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Relation between fat and protein from various types of food and the confirmed and death rates of COVID-19

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Abstract. In the past three years, all countries and populations have been challenged by COVID-19 in the economy, education, lifestyle, etc., and it has raised concerns about food security. Some researchers demonstrated the effective role of diet in COVID-19, but the analysis of various types of fat and protein from diet was still required. This study focused on the impacts of fat and protein from various kinds of food on the confirmed rate and death rate of COVID-19. The study used Pearson Correlation and Linear Regression to deplore the impacts of diet on the confirmed and death rates of COVID-19 based on data on the food supply of all countries from the United Nations and data on confirmed cases and deaths of COVID-19 from John Hopkins University. The results showed that the confirmed rate and death rate of COVID-19 had a positive relation with the intake of fat from animal products, eggs, meat, and tree nuts and were reduced with higher consumption of fat and protein from cereals, fish and seafood, oil crops, pulses, and vegetal products.

Keywords: COVID-19, Diet, Fat Consumption, Protein Consumption.

1. Introduction

COVID-19 has influenced almost all countries and taken millions of lives in the world since late 2019 [1]. The COVID-19 pandemic challenged the economy, public health, and globalization, and many people began to reexamine food security and nutrition. Harvard University stated that a healthy diet should be composed of ½ vegetables and fruits, ¼ whole grains, ¼ quality proteins, and healthful drinks including water, coffee, and tea instead of sugary drinks and unlimited milk [2]. However, a large population in the world is still having problems with diets because of socioeconomic and cultural factors. In Western countries, overconsumption of saturated fat and simple sugar has resulted in high a rate of obesity and cognitive decline [3].

Chesnut et al. have shown the impact of diet factors on reducing the risk of COVID-19 and proven that high sugar consumption could lead to severe COVID-19 symptoms [4]. Also, Abdulah et al.'s analysis indicated that the infection rate and mortality rate of COVID-19 were raised by high consumption of fruits and sugar-sweetener drinks and low intake of beans and legumes [5]. However, these studies had general classifications of food type and had less focus on types of fat and protein in the diet. Thus, this study aimed to examine and analyze the relation between fat and protein from various kinds of food composition and the confirmed rate and death rate of COVID-19. The hypothesis of this study was that a high percentage of fat from meat and a low percentage of protein intake from vegetables and seafood would increase the confirmed rate and death rate of COVID-19. The significance of this

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study is to help the public understand the importance of a healthy diet in the prevention of disease and to provide further suggestions for future diets.

2. Methods

2.1. Data Sources

The data of COVID-19 confirmed and death cases for each country was extracted from Johns Hopkins University by 6 February 2021 [6]. Since statistics were not available for French Polynesia, Kiribati, North Korea, Myanmar, New Caledonia, and Turkmenistan, these countries were excluded from the analysis. The population data for each country in 2020 was obtained from the Population Reference Bureau (PRB) [7]. The data of fat and protein supply quantities in each country was collected by the United Nations, and they were both calculated in percentage of total consumption amount [8]. The diet factors used in the analysis included: alcoholic beverages, animal products, animal fats (butter, ghee, cream, etc.), aquatic products (aquatic plants, aquatic mammals, and others), cereals (barley, maize, oats, rice), eggs, fish, fruits, meat, miscellaneous, milk, offals, oil crops (coconut, olive, sesame seed, soybeans, and sunflower seed), pulses (beans, peas, pulses, and others), spices, starchy roots (sweet potatoes, potatoes, and others), stimulants, sugar crops (beet and cane), sugar and sweeteners (honey and others), tree nuts, vegetal products, and vegetable oils.

2.2. Statistical Analysis

The confirmed rate and death rate of COVID-19 were calculated with the number of infection cases or death cases divided by the total population of each country, and they were presented in minimum, maximum, median, and mean.

Pearson Correlation and Linear Regression were utilized in the analysis to explore the role of each diet factor on the confirmed rate and death rate of COVID-19. The impact of each diet factor on the confirmed rate and death rate was examined in simple linear regression. The correlations, P-values, and Beta of various diet factors were derived from Pearson Correlation and Linear Regression. The significant level of difference used in this study was 95%, which means that a P-value was supposed to be less than 0.05 if there was a relationship between the diet factor and the confirmed or death rate. R studio (R 4.1.2) was used in this analysis to perform all statistics analyses.

