High School Students Health Analysis and Menu Design

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Class: Grade 10 Class 5

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1 Background

It is commonly believed that for teenagers, having a healthy diet is considered to be important since they need to gain more nutrition to grow up compared to adults. Despite considering whether the amount of nutrition is sufficient or not, it is more important to balance the diet. Three of the most important and essential nutrition we need from our daily diets are carbohydrates (carbs), protein and fat, each has its own amount. Data displays that teens require an average of 50–175 grams of protein each day which can be ingest from meats, fish and dairy, [1]. For carbohydrates, teenagers should aim to consume a minimum of 130 grams per day, equates to 60 percent of daily calories. It is worth noting that carbohydrates from beans or vegetables are much better choice than simple carbohydrates (sugars, syrups and sweetened drinks), [2]. Meanwhile, researches showed that fat should make up 20% to 35% of an adolescent's total daily intake. That is around 56 to 78 grams per day for a teenager eating 2000 calories per day, [3].

Data show that the proportion of children in China who are picky eaters is as high as 59.3%, and children who are not picky eaters not only have better physical development, but also significantly higher intelligence than children who are picky eaters.Students may develop picky eating habits from an early age, which may be difficult to break over time. In the questionnaire collected in the canteen some time ago, students reported that they were not satisfied with the food in the canteen, so they often did not eat or eat a little, or only ate meat without vegetables. Some students even develop very bad eating habits in order to lose weight. Taking into account students' different eating habits and increasingly mature pursuit of body shape, the canteen hopes to customize the new menu by understanding their favorite dishes and incorporating scientific evidence of proper nutrition intake.

In order to provide a healthier and more beloved menu, the canteen service of Shanghai Pinghe High School has set a survey for students, asking for their body shape, including height and weight, to further calculate their index of healthy condition, in this essay, BMI specifically. Meanwhile, we also include the proper amount of each cuisine in our providing menu for different crowds(normal, obesity, thin). The survey also interested in students' sleeping hour, studying hour after class, sports hour and satisfaction toward food provided in cafeteria and high school lives. In addition, the survey also made students list 3 favorite food. By counting on these factors, school can provide a new menu both healthy and popular.

In this essay, we first examine the general health condition of Shanghai Pinghe School's year 10 students in §2. Then, we try to evaluate the relationship between health conditions and other variables such as sleeping, sports, studying hours in §3. In §4, we determine the ideal menu for Shanghai Pinghe School students referring to amount of different nutrition teens need to take in per day, also considering the students' preferences from the given data set in the survey. Processed data tables is shown in Appendix, §A.

2 General Health Condition

To examine students' general health condition, we bring in the concept of Body Mass Index (BMI), also known as the Quetelet Index. BMI is a measure for indicating nutritional status in adults, and is the most popular and common method for nutritional status assessment. We choose the BMI measurement because in the survey we only get height and weight of students and these are the only 2 variables considered in BMI measurement while for other measurements, they need more data such as waist circumference and the hip widest diameter. The BMI measurement is defined as

$$\frac{\text{Weight}}{\text{Height}^2} \tag{1}$$

, with height in unit m and weight in unit kg.

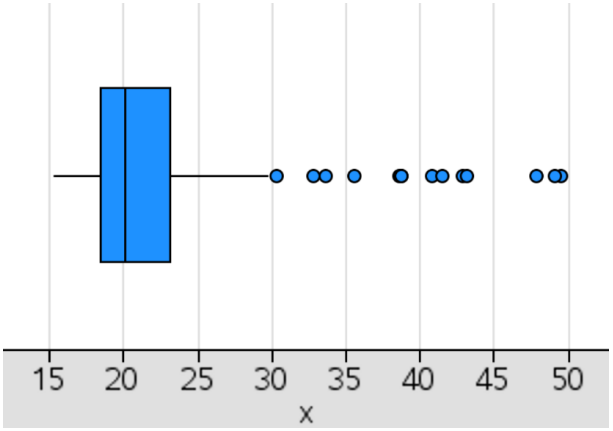

Figure 1: This is the box and whisker diagram showing the distribution of year 10 students' BMI. Some of the outliers that reach 40 is maybe the result of some students messed up units of weight.

According to WHO's standard,[4], the range of BMI value and the nutrition status it reflect is shown in Tab. 1.

BMI	Nutritional status
Below 18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Pre-obesity
30.0–34.9	Obesity class I
35.0–39.9	Obesity class II
Above 40	Obesity class III

Table 1: WHO's standard of BMI range and nutritional status.

As shown in Fig.1, most students in the middle 50% are at normal health condition. The lower quartile is at 18.35, which means that more than 25% of total students are underweight. About 25% of students have higher weight than standard. However, we need to notice that some of the outliers are mistakes when filling the survey. So in total, Shanghai Pinghe School Year 10 students have a health condition, and some of them are underweight while most are in normal states.

Some of students are outliers in the box and whisker diagram. This is mostly because students messed up with the weight unit. So they fill in twice as much weight as they actually do, causing them to have BMI's as high as 40-50, which should actually be in the normal range.

Because these data cause a lot difference, we change their data to $\frac{1}{2}$ of original ones. By calculating the BMI again, we get Fig.2 showing real distribution of Shanghai Pinghe School students' BMI.

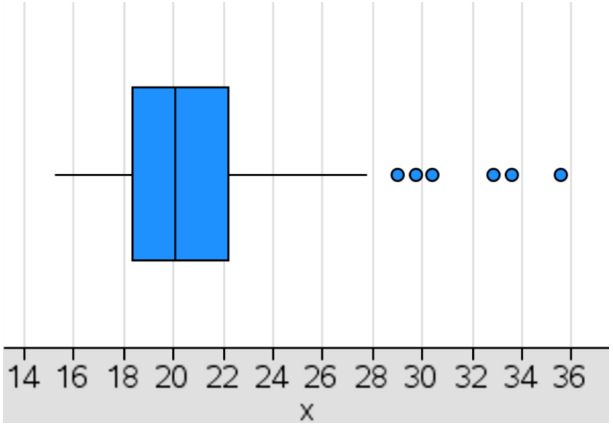

Figure 2: This is the box and whisker diagram showing the real distribution of year 10 students' BMI using corrected value.

3 Correlation analysis

We set BMI as the dependent variable and sleeping, sports, studying hours and satisfaction of high school life and cafeteria food as independent variables. Then, analyse the correlation between each independent variable and BMI.

We use the Pearson correlation coefficient to determine whether the independent variable and dependent variable have strong relationship. Pearson correlation coefficient is the covariance of the two variables divided by the product of their standard deviations, [5]. Here, the survey was conducted on a sample of 210 individuals, so we can obtain the Pearson correlation coefficient as

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{2}$$

The coefficient can also be calculated by computer. Here we use Logger Pro to plot the scattered plots graphs and also calculate the Pearson's r_{xy}.

A rule of thumb for interpreting the strength of a relationship based on its r_{xy} value is listed in Table.2.

Absolute Value of r	**Strength of relationship**
$\|r\| < 0.75$	None or weak
$0.75 < \|r\| < 0.87$	Moderate
$\|r\| > 0.87$	Strong

Table 2

The scattered plots of different variables (Fig.18-22) are listed in the §A.

