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# Research on the Dietary Allocation Strategy of College Students Based on the Planning Model

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***Abstract:*** *The nutrients to maintain human daily needs are: protein, sugar, fat, minerals, vitamins, food cellulose and water 7 categories, a total of about 40 kinds. And the nutritional element components of each kind of food are different, and the regulating effect of each nutritional element on the physiologic function of the body is also different, so a variety of foods must be matched in proportion, in order to meet the demand of nutritional elements needed by the human body. Reasonable nutrition emphasizes that the nutritional elements in the food supplied to human consumption should be complete, moderate content and appropriate proportion. For this situation, this paper, in contemporary college students, for example, to study the problem of contemporary college students how scientific diet, on the basis of the Chinese residents dietary guidelines, dietary balance principle, lists the daily food, nutrient content, with the best consumption of food and the most economic ratio as the ultimate goal, establish a target model based on linear planning. For this model, using the Matlab, the computational software optimizes the computational module, establishing the optimal objective function. Through reasonable assumption and calculation, the parameters of nonlinear planning are optimized and then the linear planning model is obtained, and a more economical and scientific dietary balanced strategy is put forward.*

***Keywords:*** *linear planning model; nutritional elements; dietary strategy*

## 1. Introduction

With the rapid development of the society, people have gradually changed their diet from food and clothing to a healthy diet now. The human body must consume large quantities of sufficient elements and trace elements every day. However, because most people's cognition of healthy diet is not comprehensive enough, there are some people's dietary structure is unreasonable, especially for contemporary college students, the understanding of food health is very shallow. At the same time, the dietary consumption behavior of college students is a complex activity process, which is affected by many aspects, such as personal economic factors, family background, social relations, etc. It is a group with regular irregular and unreasonable diet. Youth, contemporary college students are the hope of the country in the future, shoulder the great responsibility of the country. Therefore, as contemporary college students, we should pay more attention to the importance of diet to physical health, and establish a balanced and healthy dietary structure.

We know that different people differ in their metabolic capacity, and that the absorption rate of food nutrients is different. In addition, in real life, some patients with underlying diseases also differ in their dietary intake relative to others. The eating time, age, gender, BMI, exercise time may have an impact on the reasonable collocation of diet. Considering the difficulty in detecting the absorption rate of nutrients, the default population equals the absorption rate of nutrients. Before building the model, we need to make some assumptions to make our model have generalization value. Suppose that the food nutrients consumed by the human body are not consumed and fully absorbed in the process of human function digestion; And the average daily movement of men and women, without considering the excessive consumption of elements caused by excessive exercise in the model, both men and women meet the international standard BIM value, and the various elements will not dissolve or react with each other, and the content of elements in the ingredients of the same variety is consistent. The market price fluctuation of vegetables is relatively stable, not affected by economic policies. The market food ingredients can be sold at any weight, and the selection of food ingredients is diverse. Based on the comprehensive consideration of external factors, we plan to divide the target population into two male and female groups. By collecting the data of nutrition and unit price of each ingredient. In order to achieve a reasonable distribution of diet, for the general eaters, the first two aspects must meet the basic intake

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of each element of the human body, the second is to improve the cost performance of diet as much as possible on the basis of meeting the basic intake, that is, to reduce the consumption cost of diet as much as possible. The basic daily intake of each element in boys and girls is shown in Table 1 below. Based on the above analysis, this problem can be solved by using the linear programming model. The difference between price and actual intake and basic intake can be taken as the target function, and the intake of each element of human body must be met as the constraint. Then, considering age, BMI, exercise time, and eating time, respectively. The optimal solution for the intake of different elements can be obtained, which is a reasonable dietary planning strategy for the target group.

*Table 1: Dietary Nutrition Reference Intake of Chinese Residents (2016) editio*

| gender | sugar (g) | protein (g) | fat (g) | vitamin A (mcg) | Vitamin C (mg) | vitamin B12 (mcg) | calcium (mcg) | Energy (kcal) |
|---|---|---|---|---|---|---|---|---|
| aily intake of by boys | 400 | 27 | 85 | 800 | 2000 | 2.4 | 800 | 12 |
| Daily intake of by girls | 300 | 25 | 80 | 700 | 1800 | 2.2 | 700 | 9.96 |

