analysis plays a crucial role in the future of lifespans. Scientists, medical, and future researchers would use this information to understand the extension of the human lifespan better. Scientists have been seeking to extend lifespans for decades, from air conditioning to modern medicine, as time is the only constant thing. Another reason why research is essential for the future is that, with more people aging, there is also a chance for them to make an even more significant impact and delve into other topics unbeknownst to the majority. There are a few limitations to this analysis—the most notable limitation: the accessibility to different diets within those countries by a human survey. Since no sources had a survey of specific diets in the Central African Republic while Switzerland and Japan did, the data would have been unfair and biased. However, an alternative approach was taken to compare, "Wage Gap, Healthcare Spending and Salary vs Cost of Living." Wage Gap" was the only significant difference, as shown in the results.

Acknowledgments

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