

Optimization Approach On Nutritious Menu Planning For Sinusitis Patient Among Malaysian

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ABSTRACT

There are a lot of techniques available in optimization field that has been used in their study. This research is develop to design the nutritious menu planning for sinusitis patient among Malaysian with the aid of software such as LPSolve IDE and AMPL will be used for menu planning purpose. This paper review the optimization approach in order to develop the menu planning for sinusitis patient which will help sinusitis patient based on their nutrient daily intake with the affordable cost. Hence, people will apply the recommended menu planning from this research will be able to prevent themselves from having Sinusitis. The appropriate portion of meal able to relieve the sinusitis problem among the sinusitis patient.

1.0 INTRODUCTION

Sinusitis or known as sinus infection can be defined as an inflammation of the lining inside the sinuses. Sinusitis can be divided into two types of sinus infection which are acute sinusitis and chronic sinusitis which commonly happen to young children adult (Hespanhol & Aswani, 2018). In United States, there are 31 million people affected with Sinusitis which resulted from 16 million physician visits in 1985 (Silberstein, 2004). The blocking of the sinus passage will occur due to the individual facing nose swollen due to allergies, cold condition, or something in the environment. Sinusitis can be from dust, seafood and others. Sinuses itself also important in the depth and tone of human voice. When the individual is affected with Sinusitis, the sound will change when the individual are all stuffed up. There is another symptom that shows someone have sinusitis is headache. There is a study by Stammberger, H. Wolf and G. (1998) where they found that 48 out of 100 patient complain that they have headache during diagnosis of acute and chronic sinusitis. When someone is facing with sinusitis, it will reduce the quality of their life itself such as did not getting the proper sleeping, and difficult to do any work. One of the effect when the sinusitis did not recover will cause the infection of the brain by the invasion of anaerobic through the bone and vessels which involving the frontal and sphenoid sinuses (Mustafa, Iftikhar, & Choudhury Shimmi, 2015). There is a research where they not able to find the effective cost for the initial treatment and assesment of patients (Desrosiers et al., 2002). Most of the researcher consider the sinusitis to be acute sinusitis within

of symptom last less than 4 weeks. If the inflammatory in the paranasal sinuses does not resolve, it will aid with appropriate medication (Desrosiers et al., 2002). A few symptom such as facial pain, “stuffed up” nose, runny nose, loss of smell and cough of congestion.

However, most of the published paper often said the surgery is one of the main method in order to relieve the sinusitis infection after giving the appropriate medicine. There are a few ways to prevent and relief the sinusitis problem among Malaysian such as doing exercise. Exercise that will affects the immune function which reduce the risk of having any upper respiratory infection. The impact of nutrition also helpful in order to relieve the sinusitis. Some of the food with the nutrient itself will boost the immune function and control the inflammation of that body in the body. However, it will give either good or bad feedback based on the diet pattern itself. A suitable special diet for sinusitis patient will help them to reduce and relieve the sinus problem. There is anti-inflammatory diets which consists of fruits and vegetables, whole grains, cold water fish, flax, nuts. There is also a few anti-inflammatory spices that could be used to reduce the inflammation such ginger rosemary, oregano, cayenne and turmeric that help to prevent and relieve the sinusitis (Mirgain, 2016). The standard American Diet including the nutrient of omega 6 and omega 3 polyunsaturated fatty acids in their diet for particular importance. However, the anti-inflammatory diet has their own limitation or the rules that need to follow such as they need to avoid or limits the food high in trans- and omega-6 fats such as red and

processed meats, partially hydrogenated oils, corn, dairy, cottonseed, grapeseed, soy oils and peanut) and refined carbohydrates such as instant or white rice, rice, white breads, cake and cookies.

Vitamin A, Vitamin D, Vitamin C and Vitamin E are the main nutrient that able to reduce and prevent from sinusitis. Vitamin E helps in relieving some of the symptoms that associated with allergic rhinitis. Vitamin A and D are natural anti-inflammatory to reduce the inflammation of mucus membrane while the vitamin C reduce the inflammation and allergic response (Stammberger & Wolf, 1988). There is a treatment that has been done by Bell, Joshi, & Macleod (2011) which combine the usage of drugs with a few nutrient which give more than 80% relief in symptom and the frequently of the sinusitis attacked is decrease.

Since the Malaysian live in unhealthy environment such as unhealthy lifestyle which will contribute increasing the sinusitis patient especially in Malaysia since the air quality have significant toward health impacts. Air pollution contribute to increase the population of sinusitis patient. Tobacco smoke also increase the sinusitis occur which more difficult to treat (Mirgain, 2016).