Independent variable	**Pearson correlation coefficient** (r_{xy})
Sleeping hours	-0.09004
Sports hours	-0.07484
Studying hours	0.03406
Cafeteria satisfaction	0.001966
Campus life satisfaction	-0.04836

Table 3

From Tab.3, it is shown that Pearson correlations between 5 distinct independent variables and dependent variable (BMI) are weak, that is to say, whether students have slightly healthier life styles or more positive attitudes toward campus life or not is not the main cause of diversity in nutritional status, weight gain, or level of physical development. For instance, there are still most of the students who aren't satisfied with cafeteria at normal growth level. Meanwhile, among the five independent variables, Sleeping hours(-0.09004) plays the relatively strongest role and Cafeteria satisfaction(0.001966) obviously plays the weakest one.

4 Menu setting and explanation

We set the menu referencing students' preference to each dish. Also, since some of the popular dishes are junk food with high energy, we also take healthy diet into consideration, which means we will put at least one dish of vegetables in each meal, which contain dietary fiber.

Also, because the 3 favorite dishes students listed on the survey are all food for lunch and dinner, we determine the breakfast by traditional breakfast food, also referencing to Shanghai Pinghe School's breakfast menu, with roughly approximation for balancing of carbs, protein and fat.

Up to now, we can get a weekly menu with 5 distinct daily menu and each contains breakfast, lunch and supper (for Friday we do not have supper because students go home) and each daily menu contains distinct dishes.

Monday	*breakfast*	荷包蛋	肉包	酸辣粉
	lunch	菠菜	毛血旺	莴苣
	supper	水煮牛肉	沙拉	排骨
Tuesday	*breakfast*	皮蛋瘦肉粥	白菜	烧卖
	lunch	鸡块	土豆炖肉	青菜
	supper	咖喱牛肉	罗宋汤	茄子
Wednesday	*breakfast*	小米粥	小笼包	水煮蛋
	lunch	小酥肉	肥牛	凉拌黄瓜
	supper	皮蛋豆腐	口水鸡	生菜
Thursday	*breakfast*	炒粉丝	荷包蛋	酒酿小圆子
	lunch	番茄炒蛋	夫妻肺片	丝瓜
	supper	酱鸭	西兰花	冬瓜排骨
Friday	*breakfast*	油条	菜包子	豆浆
	lunch	烤鸡	娃娃菜	蒸红薯

5 Methodology

5.1 Constraints

For each meal, we have three dishes. We set that we need to eat xg of the first dish, yg of the second dish, zg of the third dish.

Because we need to design healthy diets for students, the amount of dishes should be determined by the total mass of carbohydrates, protein, fat.

According to [2], teens need an average of 50-175 grams of protein, [1], 225-325 grams of carbohydrates, [6], and 56-78 grams of fat per day, [3]. We need to divide the total amount of nutrition intake per day to every meal. According to traditional Chinese lifestyle, people mainly eat less for breakfast and supper, more for lunch. We made the hypothesis that the nutrition intake proportion is 3:4:3, [7].

So the range of protein, carbohydrates, fat for breakfast, lunch, supper can be calculated. The intake range for protein, carbohydrates, fat for breakfast and supper are 15-52.5g, 67.5-97.5g, 16.8-23.4g per meal, respectively. For lunch, the suitable intake should be 20-70g, 90-130g, 22.4-31.2g for protein, carbs, fat.

It is worth noting that normal people will eat at lunch and dinner, so we subtract 1 bowl of rice's nutrition (5g of protein, 47g of carbs and 1g of fat) directly from the base of range. So the ranges excluding rice for lunch becomes 15-65g of protein, 43-83g of carbs and 21.4-30.2g of fat. And for supper, the ranges excluding rice becomes 10-47.5g of protein, 20.5-50.5g of carbs and 15.8-22.4g of fat.

Suppose the amount of carbs in 1g of the first dish is C_1 and C_2, C_3 for the second, third dish respectively. Similarly, the amount of protein in 1g of the dishes are P_1, P_2, P_3 and the amount of fat in 1g of the dishes are F_1, F_2, F_3.

So we can get the inequalities below for breakfast:

$$C_1 \cdot x + C_2 \cdot y + C_3 \cdot z \geq 67.5 \tag{3}$$

$$C_1 \cdot x + C_2 \cdot y + C_3 \cdot z \leq 97.5 \tag{4}$$

$$P_1 \cdot x + P_2 \cdot y + P_3 \cdot z \geq 15 \tag{5}$$

$$P_1 \cdot x + P_2 \cdot y + P_3 \cdot z \leq 52.5 \tag{6}$$

$$F_1 \cdot x + F_2 \cdot y + F_3 \cdot z \geq 16.8 \tag{7}$$

$$F_1 \cdot x + F_2 \cdot y + F_3 \cdot z \leq 23.4 \tag{8}$$

for lunch:

$$C_1 \cdot x + C_2 \cdot y + C_3 \cdot z \geq 43 \tag{9}$$

$$C_1 \cdot x + C_2 \cdot y + C_3 \cdot z \leq 83 \tag{10}$$

$$P_1 \cdot x + P_2 \cdot y + P_3 \cdot z \geq 15 \tag{11}$$

$$P_1 \cdot x + P_2 \cdot y + P_3 \cdot z \leq 65 \tag{12}$$

$$F_1 \cdot x + F_2 \cdot y + F_3 \cdot z \geq 21.4 \tag{13}$$

$$F_1 \cdot x + F_2 \cdot y + F_3 \cdot z \leq 30.2 \tag{14}$$

and for supper:

$$C_1 \cdot x + C_2 \cdot y + C_3 \cdot z \geq 20.5 \tag{15}$$

$$C_1 \cdot x + C_2 \cdot y + C_3 \cdot z \leq 50.5 \tag{16}$$

$$P_1 \cdot x + P_2 \cdot y + P_3 \cdot z \geq 10 \tag{17}$$

$$P_1 \cdot x + P_2 \cdot y + P_3 \cdot z \leq 47.5 \tag{18}$$

$$F_1 \cdot x + F_2 \cdot y + F_3 \cdot z \geq 15.8 \tag{19}$$

$$F_1 \cdot x + F_2 \cdot y + F_3 \cdot z \leq 22.4 \tag{20}$$

We search on https://www.boohee.com/ to get the constant C, P, F for every dish, listed in Tab.6 in §A.3.

5.2 Objective function

Now we have designed the constraints. For different people, we can design different objective functions. For ordinary students with no special needs, we can set the objective function to eat the most or least quality. For breakfast and lunch, we set the objective function to be the maximum of the sum of mass of three dishes, which is $\mathrm{Max}\{x + y + z\}$. The average student can eat a little more to fill their stomach and keep them from feeling hungry at other times. While for dinner, students should eat less so that they can digest the food in time, which is $\mathrm{Min}\{x + y + z\}$. For obese students, they need to eat less fat, so our objective function can be the least amount of fat required. For people who need to get fit and lose fat, their objective function is the maximum amount of protein.

So we can governing the objective functions for normal, obese and fitness students respectively.

