***IJACSSE Journal**- International Journal of Advanced Computer Systems and Software Engineering*
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E-ISSN: 2716-5256 online

NUTRIENT PLANNING FOR HEART PROBLEM (STROKE) PATIENT BY USING OPTIMIZATION TECHNIQUE

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ARTICLE HISTORY
Received: 5 December 2020
Accepted: 23 January 2021
Published Online: 31 January 2021

KEYWORDS
stroke
nutrient planning
optimization technique

ABSTRACT

Optimization technique has been widely used in many areas and one of the areas is applied in nutrient planning. This research focuses on heart problem (stroke) patients in Malaysia to solve the nutrient and menu problem by using optimization technique. The computer software such as LPSolve IDE will be used for menu planning purpose. Besides, this research also focuses on Recommended Nutrient Intakes for Malaysia (RNI 2017) as references. The results of this research will contribute to the benefit of society in particular for patients with heart problem (stroke). This research also will identify which nutrients is suitable and appropriate that meets the nutritional requirement. Thus, people that apply the recommended menu planning from this research will be able to prevent and reduce themselves from stroke risk.

1.0 INTRODUCTION

Stroke disease the second cause contribute to death and the third main reason of disability throughout the entire global. Stroke is a disease or illness that can negatively affect the arteries leading to and within the brain. It tends to occur when arteries which is blood vessel that carries blood through to the brain either blocked by clot, bursts or ruptures shown in Figure 1.1 and Figure 1.2 (AHA, 2019). The occurrence of cardiovascular disease, diabetes, and obesity is high among stroke patients. The main factors for this disease include hypertension (high blood pressure), high cholesterol, poor nutrition and having physical inactivity.

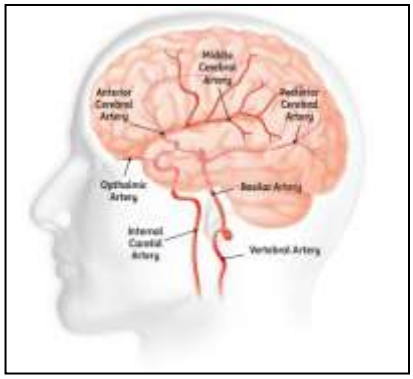

Figure 1.1: Stroke occurs when one of these arteries becomes blocked or ruptures (AHA, 2019)

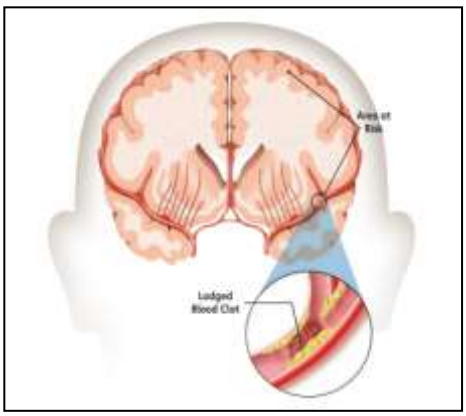

Figure 1.2: Blood clot blocking an artery in the brain (AHA, 2019)

Therefore, do physical activity and having balanced nutrition is important for managing and maintaining health especially people with stroke. Two most common styles which are Mediterranean-style is more preferred when it comes to heart problem while the Dietary Approaches to Stop Hypertension (DASH) diet is the best option for patients with high blood pressure. The dietary patterns lead to an improvement in the risk factor related to stroke (Estruch et al., 2013). Most of the stroke patients do not clear about the nutrients and the amount of food that they need for their bodies. Meal planning is also vital in having a better life for stroke patients. Stroke patients mostly should avoid solid foods at the early stage as they may lose their eating and drinking abilities due to the difficulties of

consciousness, the problem of swallowing, does not have postural stability, limitations in communication and concentrating, fatigue, depression and have limitation memory (Arsava et al., 2018).