In this world, there are a lot of treatment, method of surgery that had been introduced to prevent and cure from the sinus problem. In order to undergo surgery method, there is a few charges needed to proceed the surgery and it also depends on the level of the disease. In USA, it is estimate in excess of \$20 billion for the overall indirect cost related to sinusitis problem related to the losses in work productivity annually. In the same country, it is estimated in range between \$10 and \$13 annually for the overall fees related to sinusitis. The usage of antibiotic among sinusitis patient are very well known. Unfortunately, the usage of antibiotic for long term will give a side effect to our body itself. A few side effect was determine in the previous research which concerning in promoting antimicrobial resistance and high potential adverse effects of systemic antibiotics such as Clostridium difficile colitis, tendon disease and antibiotic disease diarrhoea. Antibiotics are not recommended for the first week infection or in the moderate level due to the risk of antibiotic resistance and other effects. Mustafa et.al, (2015) also mention that the antibiotic is recommended only if the symptoms did not relieve within 10 days.

There is a natural way that for the sinusitis patient must implement in their daily life which special menu planning in order to relieve the symptom of Sinusitis. However, there is no research regarding on daily special diet for the sinusitis problem. There is a research on special diet planning for myopia and diabetes patients but it is not suitable to sinus patient due to a lot of factor that must consider. The appropriate portion in their daily life will help them to prevent and relieve the sinus disease and also reduce the cost in their daily life. The manual planning is

design based on the nutrient that the sinusitis patient needed based on the Malaysian food.

2.0 LITERATURE REVIEW

Hussain et.al (2018) state that the sinusitis is a common health problem that characterised by mucosal inflammation of the paranasal sinus. Hussain et.al (2018) accepted the term of "Rhinosinusitis" because they believe that the sinusitis coexists with rhinitis to the most patients. Desrosiers et. al (2002) define the sinusitis as the infection of the upper respiratory tract infection. However, the term "Rhinosinusitis" is more accurate to be used in define the sinus disease/infection. The sinusitis problem can be divided into two subtype which are acute sinusitis and chronic sinusitis as stated in Hussain et.al (2018).

Acute sinusitis or known as short term Sinusitis can be consider if the duration of the symptom less than 4 weeks and the infection occur will resolve spontaneously or with the aid of appropriate medicine. If the inflammation proceed more than 12 weeks and associated with inflammatory changes and documented with the aid of imaging techniques at least 4 weeks after initiating appropriate medical therapy known as chronic sinusitis. The acute sinusitis might be change to chronic sinusitis if there is no appropriate treatment received. However, acute rhino sinusitis will be defined as a worsening of symptoms after five days or the existing of the symptoms after 10 days but less than 12 days. If the period of the symptom is less than 5 days, the diagnosis is acute sinusitis. Chronic disease can be defined as the constant or current symptom is observed over a period of several months without indication or spontaneous healing.

The chronic sinusitis will be define as the symptoms persisting for more than 12 weeks. The paranasal sinus comprised of four parts which are frontal, maxillary, ethmoid, and sphenoid sinuses (Helms & Miller, 2006). Helms and Miller (2006) also state that the obstruction of sinus drainage and the allergic rhinitis as the main factor that contribute to the sinus infection.

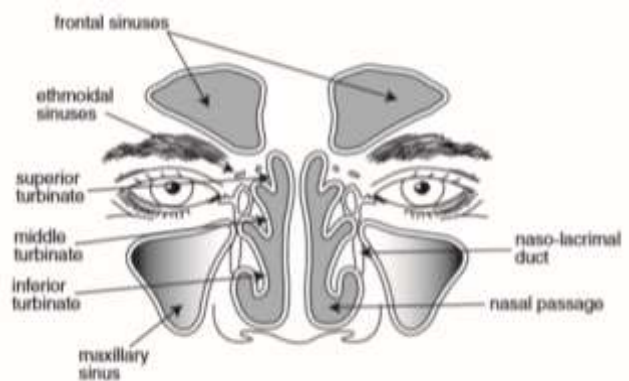


Figure 2.1: The Sinus Anatomy which the sinusitis problem occur

During diagnosis the sinusitis patient can be divided into a two types which are based on history, physical examination and diagnostic imaging. The diagnosis whether based on history nor physical examination having the difficulties in order to define either the acute sinusitis is cause by bacterial or virus during the assessment of the therapeutic management based on the symptom given by the patient. This will lead to misleading giving the medicine prescription which will give the side effect of the patient itself. Computed tomography (CT) is one of the technique/ machine that has been used for a long time in diagnosis imaging provides huge view of sinus cavity contents of an individual (Bell et.al , 2011). The computed tomography also has been done to observed maxillary sinus disease and the dentist often to make a diagnosis and plan the treatment based on the interpretation of computed tomography image (Bell et.al , 2011). However, Computed Topography has low in specify the acute sinusitis. It is only suitable for chronic sinusitis.