3. Results

The range of COVID-19 confirmed rates in different countries was 0.0003% to 10.4082% with a median of 1.0116%. The range of COVID-19 death rates was 0% to 0.1854%. The median of confirmed rate of COVID-19 in all countries was 1.0116%, and the mean of it was 2.0220%. The median of the COVID-19 death rate was 0.0120%, and the mean of it was 0.0394%, as presented in Table 1.

Table 1. Confirmed and Death Rates of COVID-19 in all countries.

	Minimum %	Maximum %	Median %	Mean %
Confirmed Rate	0.0003	10.4082	1.0116	2.0220
Death Rate	0.0000	0.1854	0.0120	0.0394

The correlation matrix showed that increasing intake of fat from animal products, animal fats, eggs, milk, and tree nut significantly raised the confirmed rate of COVID-19 ($P < 0.05$). However, the confirmed rate significantly decreased as raising the consumption of fat from cereals, offals, oil plants, pulses, condiments, and vegetal products ($P < 0.05$). The fat from alcohol, aquatic products, fish, miscellaneous, sugar crops, sugar, and sweeteners did not show a significant relationship with the confirmed rate of COVID-19. The results can be seen in Table 2.

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Table 2. Correlation of Confirmed Rate of COVID-19 with Fat from Various Food.

	Pearson Correlation with Confirmed Rate	
	Correlation r	p Value
Alcoholic Beverages	-0.083	0.286
Animal Products	0.482	<0.001
Animal Fats	0.511	<0.001
Aquatic Products	-0.089	0.257
Cereals	-0.419	<0.001
Eggs	0.343	<0.001
Fish	-0.146	0.062
Fruits	-0.093	0.237
Meat	0.155	0.047
Miscellaneous	-0.068	0.387
Milk	0.415	<0.001
Offals	-0.242	0.002
Oil crops	-0.370	<0.001
Pulses	-0.308	<0.001
Spices	-0.180	0.021
Starchy Roots	-0.314	<0.001
Stimulants	0.468	<0.001
Sugar Crops	-0.119	0.130
Sugar and Sweeteners	-0.077	0.327
Tree nuts	0.239	0.002
Vegetal Products	-0.482	<0.001
Vegetable Oils	-0.154	0.049

The correlation matrix also showed that the COVID-19 death rate significantly increased because of the increasing intake of fat from animal products and fats, eggs, stimulants, milk, and tree nuts ($P < 0.05$). At the same time, the death rate significantly decreased with a higher intake of fats from cereals, fish, offals, oil plants, beans and legumes, spices, and vegetal products ($P < 0.05$). There is no significant relationship between the fat from alcoholic beverages, aquatic products, fruits, meat, sugar crops, sugar and sweeteners, and vegetable oils with the mortality rate of COVID-19, as presented in Table 3.

Table 3. Correlation of Death Rate of COVID-19 with Fat from Various Food.

	Pearson Correlation with Death Rate	
	Correlation r	p Value
Alcoholic Beverages	-0.081	0.301
Animal Products	0.442	<0.001
Animal Fats	0.519	<0.001

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Table 3. (continued).

Aquatic Products	-0.084	0.283
Cereals	-0.378	<0.001
Eggs	0.319	<0.001
Fish	-0.215	0.006
Fruits	-0.101	0.198
Meat	0.149	0.057
Miscellaneous	-0.171	0.028
Milk	0.340	<0.001
Offals	-0.195	0.012
Oil crops	-0.361	<0.001
Pulses	-0.298	<0.001
Spices	-0.166	0.033
Starchy Roots	-0.277	<0.001
Stimulants	0.300	<0.001
Sugar Crops	-0.117	0.137
Sugar and Sweeteners	-0.070	0.375
Tree nuts	-0.155	0.048
Vegetal Products	-0.441	<0.001
Vegetable Oils	-0.105	0.180

According to regression analysis, the confirmed rate of COVID-19 was significantly raised due to the high proportion of fat from animal products, animal fats, eggs, meat, milk, stimulants, and tree nuts ($P < 0.05$). Whereas a higher percentage of intake of fat from cereals, offals, beans and legumes, spices, vegetal products, and vegetable oils decreased the confirmed rate ($P < 0.05$). The fat from alcohol, aquatic products, fish, fruits, miscellaneous, sugar crops, sugar, and sweeteners had no significant effect on the confirmed rate of COVID-19. These results are displayed in Table 4.

Table 4. Linear Regression of Confirmed Rate with Fat from Various Food.