For normal students, we have the objective function:

$$\mathrm{Max}\{x + y + z\}, (\mathrm{Breakfast}, \mathrm{Lunch}) \tag{21}$$

$$\mathrm{Min}\{x + y + z\}, (\mathrm{Supper}) \tag{22}$$

And for obese students, the best way for them to lose weight is to intake less fat. So the objective function should be

$$\mathrm{Min}\{F_1 \cdot x + F_2 \cdot y + F_3 \cdot z\} \tag{23}$$

Students who pursuit fitness should eat more protein. Protein is essential for making muscle since it forms the building blocks of muscle tissue. Eating adequate amounts helps us maintain muscle and promotes muscle growth and repair, especially after resistance exercise. So the objective function should be

$$\mathrm{Max}\{P_1 \cdot x + P_2 \cdot y + P_3 \cdot z\} \tag{24}$$

6 Conclusion and Reflection

6.1 Calculation Results

We use the MATLAB code in §A to determine the optimize solution. Fig.3-17 show the calculation results given by solving the linear programming problem. To be specific, Fig.3-7 is solution for normal people, while Fig.8-12 is for fitness seekers and Fig.13-17 is for obese people. Each group of solutions shown in one row of graphs give the breakfast, lunch and supper from right to left in a specific day for normal, obese or fitness group of people. The feasible region is shown as the blue area and the optimal solution for each group is shown as the red point in the graphs.

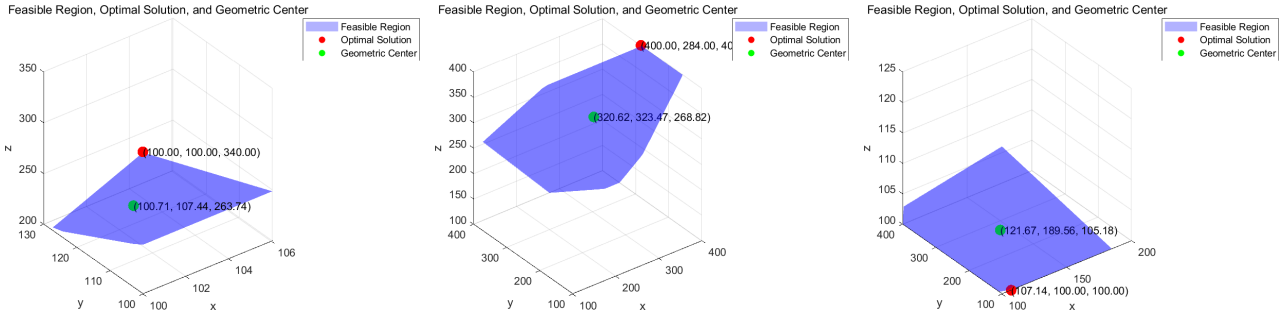

Figure 3: Feasible region of Monday breakfast, lunch and supper.

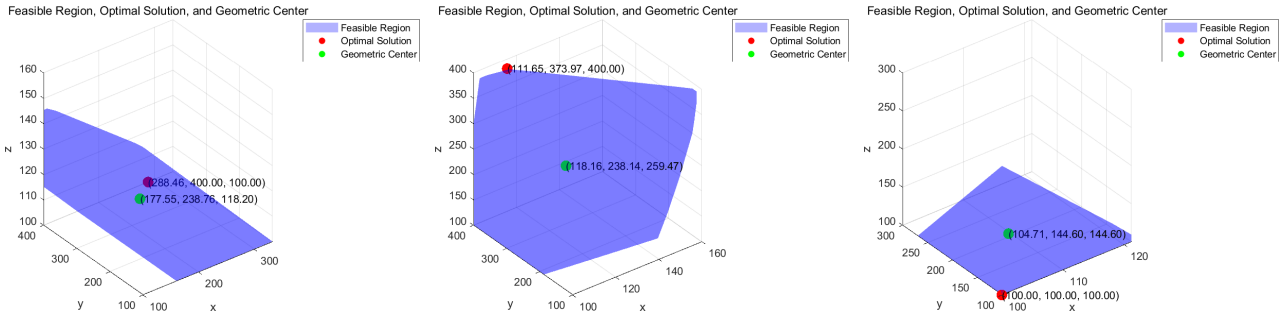

Figure 4: Feasible region of Tuesday breakfast, lunch and supper.

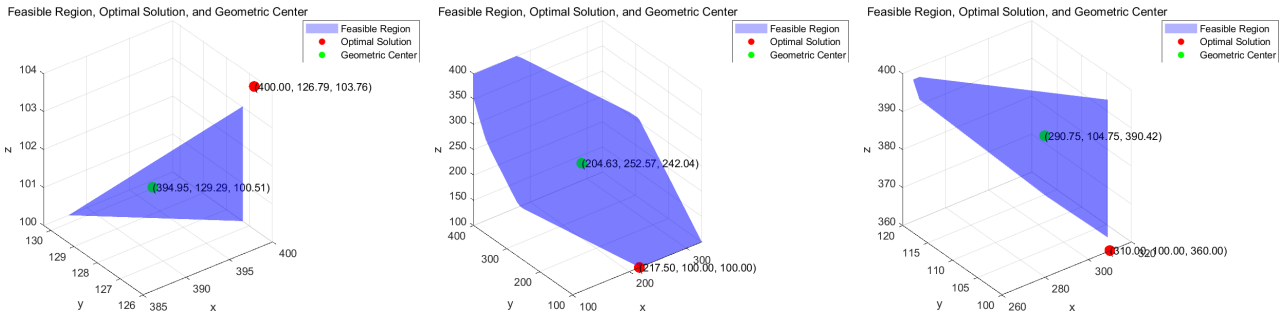

Figure 5: Feasible region of Wednesday breakfast, lunch and supper.

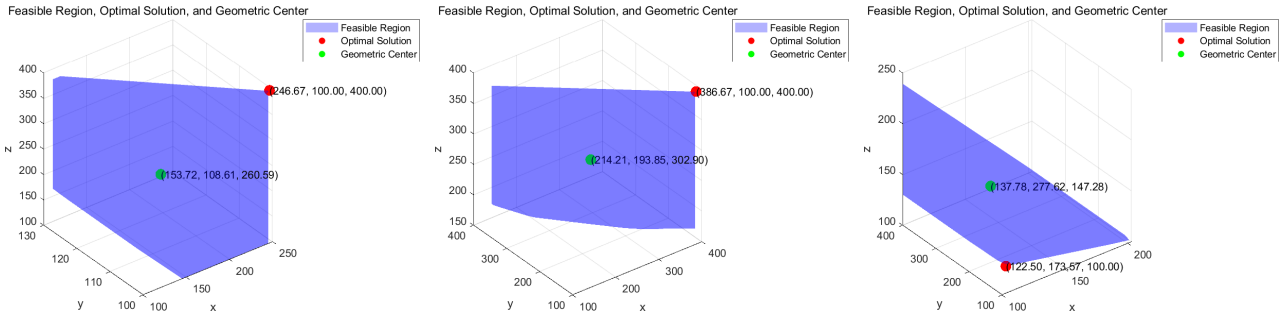

Figure 6: Feasible region of Thursday breakfast, lunch and supper.