Hussain et.al (2018) state that computed tomography (CT) is the gold standard for radiographic evaluation of the paranasal and it must considered in the ORL setting. When the medical therapy fails, surgery is planned and complication is suspected during diagnosis. There are a few recommendation on therapeutic management for acute sinusitis but their recommendation did not mention the any manual planning or diet that the sinusitis patient should take. There are a few symptoms that should concern regarding on sinusitis. Most of the article often says that for those patient having headaches, it might be the patient having the sinus infection. Bell et.al (2011) state that most paranasal sinus disease will cause the symptom of pain occur within one week following the upper respiratory tract infection and it is usually viral in origin. Based on Stammberger and Wolf (1988) stated that the patient having headaches is connected to some sinus problem. It has been proved by 48 out of 100 patient of acute sinusitis and chronic sinusitis having headache as show in Figure 2.2.

TABLE 1. PREDOMINANT SYMPTOMS IN 100 CONSECUTIVE PATIENTS WITH SINUSITIS REFERRED TO GRAZ ENT DEPARTMENT

<i>Symptom</i>	<i>No. Patients</i>
Congestion/obstruction	82
Secretion	64
Fullness/pressure — mild pain	62
Severe headaches	48

Figure 2.2: The list of symptoms that having by sinusitis patient, (Stammberger and Wolf, 1988)

The endoscopic approach is one of the functional endoscopic sinus surgery which is minimal operations that often can help in relieving to the symptoms that have been

presents for months and years. Stammberger and Wolf, (1988) used endoscopic approach after identification of the symptoms. This approach also followed by Computed Tomography (CT) scan which able to discover the disease hidden form the eye by using operating microscope and conventional radiograph.

However, the endoscopic approach has limitation where sometimes they will miss the particular location of the disease even though repeated step has been done. One of the reason why the Computed Tomography must be included in endoscopic approach. This research only introduce the endoscopic approach and how it works properly but they did not state any precaution or healthy food that must be concern in order to make sure the sinusitis problem will recover.

Hussain et. al (2018) state that the Sinusitis will drive to major problem that affect the quality and productivity of life. The study by Hussain et. al (2018) explained the important of primary healthcare provider that must concern on the diagnosis and management of the disease. The person who is active smoker and having allergic rhinitis has a high risk of having acute sinusitis meanwhile the individual having smoker, asthma, allergies, chronic bronchitis, emphysema and acute rhinosinusitis has a high risk of having chronic rhino sinusitis. Hussain et. al (2018) present different way physical examination during diagnosis session which they used anterior rhinoscopy as a part of the clinical assessment if the individual is suspected acute rhinosinusitis in a primary care setting. However, the anterior rhinoscopy is limited for diagnosis chronic rhinosinusitis. Chronic rhinosinusitis requires a nasal endoscopy by an ortho-laryngology (ORL) surgeon which provide better visualization of the disease. There are a few treatment for acute rhinosinusitis which are nasal irrigation, corticosteroids, oral antihistamine, antibiotics and analgesics. The treatment for chronic rhinosinusitis is limited for giving the medicine due to some consideration must be taken and patient having chronic rhinosinusitis is offered to the surgery if the medical treatment is failed. This paper illustrate the management of sinusitis at the primary care from the diagnosis until the treatment offered to the sinusitis patient. Unfortunately, this paper did not mention any healthy food that the patient could consume in their daily life. Diament (1992) suggest in his paper that MRI is one of the diagnostic modalities which could give advantages of the paranasal sinus. However, paranasal sinus also has several limitations including high cost, consuming times in long imagine that make sedation necessary in most of the children and inability to direct display body landmarks, which is one of the most importance to the endoscopic region.

Smith, (2015) state that the sneezing is the common symptom especially infants. The individual facing acute sinusitis usually having fever. They found out that if the infants having the chronic sinusitis has the same nature as chronic infectious arthritis and the characteristic changes

of chronic adult paranasal sinus disease. In this paper also state that the important etiologic factors in produce the sinus disease are diet and climate. The researcher also state the diet is one of the important for the treatment of sinusitis disease in infants and young children. Dr. Amy Daniels is one of the dietitian in the Department of Paediatrics in the University Of Iowa. Based on his research, animal that having low diet fat soluble vitamin are expose to sinusitis infection, and infection of middle ear.