## 2. Symbol description

| sign | explain |
|---|---|
| $m_i$ | It represents the price of the first i raw material, i value 1,2,3,4,5, indicating whole grains, meat, vegetables, fruits and other categories respectively |
| $n_{ij}$ | It represents the average daily demand of the i th raw material for the j th population |
| $h_{iy}$ | Represents the unit content of the y th nutrient in the i th raw material, y value 1-8 respectively |
| $n_{iy}$ | It represents sugar, protein, fat, vitamin A, vitamin C, vitamin B12, calcium, and energy |
| $c_{iy}$ | It represents the loss rate of the y th nutrient in the i th raw material caused by cooking |
| $d_{iy}$ | It represents the absorption rate of the y th nutrient in the food made from the i th raw material |
| $b_j$ | It represents the average daily cost of the k th daily diet in the population |
| $f_j$ | Total difference between daily dosage and average daily demand of each raw material in the population in the j |

## 3. Diet allocation planning model was established

Through the problem analysis, we can solve it by using a linear programming model. Linear planning is a model that is often used to solve the problems of using or allocating limited resources, that is, labor, raw materials, machines, and capital that minimize the cost or maximize the profit[1-2].

**Step 1. Determine the decision variable**

Set $d_{ij}$ as the fixed value, the average daily demand of different raw materials for different populations is $a_{ij}$, where i = 1,2,..., 5, j = 1,2. Taking the most economical and the smallest gap with the recommended dietary nutrient intake of the Chinese Nutrition Society as the formulation. The goal of a balanced diet program,

The calculation function is:

$$\begin{cases} b_j = \sum_{i=1}^{5} x_{d_{ij}} m_i x_{ij} \\ f_j = \sum_{i=1}^{5} x_{d_{ij}} \left| x_{ij} - n_{ij} \right| \end{cases} \tag{1}$$

The $x_{d_{ij}}$ is a gender function, $x_{d_{ij}} = 1$ when the i th raw material of the j th population is studied; otherwise the value is zero. Minimum total cost, demand for $\min b_j$,

**Step 2. Determine the objective function**

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So the objective function of this problem is:

$$\min Z_j = \min \begin{cases} \sum_{i=1}^{5} x_{d_{ij}} m_i x_{ij} \\ \sum_{i=1}^{5} x_{d_{ij}} \left| x_{ij} - n_{ij} \right| \end{cases} \tag{2}$$

**Step 3. Determine the constraints**

Cooking can lead to the loss of nutritional elements, the human body has different absorption rate of different nutritional elements, and requires to meet the recommended amount of the nutrition society. Therefore, considering the above factors, establish the function:

$$\sum_{j=1}^{5} x_{d_{ij}} x_{ij} \left(1 - n_{iy}\right) c_{iy} h_{iy} \geq d_{jy}$$
$$j = 1,2; y = 1,2,3,4,5 \tag{3}$$

From the above analysis, we can see that when the total cost is minimized, the decision variable is $x_{ij}$, so the final problem boils down to finding the minimum value of the objective function under the constraints. Considering the complexity of food absorption, the absorption rate is 100% and the food loss rate is 0. Therefore, the model can be simplified to:

$$\sum_{j=1}^{5} x_{d_{ij}} x_{ij} h_{iy} \geq d_{iy}$$
$$j = 1,2; y = 1,2,3,4,5 \tag{4}$$

## 4. Plan model solution

According to the content of each element of the above common food ingredients, it is not easy to count due to the wide variety of food ingredients.[3] In order to distribute a reasonable diet separately, we follow five categories: meat, vegetables, coarse grain (staple food), category, fruit and other categories. Other categories include milk, drinks, eggs and other difficult ingredients [4]. The specific categories are provided as follows Table 3 to Table 7:

