MINIMISING FAT IN DAILY FOOD INTAKE USING LINEAR PROGRAMMING

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ABSTRACT

This study aimed to minimise fat intake in the daily food intake of women aged 18 to 25 in Malaysia while still meeting their nutrient requirements. Using linear programming, the study focused on four food groups and 88 food items to determine the optimal daily fat intake for women. The study identified "good" unsaturated fats as important for preventing serious health consequences and categorised fats into four primary types: saturated, trans, monounsaturated, and polyunsaturated. However, some food items in the food composition database did not list nutrient values for specific types of fat, making it challenging to distinguish fat types in consumed food. The study utilised binary linear programming and Excel Solver to obtain optimal solution results on three constraints involved in the study. The solution approach involved selecting the best food item based on the food group that satisfies eight nutrient requirements intake. The selected foods included Naan bread for carbohydrates, chestnut, raw, chicken satay, cockles boiled and chicken fillet sandwich for protein. For fruits or veggies, cooked green peas with salt were chosen, and for a complete meal, nasi dagang, spaghetti with cheese and meat sauce, and fried kuetiau were selected. The study successfully identified an optimal solution that resulted in a daily fat intake of 27.46 g while still meeting nutrient requirements. The study's findings suggest that individuals can reduce their fat intake while still maintaining a balanced diet by selecting the right foods from different food groups. The study's results could be useful for healthcare professionals and individuals seeking to reduce their fat intake for health reasons.

Keywords: *Binary Linear Programming, Diet Problem, Mathematical model, Minimising*

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1. Introduction

Dietary approaches are an important factor in health, especially in overcoming the uptake of excess fat in food. Previously, fat often had a negative connotation in nutrition. However, not all fats are bad for health. There are four primary dietary fats in the food that are different in physical properties and chemical structures: saturated fats, trans fats, monounsaturated fats and polyunsaturated fats. Research has shown that total fat does not cause harm to someone's health, but it is due to a high intake of saturated and trans-fatty acids (TFAs).

In contrast, monounsaturated fats and polyunsaturated fats are considered safe to consume. This show that the total fat content is not the significant factor here rather, the type of fat eaten is the most important in dietary fat (Astrup et al., 2002). Dietary fats are obtained from plants and animals. The types of dietary fats are saturated and unsaturated fatty acids. In animal fats, there is a high content of saturated fatty acids. While at room temperature, the fats are in a solid state and have a high melting point. Compared to plant fats (i.e., vegetable oils), it has a high content of unsaturated fatty acids and is in a liquid state at room temperature. TFAs are a form of unsaturated fat that comes in natural and artificial forms. It contains trans double bonds in the trans configuration instead of cis bonds. The transformation of a molecule into a different isomer is known as isomerisation, caused by Partially Hydrogenated Oils (PHOs) of polyunsaturated oils resulting in converting liquid state fats into semi-solid fats at room temperature. Artificial trans fats are often used to keep food fresh for a more extended period (Institute of Medicine (U.S.). Panel on Macronutrients. & Institute of Medicine (U.S.). Standing Committee on the Scientific Evaluation of Dietary Reference Intakes., 2005; Mozaffarian et al., 2006). These artificial TFAs should be avoided to prevent serious health consequences as the sources are usually found in pre-packaged foods, fried foods, fast food restaurants, margarine, and bakery products.

The Malaysian Cohort and Morbidity Survey (NHMS) (2019) survey indicated that 38.1 to 47.7 percent of Malaysian adults have a vital cardiovascular disease risk factor. It is also stated that 19.7 percent of obese Malaysian and 30.4 percent of overweight Malaysian have become a great concern regarding health issues in Malaysia (NCCFN, 2021). Psychological and medical conditions are also risk factors leading to obesity due to emotional instability and medical conditions, such as depression and hypothyroidism, cause them to eat more than usual (Taher S, 2020). One of the risk factors included in non-communicable diseases (NCDs) is obesity caused by external factors such as lifestyle and nutrient intake. Obesity is correlated with cardiovascular disease, diabetes and certain types of cancer (Chu & Singh, 2021). Many cause factors of obesity, such as genetic variation, eating patterns and socioeconomic status, lead to choosing unhealthy food (Cahyaningrum et al., 2016).