However, it is not clear result in order to compared with the children that having the sinus infection. Dr Amy Daniels says that it is significant when the babies receiving formula which consist low fat had carrying 1 to 1.2 percent, on the total mixture which shown signs of mastoid infection. It is different when the babies receiving formula with fairly high percentage available did not give any signs of mastoid infection occur. Dr Amy Daniels state that the diet itself cannot relieve the sinus infection. It is recommended by removing the source of infection initially and then proper diet pattern will be included. The diet should contain amount of vegetables, butter, fruits, milk, cereals foods and eggs. The amount of carbohydrate foods must be limited since the tendency for children to consume bread, potatoes and cereals is high. The consumption of liver oil is necessary in order to make sure amount of fat vitamin supplied is enough. It is recommended to take once or twice per day. This article is about the discussion of the paranasal sinus disease in infants and young children and a few treatment has been discuss in this article. However, the recommendation given did not in particular form such as diet. They only mentioning on type of food which is good to recover the sinus but there is no portion that included in their discussion.

Mustafa et.al (2015) defined the sinusitis is inflammation of the paranasal sinus or well known as rhino sinusitis which due to infection allergy or autoimmune problem. Acute rhino sinusitis is an infection that may last up to four weeks and chronic rhino sinusitis is the infection where the symptom and signs last more than 12 weeks.

The researcher also state that all the type sinus problem give the similar symptom which difficult to distinguish which lead to wrong or not suitable method during diagnosis the symptom. X-rays, Computed tomography (CT) or magnetic resonance imaging (MRI) are used during diagnosis of acute sinusitis even though the method is not generally recommended unless complication of the patient occur. Mustafa et.al (2015) gave the suggestion that by drinking adequate amount of water to thin the mucus. Consume antibiotic is not recommended for most cases of sinusitis. If the symptoms did not recover within 10 days, the clinic/hospital will provide Amoxicillin/Clavunate. If the medicine did not give any response to any sinusitis patient, a surgery should be considered with the proper procedure. This paper was studying the treatment and pathophysiology of the acute and chronic rhinosinusitis.

Unfortunately, the treatment that listed in this study did not state the healthy food that the patient could consume daily instead of taking the appropriate medicine and surgery. Helms and Miller (2006) state that the advantage of imaging in diagnosis is limited where X-ray, computed tomography scans are not give particular information. Furthermore, the poor of tissue recognition is not the reason of difficulty with imaging procedures, but there is lack of specificity to the disease itself as there is array of conditions with similar presentations.

When the sinusitis is recover, it also relieve the individual who have asthma spontaneously. There is a research regarding where the children and adults indicate that appropriate medical or surgical therapy of sinusitis which leads to the improvement of asthmatic state. Study by Slavin (1992) shows that the patient who have asthma is difficult to control will improve when the coexistent sinusitis is treated with medical or surgical treatment. Hence, planning a healthy diet for sinus problem, it also relieve another disease such as asthma. In study Naclerio, (1992) where the most complication occur among children is acute sinusitis. The complication could be determine with the involvement of the particular sinus.

Helms and Miller (2006) state that approximately 14 percent of the population in the United States having the Chronic Sinusitis which is one of the most common long term illness. . In theirs paper covers etiology, pathology, and diagnosis of Chronic Rhinosinusitis including the main and alternative treatment. The alternative therapeutics includes nutrients and botanicals such as ascorbic acid, bromelain, N-acetylcysteine, quercetin, undecylenic acid, and *Urtica dioica* and other herbal medicines) and the procedures in nasal irrigation and nasosympatico treatments. They also had discuss regarding on the influences of diet and the air quality on Chronic Rhino Sinusitis. Technically, Chronic Rhino sinusitis involves the physiological disruption of the mucus membranes from particulates, allergens, infection, and immune system dysregulation. Thus, Helms and Miller (2006) defined the Rhino Sinusitis as the inflammation of the contiguous tissues of the upper respiratory tract, where insult to the nasal mucosa also affects adjacent sinus disease. The diagnosis of the Sinusitis based on the how chronic the symptom. Acute sinusitis is inflammation for less than eight weeks in children and 12 weeks for adults. For chronic Rhino Sinusitis, they defined as the existing of the symptom more than 12 weeks respectively.