The use of mathematical modelling in optimization is not new. The application and implementation of mathematical modelling and mathematical programming to the menu planning has been successful for the past thirty years (Lancaster, 1992). The technique of optimization is designed to determine the minimum or maximum value of an objective function that subject to constraints or limitations that represent user preferences. Optimization research involves the analyzing of mathematical problems and developing the suitable algorithm to solve them. Diet optimization or diet modelling has been introduced by Georges Stigler, who applied diet problem in the mathematical model. To identify and determine the set of foods that met daily nutritional requirements at minimum cost is the aim and purpose of the diet problem (Wirths, 2010). Optimization technique such as linear programming, integer programming, goal programming and fuzzy linear programming aids in planning for dietary and nutrients needs. The methods have been used by past researchers and attract them to model the diet or nutrition planning and design the optimal diet plans. Therefore, the goal of this research is to fill the gap to improve and enhance the performance of previous mathematical programming approach that can be used to solve the menu planning for stroke patients at a lower cost.

2.0 LITERATURE REVIEW

Numerous studies have been discussed about the burden of stroke in global. Each stroke is different. The effects for some people may be relatively minor and may not last long, while others may be left with more serious long-term risks. The overall stroke burden has risen in both men and women of all ages in terms of total numbers of people affected by or who remained disabled even though the stroke occurrence, prevalence, mortality and disability-adjusted life year rates continue to decline from 1990 to 2013 (Feigin, Norrving, & Mensah, 2017). In the study of Martins et al. (2019) there are some priorities to reduce the burden of stroke by strengthen primary prevention, emergency treatment and rehabilitation. There are 3 different types of strokes which are ischemic stroke, intracerebral haemorrhage and subarachnoid haemorrhage. Each of the types differ with respect to survival and long-term disability (Who, 2006).

Stroke is one of the top diseases causes of death and top 10 causes of hospitalization in Malaysia (Gan et al., 2012). The disease can be preventable through healthy lifestyle choices including proper diet that consist of suitable nutrition and physical activity. In Malaysia, nutritional environments, awareness and economic differences can be considered as factors of stroke. High prevalence of high-calorie foods, obesity and lower-calorie foods are the environmental factors related with diet and nutrition in this region (Zhu, 2019). Due to the high fat and calories, fast food also linked to the stroke. Hankey (2012) stated that poor nutrition and over nutrition can raise the risk of stroke. From the study, reliable evidence implies dietary supplementation of antioxidant vitamins, B vitamins, and calcium does not minimize stroke risk. Less reliable evidence indicates that diets that are conservative, consistent with the Mediterranean or DASH diets, low in salt or sodium, high in potassium and meet the energy requirements can prevent stroke. However, Larsson (2017) concluded that a diet or nutrient rich in fruit and vegetables and lowered in sodium and processed (sodium-preserved) meat may reduce the risk of stroke as shown in Figure 2.1. More research on the role of vegetable oils, nuts, chocolate, coffee, tea and micronutrients in the prevention of strokes needed since randomized controlled trials (RCT) is unavailable to confirm those relationships.

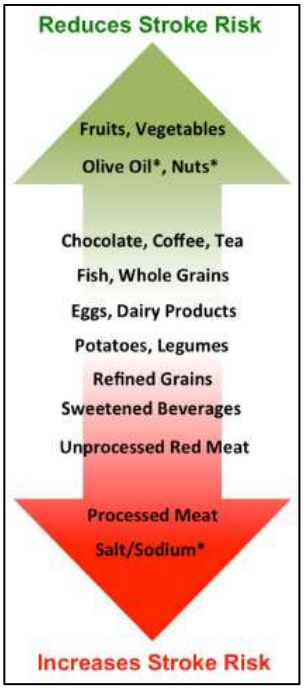

Figure 2.1: Relationship of food affect the risk of stroke (Larsson, 2017)

2.1 Linear Programming

An optimization approach has been studied by Levesque, Delisle, & Agueh (2015) to identify the daily number of food groups and sizes of foods that can be recommended in Benin by using linear programming. The results showed that although local diets only meet 70% of the Recommended Nutrient Intake (RNI) not 100% for limiting micronutrients (Fe, Ca, Folate and Zn) but it was possible to identify the daily quantity of food group and the sizes of food. Besides, the method of linear programming also has been used by