Diet problem is one of the commonly studied optimisations used to select a complete set of foods that satisfied a daily requirement based on the recommended nutrient intake. The typical constraints modulate the number of vitamins, minerals, fats, sodium, cholesterol, and calories (Van Dooren, 2018). Dietary fats are a subset of lipids and are the diet's primary energy source. The fats came naturally from plants (i.e., seeds, fruits and nuts) and animals (i.e., meat, fish, eggs and milk). It can also be found as artificial that has been used in producing foods mainly to improve taste and texture. There are four dietary fat types: saturated, monounsaturated, polyunsaturated and trans, which behave differently inside the body (David C. Dugdale, 2020). George Stigler formulated the Diet problem in the 1940s with the goal of minimising the diet cost for an adult by the available list of 77 foods and solved by using the simplex method, which is one of the approaches in solving linear programming models. With the absence of computing facilities, he managed to solve the optimisation problem and met the recommended dietary allowances (RDAs) of the National Research Council in 1943. With further development of the model, it is used in solving the issues of food balancing and is helpful in designing a healthy food plan, especially for chronic diseases (Mohan, 2011). George Dantzig introduced a linear program in the early 1950s, which helped develop diet solutions because using a computer to solve diet solutions is good in high calculation capacity (Van Dooren, 2018). With a long history of diet problems, mostly the diet solutions are obtained in the year 2000 or later with the evolvement of a computer program that can help to calculate the larger capacity of diet problems.

Much literature has shown that Linear Programming can be applied in many areas of diet problems, such as food aid programs, individual dietary solutions, chronic diseases, students' dietary habits and many others (Okubo et al., 2015; Van Dooren, 2018). Linear programming is a mathematical technique that involves finding optimal solutions. It deals with a linear objective function that can be expressed using the decision variable's linear equality and inequality constraints. A linear function is in the form of $a_0 + a_1x_1 + a_2x_2 + a_3x_3 + ... + a_nx_n = 0$ where a are the coefficients and x are the variables of the equation. It often written using summation form as $a_0 + \sum_{i=1}^{n} a_i x_i = 0$. The objective function of linear programming is in the form of minimise or maximise $Z = \sum_{i=1}^{n} c_i X_i$ where c_i is the objective function coefficients and X_i represented i^{th} decision variable. The constraints are denoted in the general form, which subject to $\sum_{i=1}^{n} a_{j,i} X_i \le b_j \;\; j = 1, 2, ..., m$ and the non-negativity constraints denoted as $X_i = 1, 2, ..., n$ (Britannica, 2017). Early study has suggested the use of linear programming in calculating the changes to food, which the constraints used to decide the variety of possible solutions. It studies an individual depending on any nutritional requirement, such as an individual with chronic disease. Usually, foods that require significant changes in food quantities will be swapped by introducing new foods, resulting in better nutrient targets (Soden & Fletcher, 1992).

Linear programming helps produce a balanced diet and interpret daily food recommendations into a nutritional model. This method can be adopted to imply a significant potential in finding solutions for various complex diet problems. There are numerous research papers that use linear programming for diet problems and the selected literature applied the method of linear programming to solve a variety of diet problems (Cahyaningrum et al., 2016; Darmon et al., 2006; Gao et al., 2006; Gusnedi et al., 2022; Hallinan et al., 2021; Hassanzadeh Amin et al., 2020; Jalil et al., 2017; Kim et al., 2019; Kiresur & Chourad, 2015; Namoco et al., 2021; Yu et al., 2018).

In the literature, most aim to obtain the optimum diet that follow the nutritional requirement following the current nutritional recommendations of the respective country using linear programming. While Gusnedi et al. (2022) and Hassanzadeh Amin et al. (2020) used linear mixed model and multiple objective linear programming, respectively. The constraints in the literature are varied to the daily nutrient requirement of the selected group of subjects based on age group, total energy consumption, food price, the minimum and maximum food items that were usually consumed, the minimum and maximum required nutrients in the foods and diets and the recommended amount of food guide servings. Hassanzadeh Amin et al. (2020), Cahyaningrum et al. (2016), Namoco et al. (2021) and Jalil et al. (2017) conducted a study on finding the selected food items for a diet problem. This paper has set cost as one of the constraints. They formulated a linear programming model with the preferred food of the target's usual intake and devised an outcome to minimise the total cost. Kim et al. (2019) and Cahyaningrum et al. (2016) considered the recommendation of diet according to the person's preference, such as the price, cultural factors, taste and others.