*Table 2: Prices of common foods and their nutritional composition*

| stock | sugar (g) | Protein (g) | fat (g) | Vitamin A (mcg) | vitamin C (mg) | vitamin B12 (mcg) | Calcium (mcg) | Energy (kcal) | Unit price (Yuan / jin) |
|---|---|---|---|---|---|---|---|---|---|
| pork | 3.4 | 20.5 | 5.3 | 14.7 | 1.24 | 0.36 | 8 | 142.3 | 14.65 |
| chicken | 0.3 | 22.3 | 2.3 | 43. 1 | — | 2.37 | 17 | 111. 1 | 12.69 |
| duck | 0.34 | 17 | 12 | 51 | — | 0.74 | 6 | 177.4 | 6.57 |
| milk | 4.1 | 3.2 | 3.4 | 18 | 1.37 | 0.41 | 110 | 59.8 | 1.3 |
| egg | 0.5 | 14.8 | 11.6 | 1440 | — | 0.47 | 55 | 693.9 | 5.71 |
| crucian | 0.1 | 13 | 1.1 | 33.3 | 1.08 | 5.36 | 54 | 62.3 | 14.47 |
| carp | 0.3 | 17.7 | 10.3 | 23.4 | — | 11.2 | 117 | 164.7 | 10.33 |
| shrimp | 0.1 | 16.4 | 1.3 | 19 | — | 2.2 | 66 | 77.8 | 22.88 |
| crab | 5.9 | 14 | 1.6 | 147 | — | 5.3 | 141 | 94 | 37.81 |
| sea-tent | 12. 1 | 8 | 0.1 | 38.5 | — | — | 445 | 81.3 | 7.81 |
| squash | 10.3 | 0.6 | 0.1 | 132 | 5 | — | 13 | 44.5 | 1.3 |
| eggplant | 3 | 2.3 | 0.2 | 58 | 7.2 | — | 20 | 23 | 5.54 |
| white gourd | 1.98 | 0.45 | — | 11.5 | 19.8 | 0.08 | 20 | 18.3 | 5.2 |
| cucumber | 3.1 | 0.9 | 0.2 | 22 | 15 | — | 15 | 13.8 | 4.93 |
| tomato | 3.6 | 0.75 | 0.35 | 88.7 | 7.6 | — | 8 | 20.6 | 5.56 |
| cabbage | 2.05 | 1 | 0.08 | 70 | 7.4 | — | 22 | 13 | 2.07 |
| spinach | 2.8 | 2.1 | 0.2 | 22 | 39 | — | 22 | 21 | 3.27 |
| celery | 1.4 | 1.6 | — | 7.2 | 29 | — | 91 | 12 | 4.02 |
| turnip radish | 4.6 | 0.8 | — | — | 27 | — | 55 | 21.6 | 1.76 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| chives | 4.1 | 2.4 | 0.5 | 1223 | 39 | — | 56 | 30.5 | 5.49 |
| potato | 16.4 | 3.3 | 0.1 | 4.3 | 12 | — | 10 | 79.7 | 2. 13 |
| rice | 76.3 | 7.3 | 0.3 | — | 7.3 | 19. 1 | 7 | 337 | 7.98 |
| corn | 72.2 | 8.5 | 4.3 | 54 | 9.2 | 16.7 | 22 | 361.5 | 3.47 |
| sweet potato | 29.5 | 1.8 | 0.2 | 27 | 33 | — | 18 | 127 | 1.37 |
| soybean | 25.3 | 43.2 | 17.5 | 33.2 | — | — | 367 | 429.5 | 3.51 |
| apple | 14.8 | 0.4 | 0.5 | 99.2 | 6 | — | 12.7 | 65.3 | 5.74 |
| pear | 14.2 | 0.1 | 0.1 | 97.2 | 5.6 | — | 5 | 58 | 4.35 |

Note: According to the Standard Edition

*Table 3: Content and price List of various elements of common meat*

| meat | sugar (g) | Protein (g) | Fat (g) | vitamin A (mcg) | vitamin C (mg) | vitamin B12 (mcg) | Calcium (mcg) | energy (kcal) | unit-price (Yuan / jin) |
|---|---|---|---|---|---|---|---|---|---|
| pork | 3.4 | 20.5 | 5.3 | 14.7 | 1.24 | 0.36 | 8 | 142.3 | 14.65 |
| chicken | 0.3 | 22.3 | 2.3 | 43. 1 | — | 2.37 | 17 | 111. 1 | 12.69 |
| duck | 0.3 4 | 17 | 12 | 51 | — | 0.74 | 6 | 177.4 | 6.57 |
| crucian | 0.1 | 13 | 1.1 | 33.3 | 1.08 | 5.36 | 54 | 62.3 | 14.47 |
| carp | 0.3 | 17.7 | 10.3 | 23.4 | — | 11.2 | 117 | 164.7 | 10.33 |
| shrimp | 0.1 | 16.4 | 1.3 | 19 | — | 2.2 | 66 | 77.8 | 22.88 |
| crab | 5.9 | 14 | 1.6 | 147 | — | 5.3 | 141 | 94 | 37.81 |