Fahmida et al. (2015) to evaluate the efficiency of promoting complementary feeding recommendation (CFRs) that can enhance the maternal awareness, feeding practices and the intake of main nutrients such as calcium, iron, niacin and zinc for young Indonesian children. The findings showed that by encouraging the use of optimized CFR, there have significant increases in the consumption of nutrients where it can be accomplished. Although there was an improvement in the main nutrient intakes, the increased densities of nutrients were still below the target densities. The study of Iwuji, Nnanna, & Ndulue (2016) discussed to identify the tolerable range of nutrient for Hypertension patient. The study applied linear programming to obtain daily diet plans with lower costs that meet the nutrients of the DASH Diet. From the study, the DASH diet model has been formulated based on mathematical modelling and some sample foods in DASH food chart have been chosen to formulate 2000 calories per day.

2.2 Goal Programming

Some researchers have been applied goal programming technique in diet and nutrient planning. Goal programming has been used by Symposium et al. (2012) to build optimal diet patterns that fulfill the daily nutrient needs of man and woman. The results showed that the goal programming mathematical model is required in the optimal choice of the food intake to reduce the sum of deviations from the World Health Organization (WHO) that suggested daily nutrient requirements according to the budget available. However, there is a limitation in this study where the model is developed for the daily needs of man and woman but does not involve the consumption of food variety as a matter of necessity since it is a basic human need. Dhoruri, Lestari, & Ratnasari (2017) used goal programming model to decide the appropriate and ideal dietary menu patterns for patients with diabetes mellitus by focusing on the optimum cost. Friday's menu with zero deviations was the most optimal compared to Monday and Wednesday. Therefore, variations of the menu that have been recommended were obtained with corresponding calorie intake and optimum cost.

Goal programming is suitable when certain levels or target values selected by decision-maker need to be satisfied with these objectives. Dynamic goal programming is an extension of goal programming that has been approached by Jridi, Jerbi, & Kamoun (2018) for solving the menu planning problem that focuses on patients who suffering from haemodialysis (HD). The research has shown clearly that the proposed solution can be implemented even in more complicated and critical situations. Hernández et al. (2019) developed different models by using multi-objective technique which is goal programming to discover and provide numerous approaches to the Spanish diet. The result indicated that balanced diets are priceless compared to current diets and more convenient for the Spanish people. As some research emphasizes the crucial role of the Mediterranean diet compared to other dietary trends, it will be important if some factors have contributed to the environmental effects that are considered in the model.

2.3 Integer Programming

Generally, integer programming generates an optimum solution in a whole unit (integer value) without decimal point. An optimization method along with Zero-One Integer Programming has been developed by Ali, Sufahani, & Ismail (2016) in diet scheduling which satisfies the nutrient and dietary intake while reducing the finances required especially for the student of secondary school. The study has developed an effective daily menu plan that can be used as a guideline for school management. The researcher Sheng & Sufahani (2018) applied integer programming approach to develop a model of diet planning for patients with eczema from young age group. The findings of the study can explain the nutritional needs of the patients and the use of the method to achieve an optimum diet. Besides, a similar diet optimization approach using integer programming was proposed by Benjamin et al. (2019) to decide the food composition that meets the standard diabetic person's daily needs at a minimal cost. This study contributes basic guidelines focused on menu planning relating to Malaysian food choices. This study has constraints where the prices may differ by location and can affect the difference in values since the prices for each menu are based on different sources.