Jalil et al. (2017) have found a solution approach to linear programming for solving diet problems. This study aims to minimise total daily fat intake for a healthy diet menu plan at Mara Junior Senior College (MJSC). In this study, the researchers focused on 11 nutrients including carbohydrates, energy, fat, vitamin A, vitamin B1, vitamin B2, vitamin B3, vitamin C, iron, and calcium. It focused on the nutrients needed by students aged 13 to 17 years old for upper and lower bounds that meet guidelines on recommended nutrient intake. Through all the students' preferred menu items, Excel Solver was used to satisfy all recommended nutrient intake within the provided budget for 5 meals per day. Thus, the selected menu items were provided for students and fulfilled the budget for a healthy diet menu plan for MJSC boarding school. Most related papers regarding diet problems use linear programming as the solution approach and are able to find the final diet. In recent diet studies, this technique is famous for showing the potential for a more sensible diet on food. Thus, using linear programming as the currently available literature is a better way to solve diet problems by focusing on minimising dietary fat intake.

Diets are significant in our daily life as it resembles our current eating habits. Our health and well-being require sustainable and adequate amounts of nutrients. Risk factors related to diets exacerbate the health prevalence in a particular population. Earlier human populations practised an active lifestyle and had an unpredictable diet due to food shortages.

When technology evolved, humans started to change their lifestyles because of increased food production and sufficiency (Lee & Muda, 2019). Over the past decades, people started to shift diets by using processed and take-away foods. With the low awareness of chronic diseases such as diabetes, hypertension and obesity started to be in control of the world. Many countries are implementing several ways to prevent dietary problems (Popkin et al., 2011). A study from the Malaysian Adult Nutrition Survey (MANS) found that Malaysian adults obtained 20 percent to 30 percent on average of their total energy from fat consumption. 9 kcal of caloric density of 1 gram of fat was obtained, equal to twice the amount of carbohydrates or protein (NCCFN, 2010). High consumption of fats produced a high source of calories which can lead to dangerous health problems (i.e., diabetes and obesity), threatening Malaysians' health. The government of Malaysia has provided updated health and nutrition information online, including the regulatory measures on the recommended nutrient intake. Good outcomes in daily human life can be achieved by consuming nutrient-dense food. Having adequate carbohydrates, protein, and essential vitamins while reducing unhealthy fats help in preventing diet-related health problems. In Malaysia, it is difficult to maintain healthy fat consumption in our daily food intake. We are known for our love of foods, and many Malaysian cuisines contain saturated and unsaturated fats. Malaysia is a global palm oil supplier, and the oil is used widely in the food industry. Thus, it became the primary fat diet of Malaysians. A study conducted shows a significant difference in the average fat intake between adults living in rural and urban areas. Fat is an essential nutrient in diet requirements, but it should be taken in recommended fat intake (NCCFN, 2010).

Most foods contain a mixture of different fats. The excess fat intake worries the most because high-fat food is affordable and easily accessed. Based on the food composition database, not all foods provided with details nutrient amounts in all types of fat. Thus, it has become our motivation to embark on this study to focus on the amount of total fat generally. In the literature review, to the best of our knowledge, a study on fat consumption in Malaysia is lacking, especially research that involves a mathematical model. There is no correlation between maximum fat intakes per food serving recommended for adults. Numerous research papers implement linear programming in optimising diet problems but mostly focus on areas such as chronic diseases (i.e., diabetic patients, coronary heart disease patients and hypertension patients), menu planning and least-cost diet. Following the Stigler diet problem, the goal is to minimise the diet cost for an adult, but as time passes, minimising the cost is no longer the main focus of the study. It is because the price of food increases over time.

Lastly, to create a better way of minimising fat in daily food intake, a linear programming (LP) approach can translate the amount of fat in daily food intake based on the recommended nutrient intakes (RNI). For this study, the first objective is to study the background of fat intake among Malaysian adults. The second objective is to utilise a linear programming model that minimised daily fat intake among women aged between 18 to 25 years old. The last objective is to obtain an optimum solution for daily fat intake in women aged 18 to 25. Based on the selected foods in Malaysia that have been divided into four types of food groups, the study is to minimise the fat in daily food intake for age groups from 18 to 25 years old.