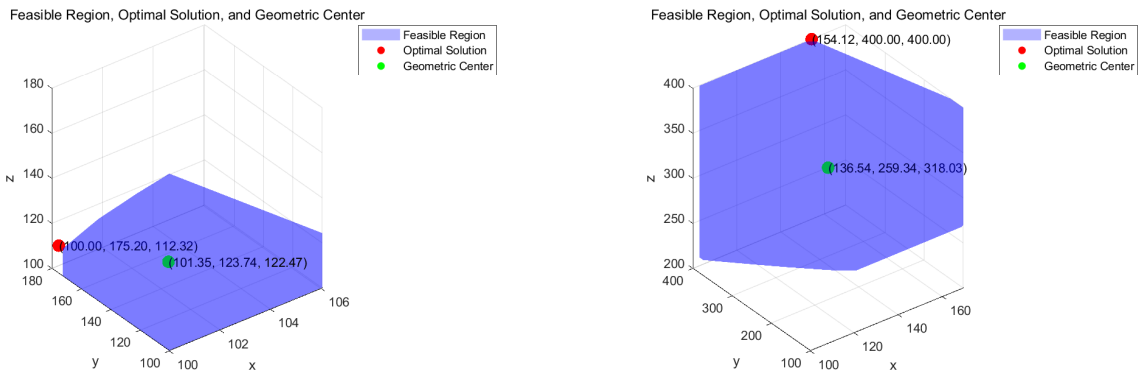

Figure 7: Feasible region of Friday breakfast, lunch.

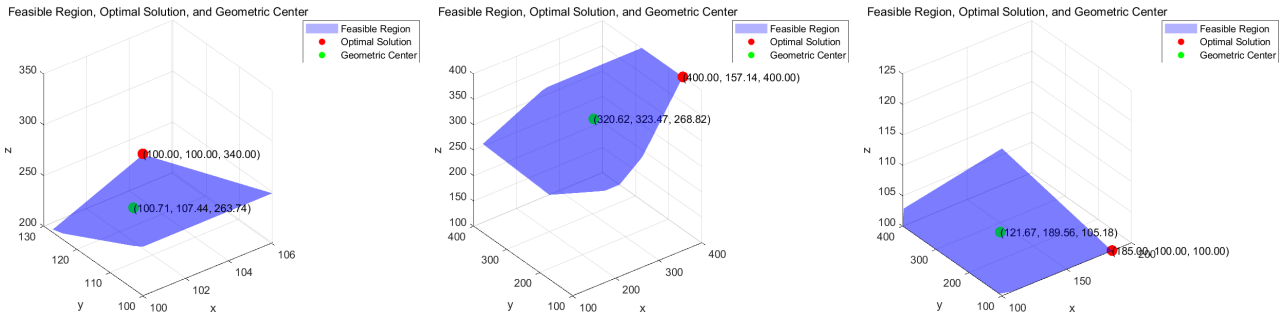

Figure 8: Feasible region of Monday breakfast, lunch and supper for fitness seekers.

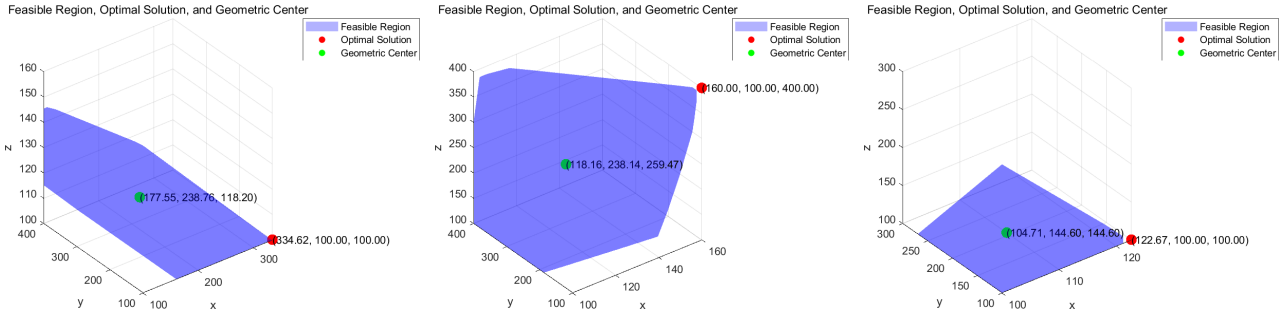

Figure 9: Feasible region of Tuesday breakfast, lunch and supper for fitness seekers.

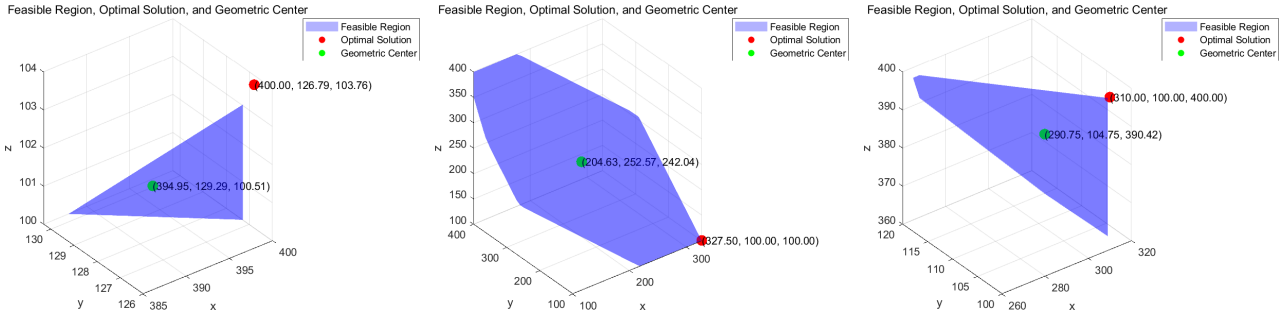

Figure 10: Feasible region of Wednesday breakfast, lunch and supper for fitness seekers.

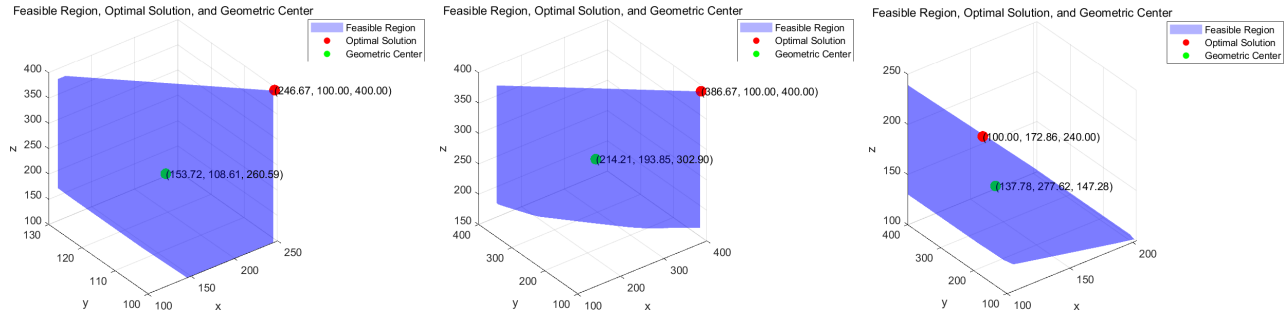

Figure 11: Feasible region of Thursday breakfast, lunch and supper for fitness seekers.