Ahmad, Syazwanie, & Sani (2019) addressed the uses of integer linear programming (ILP) to build the mathematical model of diet selection problem with the lowest cost for students in Universiti Utara Malaysia (UUM). Still, this study also has many limitations. The model recognizes only a lower nutrient limit that needs to be reached and the consultation with a dietician or nutritionist is also needed to achieve a health plan. A healthy eating habit may benefit the patients that are suffering from myopia. Ping & Sufahani (2019) carried out research to construct a mathematical model to optimize the diet through optimization techniques which are linear programming and integer programming. Mathematical models can be used in meal planning to satisfy all of the myopia patient's nutrient needs at the lowest price by considering the Malaysian Food Nutrient Composition and Recommended Nutrient Intakes (RNI) standard for Malaysia. Besides, the research also determined the intake of daily nutrient for the patients suffering from myopia through nutritionist consultation.

2.4 Fuzzy Linear Programming

Multi-objective known as one of Fuzzy Linear Programming approaches. Multi-objective linear programming applied in different fields such as work scheduling, capital budgeting, blending and cutting stock. The research by Mamat et al. (2012) proposed fuzzy linear programming in optimizing the balanced dietary planning for people with eating disorders

as well as disease-related lifestyle. The method used is to identify the amount of nutrient intake in food in daily life. Eghbali-zarch & Tavakkoli-moghaddam (2017) designed a new multi-objective mathematical programming model which is fuzzy mixed-integer programming to optimize the balanced, diversified and cost-effective diet plan for diabetic patient. The research mainly focused on men and women aged 30 years. Due to the intake of more complex carbohydrates and fibres and regulated sodium levels, the computational findings showed the favourability of the structured diet plan for diabetic patients, whereas the overall amount of sugar, saturated fat and cholesterol is minimized.

2.5 Particle Swarm Optimization

Pop et al. (2013) applied Particle Swarm Optimization (PSO) if the unhealthy behaviour is identified to produce healthier lifestyle recommendation as it will reduce the risk of cardiovascular disease. PSO models the problem of producing a healthy lifestyle as an optimization problem. From the study, the method can be used as the guidelines for a balanced lifestyle in terms of nutrition and physical activity. In the study of Fister, Fister, & Rauter (2017), the connection between eating and sports training are important as they have used the swarm intelligence approach. They proposed Particle Swarm Optimization (PSO) that would help the athletes in their eating plans. Plan training and list of the potential meals are the ideas for the PSO while the target outcome of the research is the list of meals that should be recommended and consumed by the athletes. This research showed that the solution for development an eating plan especially for athletes in training are suitable and more comprehensive yet they still need some improvements in future research.

Porras, Fajardo, & Medina (2019) also used Particle Swarm Optimization (PSO) in their study as the method is more rapid convergence, only several parameters required and the ability to determine the better solutions to the optimization problem. The study not only use PSO but genetic operators were also applied since the combination approach can create effective solutions compared to the original PSO to produce a routine diet plan for adults. The outcome of this study shows that Particle Swarm Optimization (PSO) with Genetic Operators can generate a varied diet plan that met the given constraints and have better alternative than PSO itself. The comparison between Particle Swarm Optimization (PSO) and African Buffalo Optimization (ABO) have been made thru the research of Babalola, Ojokoh, & Odili (2020). Since ABO algorithm produce very competitive result and it is also among the developed metaheuristic, therefore, the ABO algorithm was used in diet optimization. The goals of this research are to explore the development of customized diet and the recommendations in preventing Diet Related Disease (DRD) in addition to fulfill the need of nutrition. The findings of this research conclude that ABO have better approach to solve diet optimization problem compared to PSO as ABO have reached consistency in lesser time.

2.6 Genetic Algorithm

Optimization methods which are genetic algorithm and goal programming have been applied and used by Cakrak & Cimen (2017). In this research, the food supply will be focused on which is important for a well-functioning military as well as optimizing production menu plan for 1 year. Therefore, this research aims to minimize the total cost of the supply chain and identify the diversity of planned meals. The results of this research showed that the minimum cost can be achieved by improving approaches and controlling the supply chain with modern heuristics. However, another application that applied genetic algorithm is the travelling salesman problem (Jafarzadeh, Moradinasab, & Elyasi, 2017). The researcher proposed metaheuristic algorithms which are genetic algorithm with Nearest Neighbour Search (NNS) to find the best solution with least computational time. The best optimal path solution has been obtained within minimum time. Besides, genetic algorithm and simulated annealing in metaheuristic have been used in nutrition decision support system (NDSS) in Figure 2.2 by Ileri & Hacibeyoglu (2019) for the nutritionist to regulate the cycle of hospital's nutrition and also provide the best possible diet menu for patients with decreasing cost. Clearly, from the research, the daily diet menu plan has been analysed and suitable menus for patients have been suggested in a short time and effective cost.