	Regression with Confirmed Rate			
	Beta	Std. Error	t	p Value
Alcoholic Beverages	-20.316	18.971	-1.071	0.286
Animal Products	0.142	0.020	7.004	<0.001
Animal Fats	0.384	0.048	7.573	<0.001
Aquatic Products	-51.146	44.922	-1.139	0.257
Cereals	-0.307	0.052	-5.875	<0.001
Eggs	1.245	0.268	4.651	<0.001
Fish	-0.379	0.201	-1.883	0.062
Fruits	-0.257	0.217	-1.186	0.237
Meat	0.079	0.040	2.003	0.047

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Table 4. (continued).

Miscellaneous	-2.319	3.674	-0.867	0.387
Milk	0.295	0.051	5.803	<0.001
Offals	-5.011	1.576	-3.179	0.002
Oil crops	-0.203	0.040	-5.068	<0.001
Pulses	-1.966	0.477	-4.126	<0.001
Spices	-0.935	0.402	-2.328	0.021
Starchy Roots	-2.005	0.476	-4.214	<0.001
Stimulants	1.570	0.233	6.735	<0.001
Sugar Crops	-12.263	8.057	-1.522	0.130
Sugar and Sweeteners	-31.430	31.962	-0.983	0.327
Tree nuts	0.684	0.218	3.135	0.002
Vegetal Products	-0.142	0.202	-7.005	<0.001
Vegetable Oils	-0.054	0.027	-1.986	0.049

The regression also indicated that the death rate significantly increased as the intake of fat from animal products, animal fats, eggs, milk, stimulants, and tree nuts raised ($P < 0.05$). However, the death rate was significantly reduced with higher consumption of fat from grains, fish, offals, oil plants, pulses, spices, starchy roots, and vegetal products ($P < 0.05$). According to regression, the fat from alcoholic beverages, aquatic products, fruits, meat, sweeteners, and vegetable oils did not have a significant impact on the death rate of COVID-19, as shown in Table 5.

Table 5. Linear Regression of Death Rate with Fat from Various Food.

	Regression with Confirmed Rate			
	Beta	Std. Error	t	p Value
Alcoholic Beverages	-0.401	0.392	-1.038	0.301
Animal Products	0.003	0.000	6.263	<0.001
Animal Fats	0.008	0.001	7.735	<0.001
Aquatic Products	-1.000	0.928	-1.077	0.283
Cereals	-0.006	0.001	-5.196	<0.001
Eggs	0.024	0.006	4.277	<0.001
Fish	-0.012	0.004	-2.807	0.006
Fruits	-0.006	0.004	-1.291	0.198
Meat	0.002	0.001	1.920	0.057
Miscellaneous	-0.120	0.054	-2.211	0.028
Milk	0.005	0.001	4.604	<0.001
Offals	-0.083	0.033	-2.531	0.012
Oil crops	-0.004	0.001	-4.920	<0.001
Pulses	-0.039	0.010	-3.969	<0.001
Spices	-0.018	0.008	-2.149	0.033
Starchy Roots	-0.036	0.010	-3.671	<0.001

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Table 5. (continued).

Stimulants	0.021	0.005	3.997	<0.001
Sugar Crops	-0.249	0.166	-1.495	0.137
Sugar and Sweeteners	-0.587	0.660	-0.890	0.375
Tree nuts	0.009	0.005	1.993	0.048
Vegetal Products	-0.003	0.000	-6.264	<0.001
Vegetable Oils	-0.001	0.001	-1.347	0.180

For the consumption of protein, the correlation matrix showed a significant positive impact of protein from alcohol, animal products and fats, eggs, meat, milk, coffee and tea, and tree nuts on the confirmed rate of COVID-19. However, the confirmed rate significantly decreased with raising the consumption of protein from cereals, oil crops, beans and legumes, condiments, starchy roots, and vegetal products. The protein from fish, fruits, milk, sugar crops, and vegetable oils did not have a significant effect on the confirmed rate. The statistics are shown in Table 6.

Table 6. Correlation of Confirmed Rate of COVID-19 with Protein from Various Food.