*Table 4: Content and price list of various elements of common vegetables*

| vegetables | sugar (g) | Protein (g) | | fat (g) | vitamin A (mcg) | vitamin C (mg) | vitamin B12 (mcg) | Calcium (mcg) | Energy (kcal) | Unit price (Yuan/ jin) |
|---|---|---|---|---|---|---|---|---|---|---|
| sea-tent | 12. 1 | 8 | | 0.1 | 38.5 | — | — | 445 | 81.3 | 7.81 |
| pumpkin | 10.3 | 0.6 | | 0.1 | 132 | 5 | — | 13 | 44.5 | 1.3 |
| eggplant | 3 | 2.3 | | 0.2 | 58 | 7.2 | — | 20 | 23 | 5.54 |
| wax gourd | 1.98 | 0.45 | | — | 11.5 | 19.8 | 0.08 | 20 | 18.3 | 5.2 |
| cuke | 3.1 | 0.9 | | 0.2 | 22 | 15 | — | 15 | 13.8 | 4.93 |
| tomato | 3.6 | 0.75 | | 0.35 | 88.7 | 7.6 | — | 8 | 20.6 | 5.56 |
| cabbage | 2.05 | 1 | | 0.08 | 70 | 7.4 | — | 22 | 13 | 2.07 |
| spinach | 2.8 | 2.1 | | 0.2 | 22 | 39 | — | 22 | 21 | 3.27 |
| celery | 1.4 | 1.6 | | — | 7.2 | 29 | — | 91 | 12 | 4.02 |
| turnip radish | 4.6 | 0.8 | | — | — | 27 | — | 55 | 21.6 | 1.76 |
| leek | 4.1 | 2.4 | | 0.5 | 1223 | 39 | — | 56 | 30.5 | 5.49 |
| potato | 16.4 | 3.3 | | 0.1 | 4.3 | 12 | — | 10 | 79.7 | 2. 13 |

*Table 5: Content and price list of various elements of common staple food*

| sorghum | sugar (g) | Protein (g) | Fat (g) | vitamin A (mcg) | vitamin C (mg) | vitamin B12 (mcg) | Calcium (mcg) | Energy (kcal) | Unit price (Yuan/ jin) |
|---|---|---|---|---|---|---|---|---|---|
| rice | 76.3 | 7.3 | 0.3 | — | 7.3 | 19. 1 | 7 | 337 | 7.98 |
| corn | 72.2 | 8.5 | 4.3 | 54 | 9.2 | 16.7 | 22 | 361.5 | 3.47 |
| sweet potato | 29.5 | 1.8 | 0.2 | 27 | 33 | — | 18 | 127 | 1.37 |
| soybean | 25.3 | 43.2 | 17.5 | 33.2 | — | — | 367 | 429.5 | 3.51 |

*Table 6: Content and price list of various elements of common fruits*

| fruit | sugar (g) | Protein (g) | fat (g) | vitamin A (mcg) | vitamin C (mg) | vitamin B12 (mcg) | Calcium (mcg) | Energy (kcal) | Unit price (Yuan/ jin) |
|---|---|---|---|---|---|---|---|---|---|
| apple | 14.8 | 0.4 | 0.5 | 99.2 | 6 | — | 12.7 | 65.3 | 5.74 |
| pear | 14.2 | 0.1 | 0.1 | 97.2 | 5.6 | — | 5 | 58 | 4.35 |
| Banana | 23 | 1.3 | 0.2 | 58.2 | 11 | — | 8 | 99 | 4.46 |
| orange | 12. 1 | 1 | 0.3 | 63.3 | 42 | — | 60 | 55. 1 | 4. 12 |
| lemon | 4.9 | 1.1 | 1.2 | 3.6 | 22 | — | 112 | 34.8 | 4.5 |
| peach | 11. 1 | 0.8 | 0.1 | 2.39 | 6 | — | 8 | 48.5 | 14 |

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*Table 7: Average content and unit price of various classes*

| raw material | Sugar (g) | protein (g) | fat (g) | vitamin A (mcg) | vitamin C (mg) | Vitamin B12 (mcg) | calcium (mcg) | energy (kilocalorie) | unit-price (Yuan/ jin) |
|---|---|---|---|---|---|---|---|---|---|
| vegetables | 5.453 | 2.017 | 0.203 | 152.473 | 18.909 | 0.08 | 64.75 | 31.608 | 4.09 |
| millet | 50 825 | 15 2 | 5 575 | 38 067 | 16 5 | 17 9 | 103 5 | 313 75 | 4 0875 |
| fruit | 13.35 | 0.783 | 0.4 | 53.982 | 15.433 | 0 | 34.283 | 60.117 | 6.195 |
| other | 2.3 | 9 | 7.5 | 729 | 1.37 | 0.44 | 82.5 | 376.85 | 3.505 |
| meat | 1.491 | 17.271 | 4.823 | 47.357 | 1.16 | 3.933 | 58.429 | 118.514 | 17.057 |