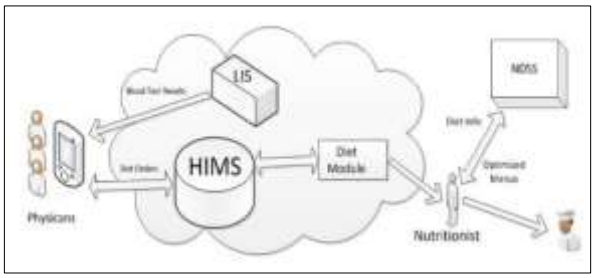

Figure 2.2: Architecture of the nutrition decision support system (NDSS) (Ileri & Hacibeyoglu, 2019)

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3.0 CONCLUSION

In conclusion, optimization techniques such as linear programming, goal programming, integer programming and fuzzy linear programming can be used for menu or nutrient planning with optimum cost based on previous studies. The different method approaches also have been discussed through this research and summarized in Table 1. This research focuses on heart problem (stroke) patients in Malaysia to solve the nutrient and menu problem by using optimization technique which are linear programming and integer programming. The computer

software such as LPSolve IDE will be used for menu planning purpose. Besides, this research also focuses on Recommended Nutrient Intakes for Malaysia (RNI 2017) as references. The most well studied patterns are the DASH and Mediterranean diet. The findings of this research will give some contributions to the benefit of society especially for heart problem (stroke) patients. This research will identify which nutrients is suitable and appropriate that meets the nutritional requirement. Overconsumption of calories and salt are the two main nutritional threats to global health and the risk of strokes. Thus, people that apply the recommended menu planning from this research will be able to prevent and reduce themselves from having eating disorder and the lifestyle associated especially for stroke patients.

References

AHA. (2019). Explaining Stroke. *National Stroke Association*, 43.

Ahmad, N., Syazwanie, N., & Sani, A. (2019). *Optimal diet selection for university students using integer linear programming Optimal diet selection for university students using Integer Linear Programming*. In *AIP Conference Proceedings*, *2138*(1).

Ali, M., Sufahani, S., & Ismail, Z. (2016). A new diet scheduling model for Malaysian school children using zero-one optimization approach. *Global Journal of Pure and Applied Mathematics*, *12*(1), 413–419.

Arsava, E. M., Aydoğdu, İ., Güngör, L., Işıkay, C. T., & Yaka, E. (2018). Nutritional Approach and Treatment in Patients with Stroke, An Expert Opinion for Turkey *24*(3), 226–242.

Babalola, A. E., Ojokoh, B. A., & Odili, J. B. (2020). African Buffalo Optimization Algorithm for Personalized Diet Optimization. *2020 International Conference in Mathematics, Computer Engineering and Computer Science*, (*ICMCECS*), (pp. 1-4).

Benjamin, M., Syafiqa, N., Sapri, M., Ruchhi, M., & Bedi, S. (2019). *A diet recommendation for diabetic patients using integer programming A Diet Recommendation for Diabetic Patients Using Integer Programming*. *In AIP Conference Proceedings, 2138(1).*

Cakrak, M., & Cimen, E. B. (2017). A novel approach for stigler's diet problem in genetic algorithm. *ACM International Conference Proceeding Series*, pp.201–206.

Dhoruri, A., Lestari, D., & Ratnasari, E. (2017). Menu variations for diabetes mellitus patients using Goal Programming model. *AIP Conference Proceedings*, *1867*(1).