Helms and Miller (2006) state that the advantage of imaging in diagnosis is limited where X-ray, Computed Tomography scans are not give particular information. The conventional treatment that has had been introduced which are surgical drainage, antibacterial and corticosteroids, with adjunctive care involving decongestants and antihistamine. Antibiotics is one of the common treatment in the clinical. However, meta analysis of 49 trials reported insignificant cure rates across antibiotic classes in a 2006

Cochrane Review. The alternative medicine that has been proposed such as ascorbic acids, Bromelain, N-acetylcysteine (NAC), Quercetin, Undecylenic acid, Urtica dioica (Stinging Nettle). In 2004, there is a prospective trial examined blood level of various vitamins and minerals in children with Chronic Rhinosinusitis compared to the healthy, age-matched controls. As the result, a few nutrient such as Vitamin E, Vitamin C, Zinc and Copper were significantly reduce the Chronic Sinusitis group compared to controls. Bromelain is a proteolytic enzyme complex from pineapple, which act as anti-inflammatory and mucolytic in Sinusitis. German clinical study in 2005 shows that children that having acute sinusitis exhibited statistically significant faster symptom recovery ($p = 0.05$) compared with the standard treatment.

Nasal irrigation and Urtica dioica (Stinging Needle) are alternative procedures that has been used in treatment of sinusitis. Dietary factors also influence the presence of Sinusitis. Most of the Naturopathic Physicians suggest that food allergy or sensitivities are often obstacles in relieving the Sinusitis. Peter D'Adamo, ND, in his popular blood-type diet books, suggests that food lectins are the molecular perpetuator of sinus inflammation. It is recommended that dairy, wheat, and corn will promote more globular than planar mucus, disable sinus drainage and promote antigen exposure.

Special diet planning and the appropriate nutrient intake could help the sinusitis patient relieve their pain. Diet not just only help the sinus patient, it also important for managing body weight in maintaining good health (Hespanhol and Aswani, 2018). Special diet planning could refer to the specialist where the patient will have the counselling session with a few fees. In United States, poor diet and nutrition has immense financial and health cost. Hence, the development of new method for diet planning could help the individual or families have a better in their financial and the quality in diet and meals. (Hespanhol and Aswani, 2018).

Hespanhol and Aswani, (2018) mention that planning a special diet is time consuming and complicated. However, the optimization technique able to create the model for special diet for sinusitis patient. Hespanhol and Aswani, (2018) state that diet planning was the one of the first optimization problem to be formulated. Jridi et. al (2018) state that the menu planning problem was a scheduling problem in order to find an optimal set of meals that satisfy the individual nutrient intake, structural and other requirements during a period of time which corresponds to its objective. Furthermore, the term "programming" is used in dynamic programming was the synonym of "optimization" which means "planning" (Jridi, et. al, 2018)

2.2 LINEAR PROGRAMMING

Linear programming is one of the optimization technique in which a linear function is maximize or minimized when

subjected to various constraint. It helps to solve some of very complex optimization problems by making a few simplifying assumptions. Dibari et.al (2012) state that linear programming analysis is an operational research approach in solving multifactorial problems including the diet planning. Linear programming not only design the individual diet, but linear programming also could be one of the support decision making in nutrition education, define food fortification activities, agricultural programs and analysis of economic constraint on human diets (Iwuji et.al , 2016). Linear programming is the most popular in determining the minimum cost of food in order to meet the nutritional requirement either for specific group of disease or general health. Linear programming optimization consisting of three major element which are the objective function, the decision variable (the variable that changed by the model) and constraint (the criteria that need to be meet).

Linear programming has been applied in the diet planning. Dibari et. al (2012) used linear programming in his research to formulate the lowest price and the weights of the chosen commodities in ready-to-used therapeutic foods. The constraint were based on current UN recommendations for the micronutrient content of therapeutic food. The goal in this research was to design the cheapest formulation of a RUF that fulfils all the criteria that has been mention in his research.

The constraint that has been included were energy and nutrient concentration, palatability, texture and total food ingredient weight. Unfortunately, the researcher did not mention the important nutrient that researcher consider for the children less than 5 years old which they are currently affected by severe acute malnutrition and the children affected need to be treated using special nutritional products. Ready-to-use therapeutic product is one if the nutritional product that used to treat the problem. The research succeed design the prototype for RUTF but they have limitation to find price data for ingredient since it is influence by seasonality of that state.