According to the above table, if the food nutrients are brought into the planning model, and the model that meets the optimal food matching for college students is calculated as follows:

$$\min Z_1 = \begin{cases} \sum_{i=1}^{5} x_{d_{i1}} p_i x_{i1} \\ \sum_{i=1}^{5} \left| x_{i1} - n_{i1} \right| \end{cases} \tag{5}$$

$$\begin{cases} \sum_{i=1}^{5} x_{i1} h_{i1} \geq d_{11} \\ \sum_{i=1}^{5} x_{i1} h_{i2} \geq d_{12} \\ \sum_{i=1}^{5} x_{i1} h_{i3} \geq d_{13} \\ \sum_{i=1}^{5} x_{i1} h_{i4} \geq d_{14} \\ \sum_{i=1}^{5} x_{i1} h_{i5} \geq d_{15} \\ x_{i4} \geq 0, i = 1,2,\cdots 5 \end{cases} \tag{6}$$

The optimization results are shown as follows Table 8;

*Table 8: Optimization Results Table*

| sex | Vegetables (100 g) | Coarse grain (100 grams) | Fruit (100 grams) | Other (100 g) | Meat (100 grams) |
|---|---|---|---|---|---|
| man | 95.4999 | 11.7692 | 0 | 0 | 0 |
| woman | 85.3841 | 11.2407 | 0 | 0 | 0 |

## 5. Sensitivity analysis

Each change in the parameter set in the model affected the food content and the total cost of food in the final dietary model. Therefore, sensitivity analysis is used to verify the impact of changes in a parameter in the model structure, that is, the reasonable range of changes in a parameter in the dietary structure, as well as the impact on the overall goal[5].

**Sensitivity analysis results**

1) Numerical treatment

Considering the impact of rounding, the following provisions are made for the convenience of calculation: Where the sensitivity analysis is in the middle The absolute value of the value is less than or equal to 0.00001, and the element value is set to 0.0. $1.0\times10^{35}$ was used instead of the $+\infty$, $-\left(1.0\times10^{35}\right)$ replace $-\infty$.

2) parameter analysis

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While maintaining the optimal solution, satisfy the $x_{ij}$ value range of the following inequality:

$$\sum_{j=1}^{6} x_{d_{ij}} x_{ij} \left(1 - n_{ij}\right) c_{ij} h_{ij} \leq d_{jy} \tag{7}$$

## 6. Results analysis and countermeasures

Results analysis: The results of the model show the importance of whole grains and vegetables in the human body to some extent. In this study, several assumptions were made in order to facilitate the calculation, including no loss of nutrients in the process of food cooking, and that all the nutrients consumed by the human body are absorbed. There is some deviation in the process of model solution, but through the continuous fitting and approximation of the model, the model that best conforms to the characteristics of the diet is obtained. In fact, it is not that more expensive food has higher nutritional value that we end up with a scientific diet with the least economy and the best nutritional value. This model is highly theoretical, but the scope of adaptation is limited. This model considers the uncertainty of population demand, improves the accuracy of the model, and can better make scientific dietary recommendations. After the establishment of the model, through the verification of common recipes in daily life and combined with the market price, the deviation compared with the recommended amount of diet obtained by the model calculation is very small, indicating that the model established in this study is universal.

For the mathematical model of scientific diet plan for college students, more factors should be considered, and the specific market research data, such as the needs of different professionals, such as physical education, mathematics, Chinese language, and different degrees, the daily nutritional content is different; each person leads to different absorption of food nutrition; the dishes and vegetable prices are different. Change or remove a food at will, it is not difficult to find that this will have a big change in people's daily activities.

As college students, we should learn to eat diverse staple food, more vegetables, fruits and potatoes, often eat milk, beans and soy products, often eat fish, poultry, eggs, lean meat, eat less fat and meat and meat oil, energy intake and physical activities to balance, maintain a suitable weight, eat light and less salt food, drinking should be limited.

(1)The staple food is diverse, and cereal food is the main body of traditional Chinese diet. In thickness, do not always choose grinding too fine rice and wheat, because most vitamins, minerals and dietary fiber are found on the surface of cereals.

(2)Energy intake and body exercise to balance, keep the appropriate weight, intake and physical activity is the two factors to control weight, food provides the body metabolism and physical activity of energy consumption, if eat too much and insufficient activity, excess energy will accumulate in the body in the form of the fat, gain weight, long gain, if insufficient, labor or exercise is too large, due to lack of energy, thin, should keep the balance between food and energy consumption.

(3)Eating light food is good to health, do not be too greasy, not too salty, do not eat too much meat and fried, smoked food. Sodium intake is positively related to the incidence of hypertension, so the daily amount of salt should not exceed 6 grams. In addition to salt, the source of life also includes soy sauce, pickles, MONOsodium glutamate and other high sodium food and industrial food, to develop the habit of less salt food.

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