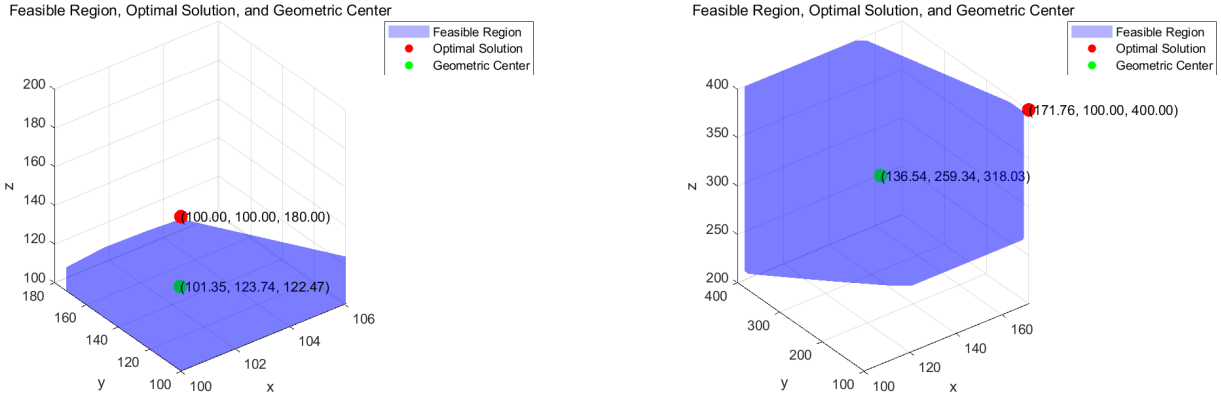

Figure 12: Feasible region of Friday breakfast, lunch and supper for fitness seekers.

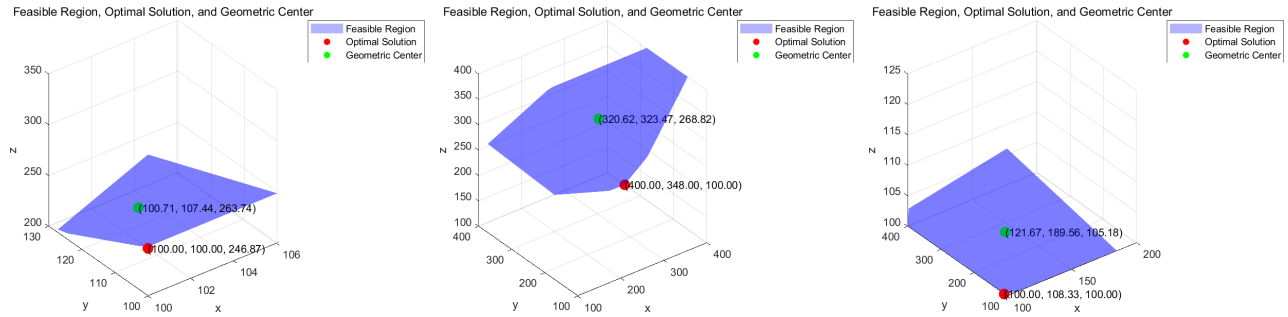

Figure 13: Feasible region of Monday breakfast, lunch and supper for obese people.

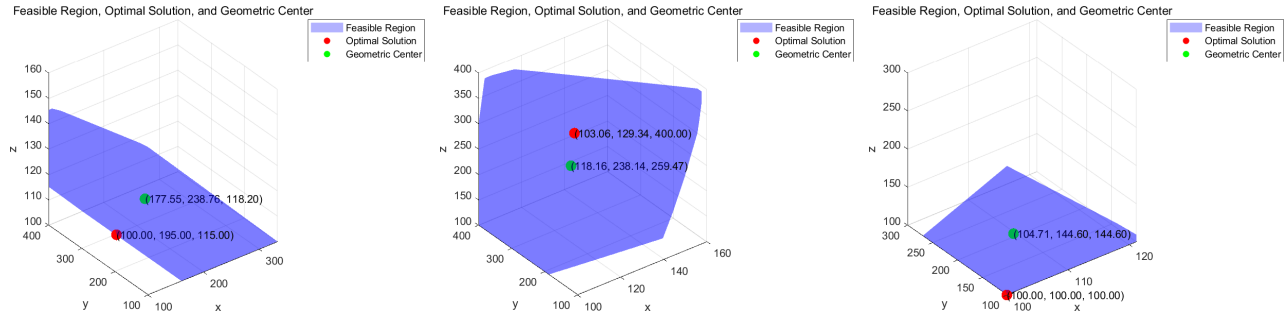

Figure 14: Feasible region of Tuesday breakfast, lunch and supper for obese people.

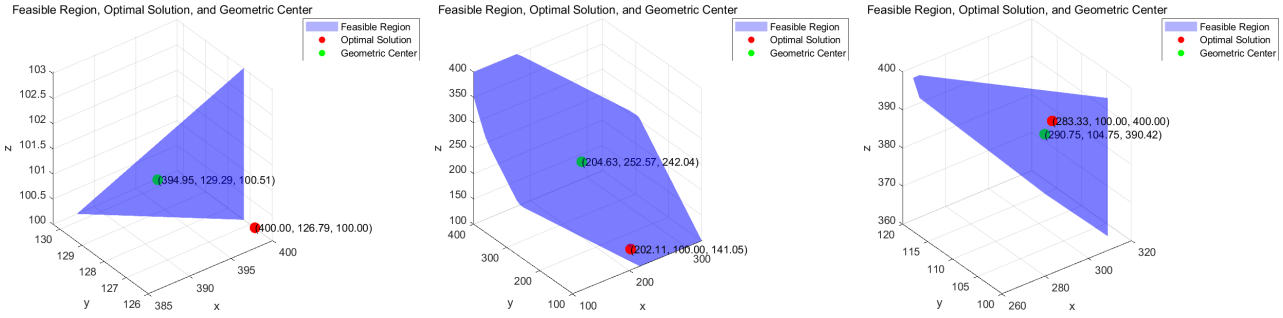

Figure 15: Feasible region of Wednesday breakfast, lunch and supper for obese people.

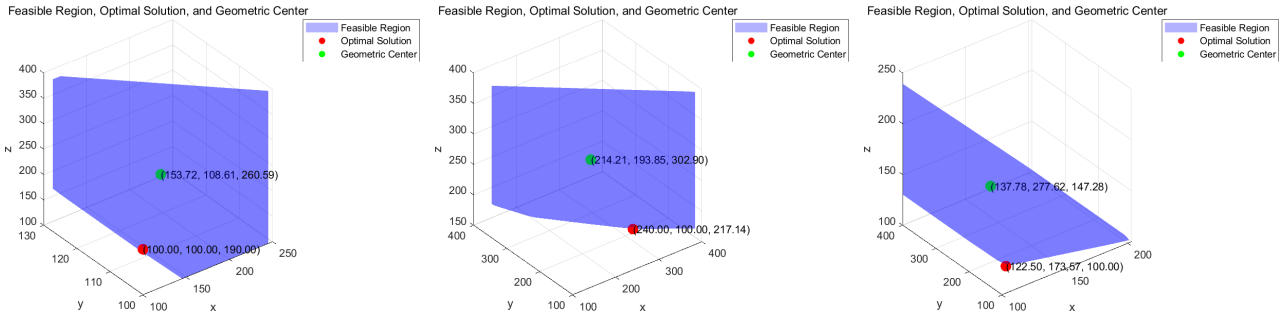

Figure 16: Feasible region of Thursday breakfast, lunch and supper for obese people.

