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A Case Study on the Relationship between Fitness Intensity and Dietary Pattern to Intestinal Flora

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Abstract

Exercise and diet are two major factors that can cause change to the structure or the biodiversity of human gut microbiota. In this manuscript we have studied relationship between fitness intensity and dietary pattern to intestinal flora by evaluating case studies and analyzing data. We found that if only a single factor was considered, the correlation between diet pattern and individual intestinal flora was higher than that of body strength and individual intestinal flora. If they consider both the correlation between the two and individual intestinal flora, the correlation between fitness intensity was even higher.

Keywords

Exercise Intensity, Diet, Gut Microbiota, Data Analysis

1. Introduction

In recent years, human gut microbiota has been discussed by the public because of its health benefits. There are about 100 trillion microbes, including bacterium, fungi, and viruses, found in our gastrointestinal tract (GI tract). They form an ecosystem within our gut. You might wonder why are they allowed to live and reproduce inside our body, instead of being destroyed by our immune system? In fact, human immune system has learnt to live symbiotically with those microbes. Some bacteria in the GI tract are pathogenic. If their number increased sharply or if they enter other parts of the body, the risk of getting inflammation would increase [1]. The immune system will kill bacteria which cross the intestinal barrier [2]. Fortunately, most microbes can help with our digestive sys-

tem and boost our metabolism. The main food for intestinal microbes is dietary fiber that's difficult to digest. When microbiota breaks down these fibers, they produce short-chain fatty acids, vitamins and amino acids that human body cannot make. Butyrate, a short-chain fatty acid, can repair intestinal mucosal epithelial cells, provide cells with energy, and increase satiety [3]. The loss of short-chain fatty acids is also associated with obesity [4]. In addition, the host's eating habits possibly determine the dominant flora. For example, people who have a high protein diet show a bigger proportion of genus Bacteroides than the general population. But they have fewer bacteria that belong to phylum Firmicutes. On the other side, population who consumes more fibers in their diet shows a greater percentage of genus Prevotella [5]. Prevotella abundance is commonly used as a biomarker for lifestyle and dietary habits in microbiota studies [6].

The growing interest in human gut microbiota has led to the publication of numerous scientific articles, that seek to understand the molecular biology of these microbes and learn how to live in harmony with them. In this paper, we explore the effects of diet and exercise intensity on intestinal flora. We will accomplish our goal by analyzing a study done on professional cyclists. We hope to solve questions like: How would your diet change the composition of your gut microbiota? Does exercise intensity play a role in determining the concentration of intestinal flora? Diet and exercise are two major factors that seem to have an impact on microbes in our GI tract. It's beneficial for our health to understand the interrelationships. It's also exciting to know if we can improve our overall wellbeing by making changes to our daily habits.

2. Results

After data analysis, our results are as shown: the first, exercise intensity is related to individual's microbiota composition, the second, diet habit is strongly related to individual's microbiota composition.

3. Materials and Methods

3.1. Data Collection

We used data from [7]. The table below shows participants' data, including their diet habit, alcohol consumption, exercise load, and race category (recorded from usacycling.com). It also displays Prevotella abundance, mWGS taxonomic cluster.

3.2. Analyzing the Relationship between Exercise Intensity and Prevotella Abundance

In **Table 1**, exercise load is categorized using hours per week. It can be represented by four groups: 6 - 10, 11 - 15, 16 - 20, 20+. For the sake of simplicity, we will regard 20+ as 21 - 25. Then, we take the average of each work load, simplifying the groups as 8, 13, 18, and 23. In order to obtain **Table 2**, first we

Table 1. Reported metadata.