Furthermore, Iwuji et. al (2016) used linear programming in his research to obtain daily minimum cost diet plans that meets the nutritional requirement for controlling the hypertension. Hypertension is the disease that compulsory to have strict diet in order for the patient to survive. The diet planning has been design based on the nutrient the patient could consume and the calorie intake for that individual. The calorie intake was based on their age, level of activity and weight of the individual. The serving size of food were measured in the Nutrition and Dietetics Laboratory of Michael Okpara University of Agriculture. However, it would be better if the researcher include the portion of the food that will help the patient to prepare the food. The general structure of the model were given as follows:

Objective function:

$$\text{Min } Z = C_1X_1 + C_2X_2 + C_3X_3 + \dots + C_nX_n$$

Subject to constraints:

$$a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n (\leq, \geq) b_1$$

$$a_{21}X_1 + a_{22}X_2 + \dots + a_{2n}X_n (\leq, \geq) b_2$$

$$a_{31}X_1 + a_{32}X_2 + \dots + a_{3n}X_n (\leq, \geq) b_3$$

$$a_{m1}X_1 + a_{m2}X_2 + \dots + a_{mn}X_n (\leq, \geq) b_m$$

$$\text{and } X_1, X_2, X_3, \dots, X_n \geq 0$$

Where;

m is the number of nutrient;

n is the number of food items;

a_{ij} is the number of units of nutrients i one unit of food item j;

b_i is the specific number of units of nutrient I required;

C_j is the cost of food item j;

X_j is the number of units of food item j in the solution;

$i = 1, 2, 3, \dots, n$ and $j = 1, 2, 3, \dots, m$

Arnaut-berilo et. al (2017) used linear programming and goal programming optimization models in determining and analysing the food basket in Bosnia and Herzegovina (BiH) in terms of adequate nutritional needs according to the World Health Organization (WHO) standards and World Bank (WB) recommendations. Linear programming optimization techniques has been used to design and provide the information about the absolute minimum value for daily cost and the structure of the food basket for an average person in BiH based on nutrient requirement. This paper did not present the methodology how the linear programming well-functioning in his research. This paper also provide the minimal daily food cost in BiH were 1.95 KM for the average man and 1.84 KM for the average women. This paper present the scope of study between man and women only without mentioning age, and physical activity of that person.

2.3 INTEGER PROGRAMMING

Hui and Sufahani (2019) had design the diet menu for high pressure patient which believe it could help the patient in controlling and lowering the blood pressure since the high blood pressure is one of the global public health issue. The diet menu planning not just only help the patient in lowering and controlling blood pressure. The researcher succeed manage the lowest cost that the patient need to spend for their diet menu. The researcher used linear programming and integer programming by using LP Solve IDE Software. The researcher used the integer programming since the result given in linear programming give the limitation toward the patient in order to know the real portion of the food itself that they should consume. Integer linear programming helped the patient in preparing the diet planning. The study is focusing on two condition which are a female who aged 54 with 80 kg and she is not productive person but did not having any allergy or disease. Meanwhile the other patient is a male who aged 82 with 60 kg which he is current smoker but did not having any disease. Even though both person need different nutrient requirement, but it is not suitable for sinus disease since the nutrient intake for sinusitis is different with the high blood pressure. As the result, the researcher able to design the diet planning for both person with the lower cost.

Objective function:

$$\text{Minimize Total Cost} = \sum_{i=1}^N \sum_{j=1}^P \sum_{k=1}^Q c_i X_{ijk}$$

X_{ijk} = Decision variable of food items

i for 10 food group

j for 6 meal

k, C_i is the cost for each food items i

P is the number of meal per day

Q is the number of food group

There are 6 nutrient requirement based on based on Table 1 and Table 2. Table 1 shows the nutrient boundaries that the female needed to reduce the hypertension. Meanwhile in Table 2 shows the nutrient boundaries necessary for male to reduce the hypertension.

Nutrients	Lower Bound (LB)	Upper Bound (UB)
Sodium (mg)	-	1500
Protein (g)	52	-
Potassium (mg)	4700	-
Vitamin B2 (mg)	1.1	-
Calcium (mg)	1200	2000
Vitamin C (mg)	70	2000

Table 1: The boundaries of nutrient for female that having the hypertension. (Hui & Sufahani, 2019)

Nutrients	Lower Bound (LB)	Upper Bound (UB)
Sodium (mg)	-	1500
Protein (g)	58	-
Potassium (mg)	4700	-
Vitamin B2 (mg)	1.3	-
Calcium (mg)	1000	2000
Vitamin C (mg)	70	2000

Table 2: The boundaries of nutrient for male that having the hypertension. (Hui & Sufahani, 2019)