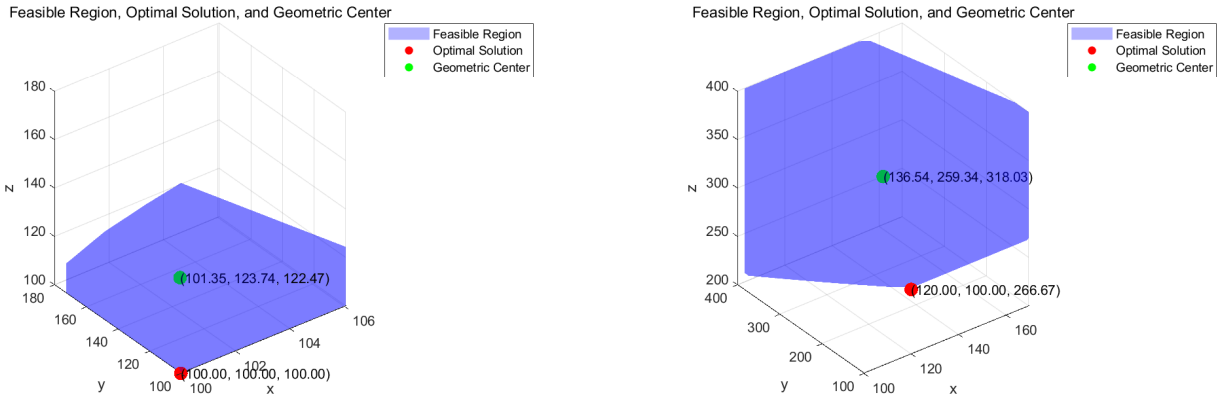

Figure 17: Feasible region of Friday breakfast, lunch for obese people.

MENU

MONDAY

Breakfast:


荷包蛋 Poached egg
100 100 100


酸辣粉 Sour and chili vermicell
340 246 340


肉包 Meatbun
100 100 100

Lunch:


菠菜 Spinach
400 400 400


毛血旺 Chongqing style boiled blood curd
284 348 157


莴苣 Asparagus lettuce
400 100 400

Dinner:


水煮牛肉 Boiled beef
107 100 185


沙拉 Salad
100 108 100


排骨 Spareribs
100 100 100

TUESDAY

Breakfast:


皮蛋瘦肉粥 Minced Pork Congee with Preserved Egg
288 100 334


烧麦 Steamed pork dumpling
100 115 100


白菜 Cabbage
400 195 100

Lunch:


鸡块 Chicken nugget
111 103 160


青菜 Green
400 400 400


土豆炖肉 Potato stew
373 129 100

Dinner:


咖喱牛肉 Beef curry
100 100 122


Borscht 罗宋汤
100 100 100


茄子 Eggplant
100 100 100

WEDNESDAY

Breakfast:


小米粥 Millet Congee
400 400 400


小笼包 Xiaolongbao
126 126 126


水煮蛋 Boiled egg
103 100 103

Lunch:


小酥肉 Crispy fried pork
217 202 321


肥牛 Beef slices
100 100 100


凉拌黄瓜 Salad cucumber chips
100 141 100

Dinner:


皮蛋豆腐 Tofu with Preserved Egg
310 283 310


生菜 Lettuce
360 400 400


口水鸡 Sichuan style chicken
100 100 100

THURSDAY

Breakfast:


炒粉丝 Stir-fried glass noodles
246 100 246


荷包蛋 Poached egg
100 100 100


Fermented glutinous rice dumplings 酒酿小圆子
400 190 400

Lunch:


丝瓜 Luffa
400 217 400


Sliced Beef and Ox Tongue in Chili Sauce 麻辣牛舌牛肉片
100 100 100


番茄炒蛋 Fried eggs with tomatoes
386 240 386

Dinner:


酱鸭 Stewed duck in soy sauce
122 122 100


冬瓜排骨 Pork ribs soup with wax gourd
100 100 240


西兰花 Broccoli
173 173 172

FRIDAY

Breakfast:


油条 Deep-fried dough stick
100 100 100


菜包子 Vegetable stuffing
175 100 100


豆浆 Soybean milk
112 100 180

Lunch:


烤鸡 Roasted Chicken
154 120 171

白菜 Cabbage
400 100 100

蒸红薯 Steamed sweet potato
400 266 400

Suggested intake mass (g) for:
- normal people
- obese
- fitness

6.2 Reflection

In this essay, we determine the state of students' health using the BMI measurement. However, the BMI measurement is inaccurate. For example, people who have more muscle mass and less body fat may weigh more, leading to higher BMI despite low-fat stores. Because BMI fails to distinguish between muscle, fat, and water, it doesn't accurately mention if the weight reflects the healthy or unhealthy version of an individual. For other measurements, they need more data such as waist circumference and hip highest diameter which are not included in the survey and hard to measure.

While determining health states of students, some of them messed up units of weight, so BMI became 2 times the real value. That causes some of the outliers and the correlations became less than real values.

While determine dishes, some of students write abstract answers due to inappropriate setting of the survey and wrong attitude towards the research. Their abstract dishes were rounded off in the dishes popularity analysis because in reality most people will not eat the abstract dishes. Also dishes with high cost and junk food which have never provided in the cafeteria before are also neglected.

Here are some examples of the dishes that we neglect, listed in Tab.4.

Serial No.	Dishes neglected	Reason
21	Pizza, hotdog, hamburger	Junk food
26	pizza, steak and ice cream	Junk food
32	三文鱼刺身潮汕生腌麦当劳	Never provided, High cost
41	橙汁山药酸汤肥牛杨枝甘露	Abstract dish
70	橙汁山药、冰激凌、炸鸡、蜜雪冰城、佛跳墙	High cost, abstract dish
75	红烧鸟毛，清蒸鸟蛋，爆炒鸟鞭	Abstract dish
134	赵子铉steak KFC	Abstract dish

Table 4: List of students' serial numbers, dishes neglected and the reason.

Theoretically, there is no limit to the quantitative relationship between the type of food and the number of constraint functions in linear programming. However, if the two are not equal, it is possible that for some meals, the requirement of a certain food is zero, which is not compatible with reality. So we set that the minimum amount of food is 100g and the maximum amount of food is 400g.