Cyclist	Sex	Diet	# alcohol beverages per week	Exercise load (h/week)	% abundance Prevotella (mWGS)	Taxonomiccluster (mWGS)	Race category
Knolly	F	Equal protein, fat, carbs	1 - 5	6 - 10	0.20%	3	PRO
Santa Cruz	F	Equal protein, fat, carbs	0	6 - 10	0.17%	2	PRO
Pivot	M	Equal protein, fat, carbs	0	6 - 10	0.13%	2	CAT 1
Breezer	F	Equal protein, fat, carbs	6 - 10	6 - 10	0.13%	2	PRO
Intense	F	Vegetarian	1 - 5	6 - 10	0.49%	2	CAT 1
Deity	M	Equal protein, fat, carbs	1 - 5	6 - 10	0.13%	3	CAT 1
Renthal	M	Equal protein, fat, carbs	1 - 5	6 - 10	0.20%	2	PRO
Iron Horse	M	Equal protein, fat, carbs	1 - 5	6 - 10	0.13%	2	CAT 1
Scott	M	Equal protein, fat, carbs	1 - 5	11 - 15	0.33%	2	PRO
Devinci	M	Equal protein, fat, carbs	1 - 5	11 - 15	0.15%	3	PRO
Ibis	M	Equal protein, fat, carbs	1 - 5	11 - 15	2.65%	3	PRO
Juliana	M	Equal protein, fat, carbs	1 - 5	11 - 15	0.18%	2	PRO
Merlin	M	High complex carbs	1 - 5	11 - 15	0.70%	3	PRO
Schwinn	M	Paleo	0	11 - 15	2.35%	2	CAT 1
Mongoose	M	Equal protein, fat, carbs	1 - 5	11 - 15	0.08%	3	PRO
Huffy	F	Paleo	0	11 - 15	9.02%	3	CAT 1
Giant	M	Equal protein, fat, carbs	0	11 - 15	1.12%	2	PRO
Commencal	M	Paleo	1 - 5	11 - 15	9.93%	3	CAT 1
Cove	F	Paleo	1 - 5	11 - 15	0.19%	2	PRO
Jamis	M	Equal protein, fat, carbs	15+	11 - 15	49.11%	1	CAT 1
Yeti	F	Gluten-free	1 - 5	11 - 15	27.18%	3	PRO
Zipp	M	Equal protein, fat, carbs	1 - 5	11 - 15	35.66%	1	PRO
Saint	F	Equal protein, fat, carbs	0	11 - 15	38.19%	1	PRO
Crank	F	Paleo	0	11 - 15	14.67%	1	PRO
Pinarello	M	Equal protein, fat, carbs	0	11 - 15	45.27%	1	CAT 1
Trek	M	Equal protein, fat, carbs	1 - 5	16 - 20	49.52%	1	CAT 1
Niner	F	Paleo	1 - 5	16 - 20	0.36%	2	CAT 1
Norco	M	High complex carbs	6 - 10	16 - 20	38.47%	1	PRO
Enve	M	Equal protein, fat, carbs	1 - 5	16 - 20	14.74%	3	PRO
Speed Play	M	Equal protein, fat, carbs	1 - 5	16 - 20	10.53%	3	PRO
SRAM	M	Equal protein, fat, carbs	1 - 5	20+	7.53%	3	PRO
Easton	M	High complex carbs	1 - 5	20+	27.03%	1	PRO
Thomson	F	Gluten-free	0	20+	12.12%	3	PRO

Table 2. Exercise load/intensity and Prevotella abundance.

	8	13	18	23
CAT	0.022	0.23136	0.2494	
PRO	0.00175	0.100917	0.212467	0.1556

divide the athletes by their race category. Second step is calculating the mean Prevotella abundance of each group.

As we can see from Table 2, there isn't a number representing Pro athletes who work 23 hours a week. So we referred to data from the other 3 groups in Pro category and we calculated the number that's missing. We obtained Table 3 by adding a row that shows an average of Cat and Pro.

Figure 1 is obtained by performing a linear regression on Table 3.

From Figure 1, we can see y is $0.0635x - 0.006$ while R square is 0.7058.

3.3. Diet and Prevotella Abundance Correlation

In Table 1, there're 5 eating habits shown. They are vegetarian, Paleo, Equal protein-fat-carbs, gluten free, and high complex carbs. Table 4 is obtained by calculating the mean value of Prevotella abundance (mWGS).

Figure 2 is obtained by performing linear regression on the data shown in Table 4.

In Table 4, Y-axis represents average Prevotella abundance and X-axis represents types of diet. We can get the linear equation which is $y = 0.0113x - 0.0492$, the coefficient of determination being 0.9828.

3.4. Considering Two Factors Together

In 3.2, we investigated the relationship between exercise intensity and Prevotella abundance. In 3.3, we investigated the relationship between diet and Prevotella abundance. From the coefficient R squared, dietary patterns are more closely related to intestinal flora.

Tables 5-7 below are obtained by performing a multiple linear regression on both factors.

Analysis: When we are considering both factors(diet and exercise intensity) as independent variables, the coefficient of determination is 0.19. However, when we look back to the individual regression done on each factor, the coefficients were closer to 1. From the standard error, we see the average error of estimation is off by 15.35 which is relatively high. In this multiple linear regression, both diet and exercise load are in positive relationship with Prevotella abundance. Diet shows a stronger link compared to exercise load. We could assume that a change in diet effect the abundance of particular gut microbiota in a greater way than changing exercise load.