Eghbali-zarch, M., & Tavakkoli-moghaddam, R. (2017). *A New Multi-objective Optimization Model for Diet Planning of Diabetes Patients under Uncertainty*. *5*(3), 37-55.

Estruch, R., Ros, E., Salas-Salvadó, J., Covas, M. I., Corella, D., Arós, F., … Martínez-González, M. A. (2013). Primary prevention of cardiovascular disease with a Mediterranean diet. *New England Journal of Medicine*, *368*(14), 1279–1290

Fahmida, U., Kolopaking, R., Santika, O., Sriani, S., Umar, J., Htet, M. K., & Ferguson, E. (2015). Effectiveness in improving knowledge, practices, and intakes of "key problem nutrients" of a complementary feeding intervention developed by using linear programming: Experience in Lombok, Indonesia. *American Journal of Clinical Nutrition*, *101*(3), 455–461.

Feigin, V. L., Norrving, B., & Mensah, G. A. (2017). *Global Burden of Stroke*. 439–449.

Fister, D., Fister, I., & Rauter, S. (2017). Generating eating plans for athletes using the particle swarm optimization. *CINTI 2016 - 17th IEEE International Symposium on Computational Intelligence and Informatics: Proceedings*, 193–198.

Gan, S. H., Loo, K. W., & Gan, S. H. (2012). *Burden of stroke in Malaysia Panorama Burden of stroke in Malaysia*. *International Journal of Stroke*, *7*(2), 165-167.

Hankey, G. J. (2012). Nutrition and the risk of stroke. *The Lancet Neurology*, *11*(1), 66–81.

Hernández, M., Gómez, T., Delgado-Antequera, L., & Caballero, R. (2019). Using multiobjective optimization models to establish healthy diets in Spain following Mediterranean standards. In *Operational Research*., 1-35

Ileri, Y. Y., & Hacibeyoglu, M. (2019). Advancing competitive position in healthcare: a hybrid metaheuristic nutrition decision support system. *International Journal of Machine Learning and Cybernetics*, *10*(6), 1385–1398.

Iwuji, A. C., Nnanna, M., & Ndulue, N. I. C. (2016). An Optimal DASH Diet Model for People with Hypertension Using Linear Programming Approach. *Open Journal of Optimization*, *5*(01), 14–21.

Jafarzadeh, H., Moradinasab, N., & Elyasi, M. (2017). An Enhanced Genetic Algorithm for the Generalized Traveling Salesman Problem. *Engineering Technology and Applied Science Research*, *7*(6), 2260–2265.

Jridi, I., Jerbi, B., & Kamoun, H. (2018). Menu planning with a dynamic goal programming approach. *Multiple Criteria Decision Making*, *13*, 74–87.

Lancaster, L. M. (1992). *Theory and Methodology The history of the application of mathematical programming to menu planning*. *57*(3), 339–347.

Larsson, S. C. (2017). Dietary approaches for stroke prevention. *Stroke*, *48*(10), 2905–2911.

Levesque, S., Delisle, H., & Agueh, V. (2015). Contribution to the development of a food guide in Benin: Linear programming for the optimization of local diets. *Public Health Nutrition*, *18*(4), 622–631.

Mamat, M., Zulkifli, N. F., Deraman, S. K., Maizura, N., & Noor, M. (2012). Fuzzy Linear Programming Approach in Balance Diet Planning for Eating Disorder and Disease-related Lifestyle. In *Applied Mathematical Sciences*, *6*(103), 5109-5118.

Martins, S. C. O., Sacks, C., Hacke, W., Brainin, M., Figueiredo, F. D. A., Pontes-neto, O. M., … Feigin, V. L. (2019). *Policy View Priorities to reduce the burden of stroke in Latin American countries*. *18*(7),674-683.

Ping, K. Y., & Sufahani, S. F. (2019). *Special Healthcare on Nutrient Boundary and Diet for Myopia Patients through Mathematical Modelling*. *1*(1), 1–5.

