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DESIGNING OPTIMAL VITAMINS INTAKE TO MAINTAIN A HEALTHY DIET USING WEIGHTED GOAL PROGRAMMING

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1. Introduction

Eating a healthy diet contributes to preventing future illness and improving quality and length of life. The right and sufficient vitamin through the diet is needed in order to maintain a healthy lifestyle. There is a condition called hypervitaminosis which is an acute emerging pathological condition of the body due to excess accumulation of any of the vitamins (Roop, 2018). The aim of this study is to prevent hypervitaminosis among people and minimize the total cost of vegetables since the cost of spending the vitamin is also one of the factors that influences the intake of vegetables. Based on the price of the results of some interviews, the number of fruit and vegetable intake has increased among the subjects if the price of fruits and vegetables is low (Sameeha, Shahimi & Abdul Karim, 2018). This study has introduced one of the ways on how to identify the optimal vitamin intakes using weighted goal programming.

We are using 11 types of vegetables that are recommended by My Food Data for a healthy diet. The 11 recommended vegetables are spinach, cauliflower, carrot, mushroom, cabbage, lettuce, cucumber, sweet potato, potato, broccoli and tomato (My Food Data 2022). The complete data of this study were obtained from a few other websites which are FDA and SELF Nutrition Data that contain the exact amount of vitamins in the exact weight of each vegetable.

2. Methodology

There are 3 steps involved in this stage. The first one is determining vitamins in each vegetable. The vegetables that have been chosen were based on the article from the Food Network website. It is suggested for people who are on a diet and prefer low-calorie foods. Besides, the quantity of vegetables was determined according to the healthy diet chart on the

FDA website. Other than that, the SELF Nutrition Data also has been used to identify vitamins contained in each vegetable based on the quantity (gram) set up.

The second step was developing optimal vitamin intake by using Weighted Goal Programming. There are 11 equations representing the 11 types of vitamins for minimization intake and the other six equations represent the six types of vitamins in maximization intake.

Finally, the last step was finding the total cost of vegetables whether it exceeds the maximum cost for daily expenses spent for vegetables. Based on other research, the maximum cost recommended by the government per day that needs to be spent is RM15. The equation for this step is proposed as the cost of vegetables will affect the amount of vitamin intake as they are based on income of individuals.

Equation (1) shows the equation for minimum vitamin requirement while equation (2) is maximum vitamin requirement and equation (3) is the total cost of vegetables.

$$\mathrm{P1}(s_1^+) + \mathrm{P2}(s_2^+) + \mathrm{P3}(s_3^+) + \mathrm{P4}(s_4^+) + \mathrm{P5}(s_5^+) + \mathrm{P6}(s_6^+) + \mathrm{P7}(s_7^+) + \mathrm{P8}(s_8^+) + \mathrm{P9}(s_9^+) + \mathrm{P10}(s_{10}^+) + \mathrm{P11}(s_{11}^+) \tag{1}$$

$$\mathrm{Q1}(d_1^-) + \mathrm{Q2}(d_2^-) + \mathrm{Q3}(d_3^-) + \mathrm{Q4}(d_4^-) + \mathrm{Q5}(d_5^-) + \mathrm{Q6}(d_6^-) \tag{2}$$

$$0.72y_1 + 0.49y_2 + 0.35y_3 + 1.15y_4 + 0.39y_5 + 0.64y_6 + 0.12y_7 + 0.47y_8 + 0.32y_9 + 1.33y_{10} + 0.63y_{11} + s_c + d_c \leq 15 \tag{3}$$

3. Results

The study shows that there are potential improvements identified among the goals for minimum and maximum vitamin intake. Other than that, the result of minimum vitamin requirement already gives the best combination of vegetables for the human body.

a. Potential increment and decrement can be detected based on the positive and negative values of deviation variables. For example, in minimizing vitamin requirement, the value of s+ and s- stands for potential improvement values that can be increased or decreased to have a better result of minimum vitamin intake. Meanwhile, for maximizing vitamin requirement, the value of d+ and d- represents the potential improvement values that can be increased or decreased in getting greater results of maximum vitamin.

b. The potential increment for minimization vitamin intake can be determined through positive deviation variables, s+. Table 1 shows the result of potential improvement for minimum vitamin requirement. It can be seen that the value of minimization goals priority for P1, P2, P3, P4, P8, P9, P11 are not fully achieved and can be improved since it does not show 0 as the value while for goals priority of P5, P6, P7 and P10 are fully achieved.

Table 1: Result of Deviational Variables / Potential Improvement

Goals Priority	s^+_i	s^-_i
P1	0.00742315	0
P2	0.00203887	0
P3	0.00398011	0
P4	0.00276657	0
P5	0	0
P6	0	0.00330282
P7	0	0.00001722
P8	0.00478959	0
P9	0.56455369	0
P10	0	0
P11	0.00871643	0

c. For the maximization problem, potential increment can be determined through negative deviation variables, d-. Table 2 shows the potential improvement for maximum vitamin requirement. The maximization goals priority of Q1, Q2, Q3, Q4, Q5, Q6 are fully achieved since the value shows 0 for d- and is already sufficient to maximize the amount of vitamin for each vegetable. It means the total goal achievement will remain based on the optimal solution of the goal programming model.

Table 2: Result of Deviational Variables / Potential Improvement

Goals Priority	$\mathbf{d^+_i}$	$\mathbf{d^-_i}$
Q1	0.003	0
Q2	0.03	0
Q3	0.1	0
Q4	0.001	0
Q1	0.2	0
Q2	0.11	0

d. Table 3 shows the results for weight of vegetables that is required in grams. The total cost after we multiplied the value of the best combination of vegetables that has been displayed with their cost is RM15. Since the cost that we get is from the minimum vitamin requirement, thus it has achieved the daily budget suggested by the government per day.

Table 3: Combination of Vegetables and Weight in Gram

Vegetables	Weight (gm)
Y1	8.8235294
Y2	7.9365079
Y3	0
Y4	0
Y5	12.200436
Y6	0
Y7	0
Y8	0
Y9	0
Y10	0
Y11	0

4. Conclusion

There are 11 types of vitamins that have been used in order to examine the 11 common goals of requirement for minimization and six common goals of vitamin requirements for maximization. The first objective is identifying optimal vitamin intake using the WGP model in preventing overdose. The maximum vitamin consumed can avoid people from hypervitaminosis. Meanwhile the second objective which is achieving the combination of vegetables needed in order to find vitamin requirements and the third objective which is minimizing the total cost of vegetables by WGP are related to each other where the combination of vegetables determines the cost of spending whether it exceeds the daily government budgetary price. In relation to this, people can budget the daily cost spent for the vitamins needed daily. Thus, WGP has proven to work in finding the optimal solutions of vitamins requirements for humans.

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