4. Discussion and Conclusion

There are certainly other factors that can affect the abundance of different gut

Table 3. Exercise load/intensity and Prevotella abundance (missing value filled in).

	8	13	18	23
CAT	0.022	0.23136	0.2494	0.2482
PRO	0.00175	0.100917	0.212467	0.1556
Avg	0.011875	0.166139	0.230934	0.2019

Table 4. Diet and Prevotella abundance.

Diet	Degree	mWGS
Vegetarian	5	0.0049
Paleo	10	0.060866665
Equal-protein-fat-carbs	15	0.121976191
Gluten-free	20	0.196500007
High complex carbs	25	0.220666667

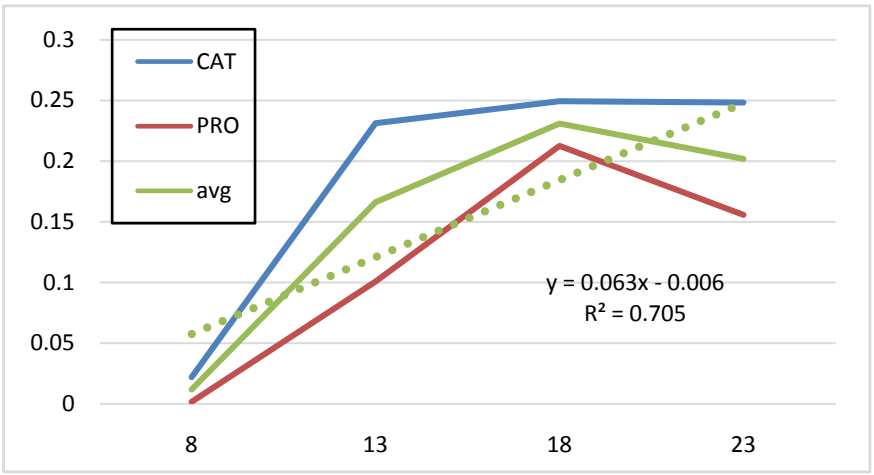

Figure 1. Relationship between exercise intensity and Prevotella abundance.

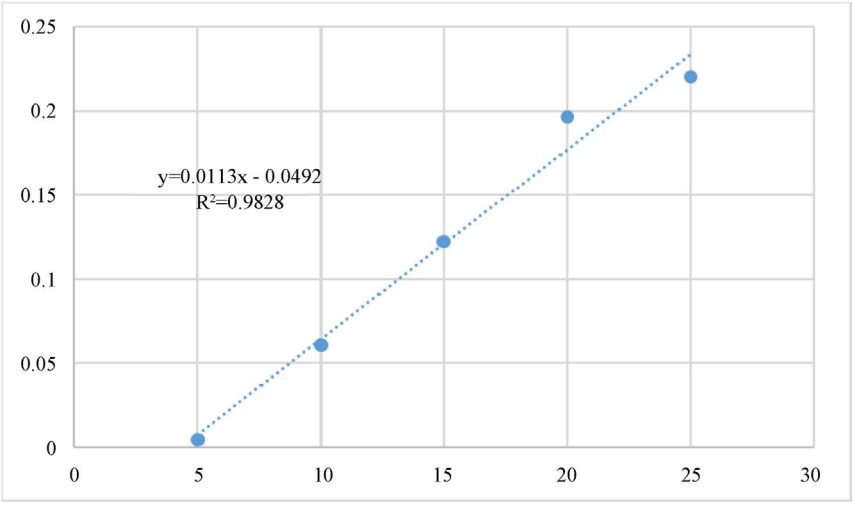

Figure 2. Correlation between diet and Prevotella abundance.

Table 5. Regression statistics.

Multiple R	0.435321621
R Square	0.189504914
Adjusted R Square	0.135471908
Standard Error	15.34762221
Observations	33

Table 6. ANOVA

	df	SS	MS	F	Significance F
Regression	2	1652.241567	826.1207834	3.507206585	0.042781479
Residual	30	7066.485221	235.5495074		
Total	32	8718.726788			

Table 7. Coefficient table.

	Coefficients	Standard Error	t Stat	P-value
Intercept	−17.46333043	11.74965846	−1.48628409	0.1476387
diet	3.385515337	3.329533079	1.016813846	0.317372703
Exercise load	1.470767553	0.751658231	1.956697197	0.059747245

flora. However, we were not able to further investigate due to the lack of data. What's more, our article needs more case studies to be convincible.

In this article, we built mathematical models to analyze data obtained from a case study. Then we calculated and investigated on the effects of exercise intensity and diet on gut microbiota.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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