Pop, C. B., Chifu, V. R., Salomie, I., Cozac, A., & Mesaros, I. (2013). Particle Swarm Optimization-based method for generating healthy lifestyle recommendations. *Proceedings - 2013 IEEE 9th International Conference on Intelligent Computer Communication and Processing, ICCP 2013*, 15–21.

Porras, E. M., Fajardo, A. C., & Medina, R. P. (2019). Solving dietary planning problem using particle swarm optimization with genetic operators. *ACM International Conference Proceeding Series*, pp.55–59.

Sheng, L. Z., & Sufahani, S. (2018). Optimal Diet Planning for Eczema Patient Using Integer Programming. *Journal of*

Physics: Conference Series, *995*(1).

Symposium, I. D., International, D., Harmony, M., Mind, Y., Free, F., Annals, B., & International, D. (2012). *Goal Programming Nutrition Optimization Model*. *23*(1), 243–246.

Who. (2006). STEPS-Stroke mannual The WHO STEPwise approach to stroke surveillance. World Health Organization.

Wirths, A. W. (2010). *Agricultural & Applied Economics Association The Cost of Human Energy in Agriculture*. *39*(1), 155–161.

Zhu, Y. (2019). Community based health promotion program for stroke in Malaysia. *2019 International Conference on Biomedical Sciences and Information Systems*, (Icbsis), 91–95.

Summary of Past Researcher Approach

Year	Researcher	Method	Objectives	Results
2015	Levesque, Delisle, & Agueh	Linear Programming	To identify the daily number of food group and sizes of foods that can be recommended in Benin.	The results showed that although local diets only meet 70% of the Recommended Nutrient Intake (RNI) not 100% for limiting micronutrients (Fe, Ca, Folate and Zn) but it was possible to identify the daily quantity of food group and the sizes of food.
2015	Fahmida *et al.*	Linear Programming	To evaluate the efficiency of promoting complementary feeding recommendation (CFRs) that can enhance the maternal awareness, feeding practices and the intake of main nutrients such as calcium, iron, niacin and zinc for young Indonesian children.	The findings showed that by encouraging the use of optimized CFR, there have significant increases in the consumption of nutrients where it can be accomplished. Although there was an improvement in the main nutrient intakes, the increased densities of nutrients were still below the target densities.
2016	Iwuji, Nnanna, & Ndulue	Linear Programming	To identify the tolerable range of nutrient for Hypertension patient. The study applied linear programming to obtain a daily diet plans with lower cost that meet the nutrients of DASH Diet.	From the study, the DASH diet model has been formulated based on the mathematical modelling and some sample foods in DASH food chart has been chosen to formulate 2000 calories per day.
2012	Symposium *et al.*	Goal Programming	To build optimal diet patterns that fulfil the daily nutrient needs for man and woman.	The goal programming mathematical model is required in the optimal choice of the food intake to reduce sum of deviations from the World Health Organization (WHO). However, there is limitation in this study where the model is developed for daily needs of man and woman but does not involve the consumption of food variety as a matter of necessity since it is a basic human need.
2017	Dhoruri, Lestari, & Ratnasari	Goal Programming	To decide the appropriate and ideal dietary menu patterns for patients with diabetes mellitus by focusing on the optimum cost.	Friday's menu with zero deviations was the most optimal compared to Monday and Wednesday. Therefore, variations of menu that have been recommended were obtained with corresponding calorie intake and optimum cost.