	Pearson Correlation with Confirmed Rate	
	Correlation r	p Value
Alcoholic Beverages	0.301	<0.001
Animal Products	0.543	<0.001
Animal Fats	0.406	<0.001
Aquatic Products	-0.079	0.315
Cereals	-0.400	<0.001
Eggs	0.462	<0.001
Fish	-0.148	0.059
Fruits	-0.073	0.356
Meat	0.397	<0.001
Miscellaneous	0.627	<0.001
Milk	-0.096	0.220
Offals	-0.391	<0.001
Oil crops	-0.335	<0.001
Pulses	-0.155	0.048
Spices	-0.219	0.005
Starchy Roots	0.355	<0.001
Stimulants	-0.161	0.039
Sugar Crops	0.125	0.110
Sugar and Sweeteners	0.244	0.002
Tree nuts	-0.543	<0.001
Vegetal Products	0.356	<0.001
Vegetable Oils	0.096	0.223

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The correlation matrix also indicated that the death rate was significantly raised because of increasing intake of protein from alcoholic beverages, animal products, dairy products, eggs, stimulants, sugar and sweeteners, and tree nuts. At the same time, the death rate significantly decreased with increasing consumption of protein from cereals, oil plants, pulses, starchy roots, and vegetal products. The consumption of protein from aquatic products, fish, fruits, milk, sugar crops, and vegetable crops did not have a significant relationship with the death rate of COVID-19, as presented in Table 7.

Table 7. Correlation of Death Rate of COVID-19 with Protein from Various Food.

	Pearson Correlation with Death Rate	
	Correlation r	p Value
Alcoholic Beverages	0.301	<0.001
Animal Products	0.543	<0.001
Animal Fats	0.406	<0.001
Aquatic Products	-0.079	0.315
Cereals	-0.400	<0.001
Eggs	0.462	<0.001
Fish	-0.148	0.059
Fruits	-0.073	0.356
Meat	0.397	<0.001
Miscellaneous	0.627	<0.001
Milk	-0.096	0.220
Offals	-0.391	<0.001
Oil crops	-0.335	<0.001
Pulses	-0.155	0.048
Spices	-0.219	0.005
Starchy Roots	0.355	<0.001
Stimulants	-0.161	0.039
Sugar Crops	0.125	0.110
Sugar and Sweeteners	0.244	0.002
Tree nuts	-0.543	<0.001
Vegetal Products	0.356	<0.001
Vegetable Oils	0.096	0.223

The regression analysis showed that the confirmed rate was significantly increased with high consumption of protein from alcoholic beverages, animal products, dairy products, eggs, meat, coffee and tea, nuts, and vegetable oils ($P < 0.05$). However, the confirmed rate was significantly reduced with higher consumption of protein from cereals, oil crops, beans and legumes, condiments, starchy roots, sugar plants, and vegetal products ($P < 0.05$). The confirmed rate was not significantly impacted by protein from aquatic products, fish, fruits, miscellaneous, offals, sugar, and sweeteners. See Table 8.

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Table 8. Regression of Confirmed Rate with Protein from Various Food.

	Regression with Confirmed Rate			
	Beta	Std. Error	t	p Value
Alcoholic Beverages	2.888	0.720	4.011	<0.001
Animal Products	0.102	0.020	8.223	<0.001
Animal Fats	6.283	1.112	5.651	<0.001
Aquatic Products	-2.208	2.189	-1.008	0.315
Cereals	-0.146	0.026	-5.554	<0.001
Eggs	1.366	0.206	6.626	<0.001
Fish	-0.129	0.068	-1.899	0.059
Fruits	-0.264	0.284	-0.927	0.356
Meat	0.200	0.036	5.512	<0.001
Miscellaneous	-0.289	0.926	-0.312	0.755
Milk	0.376	0.037	10.251	<0.001
Offals	-0.410	0.333	-1.231	0.220
Oil crops	-0.615	0.114	-5.399	<0.001
Pulses	-0.268	0.591	-4.531	<0.001
Spices	-1.100	0.551	-1.997	0.048
Starchy Roots	-0.269	0.094	-2.860	0.005
Stimulants	2.134	0.442	4.825	<0.001
Sugar Crops	-24.918	11.966	-2.082	0.039
Sugar and Sweeteners	7.778	4.837	1.608	0.110
Tree nuts	2.006	0.627	3.200	0.002
Vegetal Products	-0.162	0.020	-8.228	<0.001
Vegetable Oils	36.269	7.282	4.843	<0.001

The statistics from regression analysis also revealed that the death rate was raised due to the consumption of protein from alcoholic beverages, animal products and fats, eggs, milk, coffee and tea, sugar and sweeteners, nuts, and vegetable oils increased ($P < 0.05$). Whereas the death rate reduced with a higher intake of protein from cereals, fish, oil plants, pulses, and vegetal products ($P < 0.05$). The regression also indicated that the consumption of protein from aquatic products, fruits, miscellaneous, offals, and spices did not significantly impact the death rate of COVID-19, as displayed in Table 9.

Table 9. Regression of Death Rate of COVID-19 with Protein from Various Food.