The boundaries equation are as follows:

$$LB_i \leq \sum_{i=1}^N \sum_{j=1}^{10} \sum_{k=1}^6 w_i X_{ijk} \leq UB_i$$

LB_i = Lower bound for each nutrient content

UB_i = Upper bound for each nutrient content

w_i = weight of nutrient for the food

Suliadi F. Sufahani and Zuhaimy Ismail, (2015) has design the diet planning for student with range aged 13 – 18 in order to fulfil the nutrient requirement intake daily. The researcher used Binary Integer programming and “Delete Shuffle Algorithm” in order to design the diet menu for student based on the Malaysian recipes. There are two assumption that has been considered which are the standardization of portion and size of the ingredient for each menu to make sure the variable can only have value 0 and 1 which the requirement to use the integer linear programming exclude Water and Plain Rice. Furthermore, the assumption of nutrient contained in each menu to be consumed and the nutrient that are not destroy during the cooking the process and providing the menu. The researcher succeed design a suitable 7 day menu plan that can be used as a guide for the management of the school. However, the diet menu planning will be better if

researcher also can discover the student background such as their health condition. If the student having serious disease or any allergies, they are not able to consume the food that had been prepared by the school. Hence, the menu planning for specific disease is important which essential for the student having that specific disease.

Linear programming as an alternative way for large scale continuous tour scheduling problems that involving the meal-break window, start time band, and start time policy interval policy. This researcher focusing on an important of workforce-scheduling problems regarding on grocery and convenience stores, telephone cell centers, tollways, hospitals, airport stations, and many other service operating systems which the problems referred to as “7x 24” or “continuous” problems indicates that they encompass a continuous seven day-week, 24 hours-day planning horizon. Brusco & Jacobs, (2000) state that the common problem was to assign employees to daily shifts and weekly work days (or days-on patterns) with the objective function of minimizing total workforce size. Recently, they had designed the model using generalized set-covering formulation (GSCFs). Unfortunately the weakness of that method has been found where the method itself produce millions or billions of integer decision variables for practical scheduling environment that permits flexibility in terms of employee starting times, meal-break placement, shift length, and other factors and thus cannot be solved using available integer programming methods. Due to this difficulties, the researcher had developed compact integer programming model that represent the characteristic of scheduling flexibility. GSCFs’s decision variables was explicitly defined the number of employees that assigned to each feasible tour while the decision variable of integer programming formulation represent tours using set of shifts variables, break variables, and days-on variable. However, it is important that operation managers carefully evaluate policies and the new implicit tour-scheduling model facilities this evaluation because the management also must consider the kind of healthy food they consume daily to provide them energy and enough nutrient to contribute to that company. Hence, they also can faced the difficulty that associated with such a model is its inherent size since most of the organization use 15 minutes or 30 minutes planning intervals. The development and improve the branching method, strong cutting planes, or the use of interior-point method necessary in future research in tour – scheduling formulations.

2.4 GOAL PROGRAMMING

Diet planning for hypertension patient has been formulated using linear programming approach that has been done by Iwuji et. al (2016). However, Iwuji and Agwu, (2017) found the limitation in used the linear programming which normally give the result oversupply of certain nutrients as the nutrient level had wide deviations

of from the DASH Diets tolerance upper and lower intake level for the given calorie and sodium levels. In this paper had presented the diet menu for hypertension patient by employing goal programming or to be specific a weighted goal programming. A weighted goal programming had minimize the daily cost of the DASH eating plan as with advancement the minimization deviations of the diets' nutrient content from the DASH diet's tolerance intake levels. Furthermore, the comparison deviation between linear programming and weighted goal programming has been showed in this study. It was proven that the weighted goal programming give the minimize deviation compared to the linear programming as shown in Table 3. However, the goal programming assign the goals equal importance and it must undergo complicated process to obtain the final solution.as follows.

$$\text{Minimize } Z = \sum_{i=1}^m (w_i^+ d_i^+ + w_i^- d_i^-)$$

Subject to the constraints:

$$\begin{aligned} \text{Goal constraints: } & \sum_{j=1}^n a_{ij}x_j + d_i^- - d_i^+ \\ & = b_j \text{ for } i = 1, \dots, m \end{aligned}$$

$$\text{System constraint : } \sum_{j=1}^n a_{ij}x_j = b_j$$

$$\text{With } d_i^-, d_i^+, x_j \geq 0, \text{ for } i = 1, \dots, m \text{ and } j = 1, \dots, n$$

Where;

Z is the objective function

d_i⁻, and d_i⁺ are the negative and positive deviational variables in goal i

w_i⁻ and w_i⁺ are non negative constant representing the relative weights to be assigned to the respective positive

The result shows the daily serving size in decimal point which difficult for the patient in preparing the foods.