2018	Jridi, Jerbi, & Kamoun	Dynamic Goal Programming	To solve the menu planning problem that focus on patients that suffering from haemodialysis (HD).	The research shown clearly that the proposed solution can be implemented even in more complicated and critical situations.
2019	Hernández *et al.*	Goal Programming	To discover and provide numerous approaches to Spanish diet.	The result indicated that balanced diets are priceless compared to current diets and more convenient for the Spanish people.
2016	Ali, Sufahani, & Ismail	Integer Programming	Zero One Integer Programming have been developed in diet scheduling which satisfies the nutrient and dietary intake while reducing the finances required especially for the student of secondary school.	The study has developed an effective daily menu plan that can be used as a guideline for school management.
2018	Sheng & Sufahani	Integer Programming	To develop a model of diet planning for patients with eczema from young age group.	The findings of the study are able to explain the nutritional needs of the patients and the use of the method to achieve an optimum diet.
2019	Benjamin *et al.*	Integer Programming	To decide the food composition that meets the standard diabetic person's daily needs at minimal cost.	This study contributes basic guideline focused on menu planning relating to Malaysian food choices. This study has constraint where the prices may differ by location and can affect the difference in values.
2019	Ahmad, Syazwanie, & Sani	Integer Linear Programming	To build the mathematical model of diet selection problem with the lowest cost for students in Universiti Utara Malaysia (UUM).	This study also has many limitations. The model recognizes only lower nutrient limit that needs to be reached and the consultation with a dietician or nutritionist is also needed to achieve a health plan
2019	Ping & Sufahani	Integer Linear Programming	To construct a mathematical model to optimize the diet through optimization technique which are linear programming and integer programming.	Mathematical models can be used in meal planning to satisfy all of myopia patient's nutrient needs at lowest price by considering the Malaysian Food Nutrient Composition and Recommended Nutrient Intakes (RNI) standard for Malaysia.
2012	Mamat *et al.*	Fuzzy Linear Programming	To optimize the balanced dietary planning for people with eating disorder as well as disease-related lifestyle.	The method used is to identify the amount of nutrient intake in food in daily life.

2017	Eghbali-zarch & Tavakkoli-moghaddam	Fuzzy mixed Integer Programming	To optimize the balanced, diversified and cost-effective diet plan for diabetic patient.	Due to the intake of more complex carbohydrates and fibres and regulated sodium levels, the computational findings showed the favourability of the structured diet plan for diabetic patients, whereas the overall amount of sugar, saturated fat and cholesterol is minimized.
2013	Pop *et al.*	Particle Swarm Optimization (PSO)	To produce healthier lifestyle recommendation as it will reduce the risk of cardiovascular disease. PSO models the problem of producing healthy lifestyle as an optimization problem.	From the study, the method can be used as the guidelines for a balanced lifestyle in terms of nutrition and physical activity.
2017	Fister, Fister, & Rauter	Particle Swarm Optimization (PSO)	They proposed Particle Swarm Optimization (PSO) that would help the athletes in their eating plans.	This research showed that the solution for development an eating plan especially for athletes in training are suitable and more comprehensive yet they still need some improvements in the future research.
2019	Porras, Fajardo, & Medina	Particle Swarm Optimization (PSO)	The study not only use PSO but genetic operators was also applied since the combination approach can create effective solutions compared to the original PSO to produce a routine diet plan for adults.	The outcome of this study shows that Particle Swarm Optimization (PSO) with Genetic Operators can generate a varied diet plan that met the given constraints and have better alternative than PSO itself.
2020	Babalola, Ojokoh, & Odili	Particle Swarm Optimization (PSO)	To explore the development of customized diet and the recommendations in preventing Diet Related Disease (DRD) in addition to fulfill the need of nutrition.	ABO have better approach to solve diet optimization problem compared to PSO as ABO have reached consistency in lesser period of time.
2017	Cakrak & Cimen	Genetic Algorithm	To minimize the total cost of supply chain and identify diversity of planned meals.	The minimum cost can be achieved by improving approaches and controlling the supply chain with modern heuristics.
2017	Jafarzadeh, Moradinasab, & Elyasi,	Genetic Algorithm	Researcher proposed metaheuristic algorithm which are genetic algorithm with Nearest Neighbour Search (NNS) to find the best solution with least computational time.	The best optimal path solution has been obtained within minimum time.

2019	Ileri & Hacibeyoglu	Genetic Algorithm	To regulate the cycle of hospital's nutrition and also provide the best possible diet menu for patients with decreasing cost.	The daily diet menu plan has been analysed and suitable menus for patients have been suggested in short time and effective cost.