2. Methodology

The mathematical model of the previous study by Jalil et al. (2017) has been utilised for this diet problem according to the requirement nutrient intake of Malaysia. The cost constraint from the previous model is not included as in reality, food costs are vulnerable to fluctuations due to several factors, including changes in supply and demand, weather conditions, and other economic factors. As a result, a fixed cost constraint may become no longer in use or unfeasible in situations where the cost of certain food items experiences substantial increases or decreases. This study used Excel Solver which is a built-in program in Microsoft Excel to obtain the solution. This model used binary linear programming to minimise fat in daily food intake. The upper and lower bound for chosen gender, which is female obtained from the Recommended Nutrient Intakes for Malaysia 2017 (RNI 2017), are listed in the Table 1.

Table 1. List of nutrient requirements based on gender of female (NCCFN, 2017)

Nutrient	**Female**	
	Lower bound	**Upper bound**
Carbohydrate (*g*)	180	230
Protein (*g*)	53	61
Total fat (*g*)	47	61
Vitamin B1 (*mg*)	1.1	1.1
Vitamin B2 (*mg*)	1.1	1.1
Vitamin B3 (*mg*)	14	35
Iron (*mg*)	29	45
Phosphorus (*mg*)	700	4000
Sodium (*mg*)	1500	2300

The following are the parameters, indices and decision variables used in this study.

Parameters

i = Food group ($i \in I$)

j = Food item ($j \in J$)

k = Nutrient type ($k \in K$)

C_{ij} = Fat amount in one serving of food group, i in food item, j .

n_i = The expected number of serving of food item per group.

LB_k = Lower bound for nutrient *k*.

UB_k = Upper bound for nutrient *k*.

Indices

I = Set of food group ($i \in I$)

J = Set of food item ($j \in J$)

K = Set of food nutrient ($k \in K$)

Decision Variables

In this study, binary value are used to obtained optimal solution where X_{ij} represents the binary value for food group, *i* and food item, *j*.

X_{ij} is a binary variable, where $X_{ij} = \begin{cases} 1 & \text{, selected food group, } i \text{ for food item, } j \\ 0 & \text{, otherwise} \end{cases}$

There are eight nutrients which are carbohydrate, protein, fat, vitamin B1 (Thiamine), vitamin B2 (Riboflavin), vitamin B3 (Niacin), iron, potassium and sodium considered for this study. Each nutrient follows the recommended nutrient intake (RNI 2017) by the Malaysian Government for carbohydrates, protein, fruits or veggies, and complete meal.

The utilised model for minimising total daily fay intake is as follows:

Minimise Z = $\sum_{i=1}^{I}\sum_{j=1}^{J} C_{ij}X_{ij} = C_{11}X_{11} + C_{12}X_{12} + ... + C_{ij}X_{ij}$ (1)

Subject to the following constraints:

$$LB_k \leq \sum_{j=1}^{J}\sum_{i=1}^{I} C_{ij}X_{ij} \leq UB_k \qquad \forall\, k \in K \tag{2}$$

$$\sum_{j=1}^{J} X_{ij} = n_i \qquad \forall\, i \in \mathrm{I} \tag{3}$$

This model is a binary linear programming to minimise total daily fat intake. This objective function is represented by Z, the summation of all linear functions involving the amount of food in *j*, food item and *i*, food group. Constraint (2) states the lower and upper for each nutrient intake based on RNI 2017. Meanwhile, constraint (3) shows the requirements of food items on each food group.

3. Implementation

There are 88 food items and eight nutrient types used and listed in Appendix B. The objective function of this study is to minimise the total daily fat intake subject to nutrient requirement obtained from RNI 2017. Decision variables are used in computing the formulas in the objective and constraint cells. To satisfy the limits on constraint cells, the Solver adjusted the values in the decision variables cells. Then, Excel Solver placed the values in the decision variables when the solution is obtained. Thus, the decision variables are given algebraic designations of X_{ij} where $i = 1, 2, ..., I$ for the food group and $j = 1, 2, ..., J$ for the food item.

X_{ij} = Decision variables in food group, *i* for food item, *j*.