References

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A Appendix

A.1 MATLAB code to determine feasible region

We determine the feasible region of 3 variable linear programming using MATLAB code originally by Haokun Shi.

```
import matlab.io.*

problem = optimproblem('ObjectiveSense', 'minimize' );
%minimize when fat, and supper for normal;
%maximize when protein and breakfast, lunch for normal

%different in different meals
carbohydrate_min = 20.5;
carbohydrate_max = 50.5;
protein_min = 10;
protein_max = 47.5;
fat_min = 15.8;
fat_max = 22.4;

%carbs, protein, fat in 1 gram of 1st, 2nd, 3rd dish
carbohydrates = [0.03, 0.04, 0.02];
protein = [0.06, 0.18, 0.02];
fat = [0.04, 0.1, 0];

x = optimvar('x', 'LowerBound', 0, 'UpperBound', 400);
y = optimvar('y', 'LowerBound', 0, 'UpperBound', 400);
z = optimvar('z', 'LowerBound', 0, 'UpperBound', 400);

%obese objective function: fat(1) * x + fat(2) * y + fat(3) * z
%fitness objective function: protein(1) * x+ protein(2) * x+protein(3) * z
%normal objective function: x + y + z

objective = x + y + z;
problem.Objective = objective;

problem.Constraints.carbohydrate_min = carbohydrates(1) * x + carbohydrates(2)
    * y + carbohydrates(3) * z >= carbohydrate_min;
problem.Constraints.carbohydrate_max = carbohydrates(1) * x + carbohydrates(2)
    * y + carbohydrates(3) * z <= carbohydrate_max;
problem.Constraints.protein_min = protein(1) * x + protein(2) * y + protein(3)
    * z >= protein_min;
problem.Constraints.protein_max = protein(1) * x + protein(2) * y + protein(3)
    * z <= protein_max;
problem.Constraints.fat_min = fat(1) * x + fat(2) * y + fat(3) * z >= fat_min;
problem.Constraints.fat_max = fat(1) * x + fat(2) * y + fat(3) * z <= fat_max;
```

```
37
38
39 %constraints of mass of different dishes
40 problem.Constraints.x_min = x >= 100;
41 problem.Constraints.y_min = y >= 100;
42 problem.Constraints.z_min = z >= 100;
43 problem.Constraints.x_max = x <= 400;
44 problem.Constraints.y_max = y <= 400;
45 problem.Constraints.z_max = z <= 400;
46
47 [solution, fval] = solve(problem);
48
49 disp("Optimal Solution:");
50 disp("x = " + solution.x);
51 disp("y = " + solution.y);
52 disp("z = " + solution.z);
53 disp("Objective Value: " + fval);
54
55 %data plot
56 num_samples = 100;
57 x_range = linspace(100, 400, num_samples);
58 y_range = linspace(100, 400, num_samples);
59 z_range = linspace(100, 400, num_samples);
60 [X, Y, Z] = meshgrid(x_range, y_range, z_range);
61
62 valid_points = carbohydrates(1) * X + carbohydrates(2) * Y + carbohydrates(3) *
      Z >= carbohydrate_min & ...
63                carbohydrates(1) * X + carbohydrates(2) * Y + carbohydrates(3) *
                     Z <= carbohydrate_max & ...
64                protein(1) * X + protein(2) * Y + protein(3) * Z >= protein_min
                     & ...
65                protein(1) * X + protein(2) * Y + protein(3) * Z <= protein_max
                     & ...
66                fat(1) * X + fat(2) * Y + fat(3) * Z >= fat_min & ...
67                fat(1) * X + fat(2) * Y + fat(3) * Z <= fat_max;
68
69 K = convhulln([X(valid_points(:)), Y(valid_points(:)), Z(valid_points(:))]);
70
71 trisurf(K, X(valid_points), Y(valid_points), Z(valid_points), 'FaceColor',
      'blue', 'FaceAlpha', 0.3, 'EdgeColor', 'none');
72 hold on;
73
74 scatter3(solution.x, solution.y, solution.z, 100, 'r', 'filled');
75
76 center_x = mean(X(valid_points));
77 center_y = mean(Y(valid_points));
78 center_z = mean(Z(valid_points));
79
80 scatter3(center_x, center_y, center_z, 100, 'g', 'filled');
81
```

```
text(center_x, center_y, center_z, sprintf('(%0.2f, %0.2f, %0.2f)', center_x,
    center_y, center_z), 'FontSize', 10, 'Color', 'k');

text(solution.x, solution.y, solution.z, sprintf('(%0.2f, %0.2f, %0.2f)',
    solution.x, solution.y, solution.z), 'FontSize', 10, 'Color', 'k');

xlabel('x');
ylabel('y');
zlabel('z');
title('Feasible Region, Optimal Solution, and Geometric Center');
legend('Feasible Region', 'Optimal Solution', 'Geometric Center');
grid on;
```

A.2 Popularity of different dishes

To determine the menu, we take both the nutrition and popularity of different dishes into consideration. The popularity of different dishes is measured by the frequency of dishes appeared on the list of 3 favorite food provided by year 10 students. The frequency of different food appeared on the list is listed below in Tab.5.

A.3 Nutrition in each dish

The data of carbohydrates, protein and fat for each food is provided by https://www.boohee.com/ and listed in Tab.6.

A.4 Graph drawn to determine correlation

The graph showing relationship between sleeping hours (Fig.18), sports hours (Fig.19), studying hours (Fig.20), cafeteria food satisfaction (Fig.21), campus life satisfaction (Fig.22) and BMI, with correlation ratio -0.09004, -0.07484, 0.03406, 0.004678, -0.04836, respectively (shown in the box of every graph).

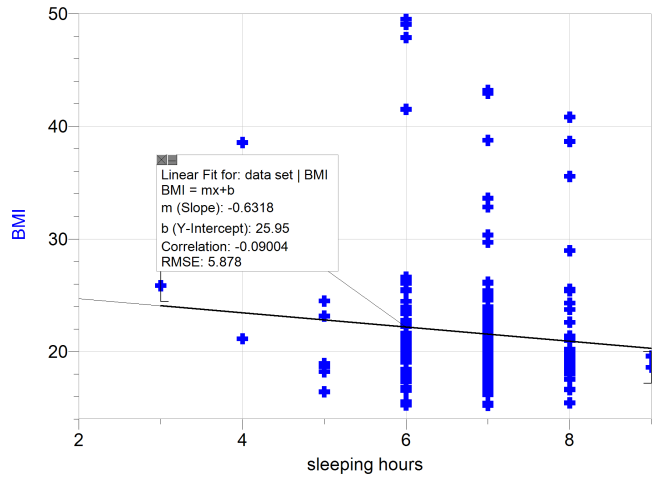

Figure 18: The graph showing relationship between sleeping hours and BMI.

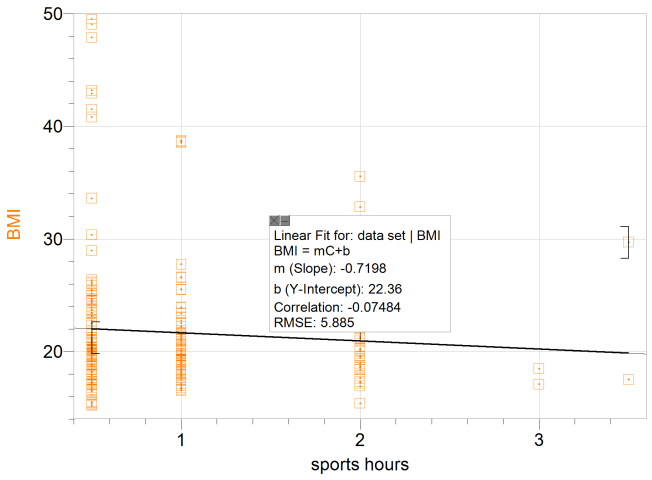

Figure 19: The graph showing relationship between sports hours and BMI.