.	Regression with Confirmed Rate			
	Beta	Std. Error	t	p Value
Alcoholic Beverages	0.066	0.015	4.472	<0.001
Animal Products	0.003	0.000	6.746	<0.001
Animal Fats	0.137	0.023	6.016	<0.001
Aquatic Products	-0.042	0.045	-0.929	0.355

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Table 9. (continued).

Cereals	-0.002	0.001	-4.401	<0.001
Eggs	0.028	0.004	6.514	<0.001
Fish	-0.004	0.001	-2.816	0.005
Fruits	-0.006	0.006	-1.005	0.316
Meat	0.004	0.001	5.246	<0.001
Miscellaneous	-0.030	0.019	-1.585	0.115
Milk	0.007	0.001	8.097	<0.001
Offals	-0.004	0.007	-0.611	0.542
Oil crops	-0.012	0.002	-5.037	<0.001
Pulses	-0.005	0.001	-4.219	<0.001
Spices	0.015	0.011	-1.322	0.188
Starchy Roots	-0.005	0.002	-2.400	0.018
Stimulants	0.035	0.009	3.694	<0.001
Sugar Crops	-0.500	0.237	-2.018	0.045
Sugar and Sweeteners	0.213	0.099	2.149	0.033
Tree nuts	0.031	0.013	2.383	0.018
Vegetal Products	-0.003	0.000	-6.746	<0.001
Vegetable Oils	0.746	0.150	4.981	<0.001

4. Discussions

The intake of fat and protein from animal products, eggs, meat, milk, stimulants, and tree nuts had a positive relation with the infection and death rates of COVID-19 but increasing the consumption of fat and protein from cereals, fish, oil crops, pulses, starchy roots, sugar crops, and vegetal products had a negative relationship with the confirmed rate and death rate.

Fish, cereals, oil crops such as soybean oil, and vegetables contain abundant n-3 PUFAs, and intake n-6 PUFAs of is commonly from livestock animals raised on grain and tree nuts [9]. In recent years, the quantity of n-3 PUFAs declined, but n-6 PUFAs increased in the worldwide diet, especially in the Western diet, which led to the substantially increasing and imbalanced ratio of n-6/n-3 [10]. The abnormal ratio of n-6/n-3 in developed countries had negative impacts on human health, resulting in inflammation, obesity, and other health problems [11]. The current studies have shown that people with obesity had a higher probability of being infected, and overweight patients had a greater risk of death after being infected by COVID-19 [12, 9]. This is a reasonable explanation that the confirmed rate and death rate of COVID-19 increased with higher consumption of fat from animal products, eggs, meat, and tree nuts and with lower intake of fat from cereals, fish, oil crops, and vegetal products.

Also, fish, pulses, and vegetal products are important sources of L-arginine and glutamine, which were proven to have benefits on COVID-19 patients [13]. It showed that L-arginine is effective in recovering the proliferation ability of T cells that is reduced due to the infection of COVID-19, and it can have a long-term effect on controlling COVID-19 [14]. Glutamine that is often served as an antioxidant also helps reduce the oxidative stress that causes deterioration in COVID-19 patients [15].

However, the analysis did not show a significant relationship between fruits, sugar, and sweeteners and the risk of COVID-19, which was not consistent with the study by Abdulah and Hassan [5]. The reason could be that the consumption of fruits and sweeteners increased the infection and mortality rate of COVID-19 by increasing sugar intake rather than fat and protein intake.

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The strengths of this study were that it provided an overall analysis of the impacts of diet on the confirmed and death rates of COVID-19 worldwide and offered a valid explanation of why some factors had impacts on the risk of COVID-19. However, limitations still existed in this study. The scientific explanation of the impact of some diet factors such as stimulants, starchy roots, and sugar crops is still missing. Also, the dietary composition can be different with factors without discussion in this analysis such as gender, age, poverty, and region. In the future, the study can take these factors into consideration how daily diet impacts the infection and mortality of COVID-19 for various groups of the population.

5. Conclusion

The confirmed rate and death rate of COVID-19 were raised by decreasing the percentage of fat intake from animal products, animal fats, eggs, meat, and tree nuts and increasing the percentage of fat and protein consumption from cereals, fish, oil crops, pulses, and vegetal products. Thus, increasing the proportion of cereals, fish, oil crops, pulses, and vegetal products and reducing that of animal products, eggs, meat, and tree nuts in the diet are conducive to the prevention of COVID-19 and the reduction of its mortality. The study provides a valid suggestion for a healthier diet so that people can better prevent diseases like COVID-19 in the future.

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