X_{ij} is a binary variable, where $X_{ij} = \begin{cases} 1 & \text{, selected food group, } i \text{ for food item, } j \\ 0 & \text{, otherwise} \end{cases}$

$$\text{Min } Z = \sum_{i=1}^{I}\sum_{j=1}^{J} C_{ij}X_{ij} \tag{4}$$

There are three constraints involved in this study which are the nutrient requirements constraint which is obtained from RNI 2017 and separated into upper and lower bound, and the food item group's constraint. First constraint (5) is the nutrient requirements which are shown below:

$$LB_k \leq \sum_{i=1}^{I}\sum_{j=1}^{J} C_{ij}X_{ij} \leq UB_k \quad \forall_k \tag{5}$$

Carbohydrate, $k = 1$:

$$180 \leq \sum_{i=1}^{I}\sum_{j=1}^{J} C_{ij}X_{ij} \leq 230$$

Protein, $k = 2$:

$$53 \leq \sum_{i=1}^{I}\sum_{j=1}^{J} C_{ij}X_{ij} \leq 61$$

Vitamin B1 (Thiamine), $k = 3$:

$$1.1 \leq \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij} X_{ij} \leq 1.1$$

Vitamin B2 (Riboflavin), $k = 4$:

$$1.1 \leq \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij} X_{ij} \leq 1.1$$

Vitamin B3 (Niacin), $k = 5$:

$$14 \leq \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij} X_{ij} \leq 35$$

Iron, $k = 6$:

$$29 \leq \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij} X_{ij} \leq 45$$

Phosphorus, $k = 7$:

$$700 \leq \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij} X_{ij} \leq 4000$$

Sodium, $k = 8$:

$$1500 \leq \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij} X_{ij} \leq 2300$$

Next, constraint (6) is the food item group's constraint based on the four food groups. The equation is as expressed below:

$$\sum_{i=1}^{I} X_{ij} = n_i \qquad (6)$$

where

n_i : number of serving for food item, *j* in food group, *i*.

$n_1 : X_{11} - X_{115}$

$n_2 : X_{21} - X_{237}$

$n_3 : X_{31} - X_{321}$

$n_4 : X_{41} - X_{415}$

Carbohydrate, $i = 1$:

$$\sum_{i=1}^{15} X_{ij} = 1$$

Protein, $i = 2$:

$$\sum_{i=16}^{52} X_{ij} = 1$$

Fruits/Veggies, $i = 3$:

$$\sum_{i=53}^{73} X_{ij} = 1$$

Complete Meal, $i = 4$:

$$\sum_{i=74}^{88} X_{ij} = 1$$

4. Result and Discussion

The binary linear programming in this study provides food items on what a female may eat based on RNI 2017. This result is attained by solving the binary linear programming model using Microsoft Excel Solver as in Table 2.

Table 2. Summarised of all food listed choice for micro and macro nutrient requirements.

Nutrient	Choice of the selected food item									Total Nutrient	Lower bound	Upper bound
	X115	X23	X215	X221	X237	X321	X45	X412	X415			
Carbohydrate (*g*)	88.9	44.8	12.7	1.3	38.5	25	91.5	50.55	36.21	200.7	180	230
Protein (*g*)	19.6	4.4	18.9	2.2	17.1	8.58	8	57.15	9.35	60.71	53	61
Total fat (*g*)	0.271	0.21	0.03	0.02	0.393	0.414	0.45	0.18	0.24	27.46	1.1	1.1
Vitamin B1 (m*mg*)	0.347	0	0.12	0.1	0.209	0.238	0.75	0.18	0.5	1.1	1.1	1.1
Vitamin B2 (mg)	6.88	1.2	6.7	1.6	7.01	3.23	1.3	3.5	1.5	1.1	14	35
Vitamin B3 (*mg*)	3.33	1.6	2.9	7.9	2.49	2.46	3.75	3.08	75	14	29	45
Iron (*mg*)	361	75	335	49	216	187	150	163	852	29	700	4000
Phosphorus (*mg*)	899	5	135	350	799	382	428	1534	230	926.6	1500	2300
Sodium (*mg*)	88.9	44.8	12.7	1.3	38.5	25	91.5	50.55	36.21	2300	180	230

The model has satisfied all nutrient requirements according to RNI 2017 as shown in Table 2. It presents the optimum solution for minimising fat intake in daily life. With a focus on four food groups, it satisfied all nutritional constraints for females aged 18 to 25 years old.