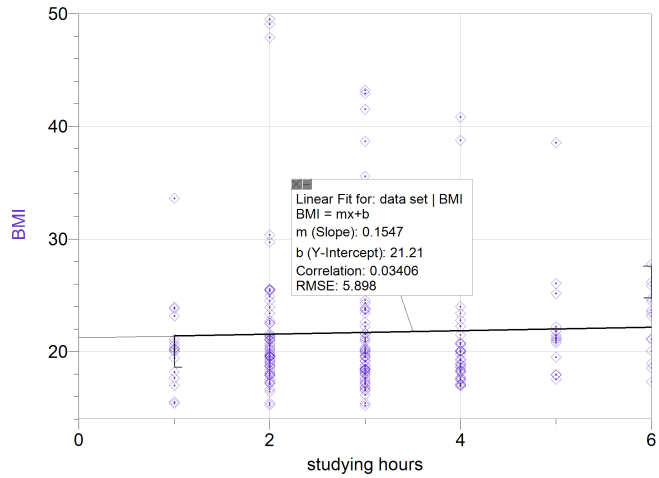

Figure 20: The graph showing relationship between studying hours and BMI

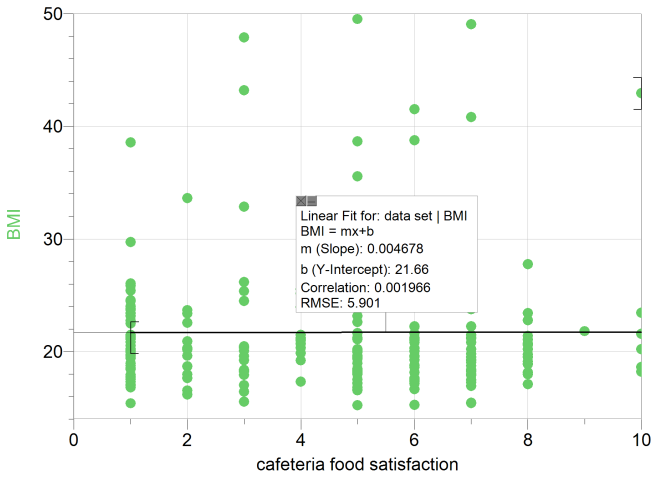

Figure 21: The graph showing relationship between cafeteria food satisfaction (rate from 1 to 10) and BMI.

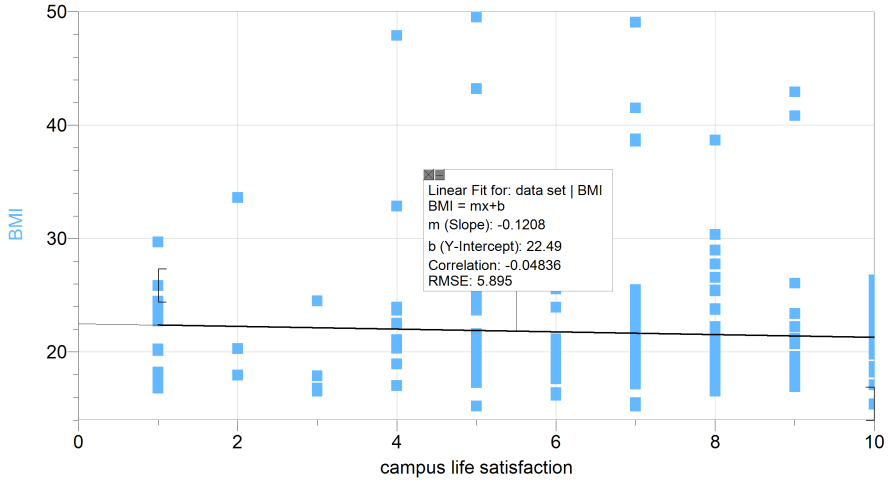

Figure 22: The graph showing relationship between students' satisfaction for campus life (rate from 1 to 10) and BMI.

Dish	Frequency	Dish	Frequency	Dish	Frequency
烤鸡/鸡翅/鸡腿	33	土豆泥	4	午餐肉	1
炸鸡/鸡米花/鸡块	30	虾排	4	鳝丝	1
面	28	红薯	3	腌笃鲜	1
小龙虾	20	口水鸡	3	萝卜牛腩	1
酱鸭	18	海带	3	牛尾汤	1
番茄炒蛋	17	冒菜	3	泡菜五花肉	1
肥牛（酸菜牛肉）	13	莴笋	3	空心菜	1
炒饭(fried rice)	11	罗宋汤(borsch)	3	蒜苔	1
豆腐(tofu)	11	广式腊肉饭	3	秋葵	1
薯条(chips)	11	夫妻肺片	3	鸭胗	1
火锅(hotpot)	9	羊肉(lamb)	3	豆角	1
粉	9	狮子头	3	番茄汤	1
青菜(杭白菜/白菜)	8	西兰花	2	黑椒牛柳	1
毛血旺	7	小酥肉	2	咕肉	1
沙拉(salad)	7	干锅花菜	2	紫菜汤	1
咖喱牛腩/牛肉	6	鱼排	2	扇贝	1
回锅肉	6	菠菜(spinach)	2	甜甜圈	1
麻辣烫	6	炖土豆	2	虾球	1
炖蛋(蒸蛋)	6	奶油蘑菇汤	2	鱼香肉丝	1
冬去春来饭	6	生菜	2	香酥鸭	1
烤鸭	5	茄子	2	剁椒鱼	1
排骨(蒜香骨)	5	冬瓜排骨汤	2	南瓜叶	1
木耳	4	牛蛙	2	鸡爪汤	1
米饭	4	叉烧	2	西葫芦	1
水煮牛肉	4	疙瘩汤	1	河粉	1
红烧肉	4	corn	1	丝瓜肉片	1
年糕	4	炖鸡	1		

Table 5

B Contribution

Cynthia: Popularity of dishes analysis, Menu translation.

Michelle: Background, Correlation analysis, Menu translation.

Stephanie: LaTeX essay writing, Graphs plotting.

Yvette: Menu artwork.

Dish	**carbs/g (C)**	**protein/g (P)**	**fat/g (F)**
荷包蛋	0.01	0.14	0.15
肉包	0.27	0.13	0.05
酸辣粉	0.16	0.02	0.07
菠菜	0.04	0.03	0
毛血旺	0.07	0.08	0.05
莴苣	0.04	0.02	0.04
水煮牛肉	0.07	0.12	0.04
沙拉	0.06	0.01	0.01
排骨	0.07	0.12	0.14
皮蛋瘦肉粥	0.13	0.05	0.03
白菜	0.02	0.01	0
烧卖	0.52	0.07	0.12
鸡块	0.1	0.2	0.17
土豆炖肉	0.16	0.06	0.03
青菜	0.03	0.02	0
咖喱牛肉	0.06	0.11	0.15
罗宋汤	0.09	0.02	0.02
茄子	0.07	0.01	0.02
小米粥	0.08	0.01	0.01
小笼包	0.28	0.12	0.09
水煮蛋	0	0.12	0.1
小酥肉	0.17	0.1	0.25
肥牛	0.03	0.08	0.01
冬瓜排骨	0.01	0.11	0.16
皮蛋豆腐	0.03	0.06	0.04
口水鸡	0.04	0.18	0.1
生菜	0.01	0.02	0
炒粉丝	0.1	0.01	0.03
酒酿小圆子	0.05	0.01	0
番茄炒蛋	0.04	0.05	0.06
夫妻肺片	0.03	0.16	0.07
丝瓜	0.14	0.01	0
酱鸭	0.06	0.09	0.08
西兰花	0.07	0.02	0
冬瓜排骨	0.01	0.11	0.16
油条	0.51	0.07	0.18
菜包子	0.26	0.06	0.02
豆浆	0.01	0.03	0.02
烤鸡	0	0.28	0.17
娃娃菜	0.03	0.04	0.01
蒸红薯	0.15	0.01	0

Table 6