For carbohydrates, it optimized the range of nutrient requirements boundaries with a value of 200.7 g. The total carbohydrate intake to be consumed is between 180 g to 230 g. For protein, 60.71 g is consumed for the four food groups fulfil the criteria of a healthy individual. The value of protein that intake recommended is 53 g to 61 g in a day. Regarding micronutrients, the intake of vitamin B1 (Thiamine) is equal and less than 1.1 *mg* for the four food groups listed. The optimal consumption of vitamin B2 (Riboflavin) is 1.1 *mg* in daily, fulfil the recommended nutrient intake.

While for vitamin B3 (Niacin), the intake of this micronutrient is 14 *mg* per day, slightly lower than the upper bound value of intake, which is 35 *mg*. For intake of iron, 29 *mg* is consumed from the selected listed food items where the recommended iron consumption per day is between 29 *mg* to 45 *mg*. It shows that women can fulfil the nutrient intake requirement in iron based on four food groups. The phosphorus intake in this study was 926.6 *mg*. The value of phosphorus intake recommended satisfy the suggested consumption from RNI 2017 which is between 700 *mg* to 4000 *mg* daily. Lastly, 2300 *mg* of sodium intake is calculated in the study, which optimized the range of nutrient requirements boundaries between 1500 *mg* to 2300 *mg*. Although all the nutrients were satisfied, following the requirements in RNI 2017, the selected item in each food group cannot fulfil the binary solution to get one food item in each food group.

Table 3. Summarised of selected food item

Food Group	**Listed Food Choice**			
Carbohydrate	Naan bread			
Protein	Chestnut, raw	Chicken satay	Cockles boiled	Chicken fillet sandwich
Fruits/ Veggies	Cooked green peas with salt			
Complete Meal	Nasi Dagang	Spaghetti with Cheese and Meat Sauce	Fried Kuetiau	

This result of selected food items as in Table 3 has been well made to satisfy all the required nutrients in daily life for women. Although the selected food has limited resources for protein and a complete meal to get each value of one food item for each food group, it is considered as the solution for this research.

This research focuses on fat intake. Following the nutrient intake suggested by RNI 2017, the recommended intake is between 47 g to 61 g for women between 18 and 25 years old. This research manages to minimise the fat intake of the selection of food items from the four food groups. However, this research found the optimum solution for daily fat intake to be 27.46 g. The intake is much less than the minimum recommended value. A binary linear programming model with a modified equation was utilised to reflect the lower daily fat intake among women in the age group. Referring to the last constraint, the value that reflects on food consumed should be in binary values, and with the expectation that after running on Excel Solver, every group will return one or zero food item. However, based on the food item selection, the Solver failed to return binary values for each group and only managed to return binary values for the food item in the carbohydrate and fruits or veggies groups.

Previous studies by Lee & Muda (2019) have demonstrated the necessity of making dietary modifications for Malaysians to stop the sharp rise in overweight and obesity rates. The findings uncovered a significant number of overweight and obese individuals among the participants. Even though the participants' calorie intake was within the acceptable range, the participants consumed more protein than was advised. In addition, consumption of fruits and vegetables high in fibre fell short of recommended levels, and sugar and fat intake were alarmingly high.

Based on the results obtained by using a linear programming model, it shows the effectiveness of using mathematical models to solve real-life problems, specifically in diet and nutrition. This study provides evidence that mathematical models can provide a structured and systematic approach to decision-making in the field of dietetics, leading to optimised solutions for addressing dietary problems. This demonstrates the potential for incorporating mathematical models into the study of dietetics and nutrition and emphasises the value of interdisciplinary collaboration in solving complex real-life problems. The use of Malaysian cuisine, which is dear to Malaysians in the current study, helped to overcome the diet problem. The optimised dietary solutions satisfy the target group’s nutritional demands by including traditional and culturally appropriate meals. The results of this study demonstrate the importance of using a mathematical model to provide optimised dietary solutions, providing valuable insights for future research in the field of dietetics and nutrition in Malaysia.

Malaysia may need more research on the database of foods and nutrients. Malaysian food composition database needs update to obtain better results. The process of updating a food composition database can be difficult, time-consuming, and resource intensive. It entails gathering and interpreting that information on the nutritional value of a wide range of foods, and then disseminating it in an approachable style. Other information sources that can be used to obtain nutrient intakes on meal choices, for instance, is from the western country such as USDA which regularly update its database to incorporate new findings and modifications of foods.

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