Foods	Daily serving size	Nutrients	Comparison of the "DASH variants" composition of daily eating plans of the Weighted GP model and the LP DASH diet model.				
			Tolerable intake target level of nutrients	Nutrient composition of weighted GP model diet plan.	% Deviation from nutrient target	Nutrient composition of LP model diet plan	% Deviation from nutrient target
Carrot (not up)	0 serving	Total fat	48 g	48 g	0%	31.80 g	61.5%
Cornmeal (white, without salt)	2.8 serving	Sodium	150 mg	150 mg	0%	123.9 mg	18.4%
Isiul (white wheat)	11 serving	Cholesterol	129 mg	129 mg	0%	21 mg	79.3%
Isiul Flakes (white wheat)	0 serving	Saturated Fat	16 g	16 g	0%	7.55 g	52.8%
Milk (low fat, skinned)	3.6 serving	Calcium	1314 mg	1314 mg	0%	1314.7 mg	0.0%
Orange	0 serving	Magnesium	542 mg	542 mg	0%	542.9 mg	0.1%
Watermelon	35.7 serving	Fiber	31.09 g	31.09 g	2.1%	30.73 g	146.9%
Risk (yellow, without salt)	10.3 serving	Potassium	4721 mg	4721 mg	0%	4633.2 mg	96.0%
Cost of eating plan	1032.07	Calorie level	Above 2880 Calorie	3880	0%	2000.2	93.1%
		Target cost of daily eating plan	Above 6400 Naira	912.87 Naira	1.3%	9044.41 Naira	0.08%

Table 3: The result which shows the comparison between two approach which are linear programming and goal programming based on the percentage of deviation from nutrient target , (Iwuji et. al, 2016)

Developing the menu planning require the development of methodology which able to combine different and conflicting goals corresponding to the dynamic programming. The dynamic goal programming has been used in solving the menu planning problem for the haemodialysis (HD) patient. Jridi et. al , (2018) state that dynamic goal programming was the extension of the classical goal programming which assigns much importance to the dependence of its variables on time. Jridi et. al, (2018) defines that the goal programming is a distance function that minimize the deviation or in other words to minimize unwanted positive and negative deviations from the achievement and aspiration levels. The objective of the model in this study was to minimize the positive and negative deviations through over all periods in each day of one week and the goals must satisfied the four nutrients which are protein, energy, sodium and potassium. As the result, the researcher design the menu planning which the patient can have various product but only one recipe for each time period. There are 5 time period that used in this research which are breakfast, morning snack, lunch, afternoon snack, and dinner. The model was verified from diet experts specializing in haemodialysis (HD) patients. However, this research need a few improvement where the researcher should list out the portion in another way to make the patient more understanding and ease for them to prepare the meal. Furthermore, it would be great if the researcher could minimize the cost spending for the haemodialysis patient in preparing the meal since the cost for haemodialysis therapy is quite expensive.

2.5 FUZZY PROGRAMMING

In real life problem model, people must deal with uncertain and inexactness in order to perform computations. Nasser and Darvishi, (2018) state that the interval analysis is an efficient and reliable tool that allows

us to handle such problems such as livestock diet formulation where the diet problem can be formulated in accordance with the amount of livestock requirement satisfaction. There are a few consideration that involve in the formulation of a balanced diet by fuzzy programming which are the economic power of stockbreeder/ the satisfaction of livestock requirement and the satisfaction percentage of animal nutrient requirement will be considered and determined.

The main reason the researcher used the fuzzy programming because it is used to deal with uncertain and inaccurate factors, which make difficult the assignment of a single plausible value to each model parameters. The result by using the fuzzy programming showed that the uncertainty of food requirements slightly affected the budget of animal diet and the results in the terms of the applied accuracy in the model. However, the researcher did not show the way they used the fuzzy programming which make the other researcher difficult to understand.

Recently, fast food became well known among people around the world. The food innovation nowadays did not give beneficial nutrient toward the consumer. Eating disorder and disease correspond to the lifestyle that have been assumed as a critical problem in the world. Mamat and Zulkifli, (2012) balanced diet planning has been planned correspond to the user in order to take a variety of foods for a few times per day. The researcher used the fuzzy linear programming approach in order to design the diet planning as follows :

$$\text{Minimize } \sum_{j=1}^n c_j x_j$$

Subject to;

$$\sum_{j=1}^n a_{ij} x_j \geq b_i, \sum_{j=1}^n a_{ij} x_j \leq d_i$$

$$i = 1, 2, \dots, m, x_j \geq 0$$

Where;

j = Food eaten per day

c_j = Amount of carbohydrate or fat

x_j = 100g of food j eaten per day

a_{ij} = amount of nutrient i in 100g food j

b_i = requirement amount of nutrient i

d_i = the maximum amount of nutrient i

m = the number of nutrients

n = number of food

The fuzzy linear programming approach was calculate the amount of nutrient in good intake and the researcher considered to estimate nutritional requirements for human body in daily routine. The amount of carbohydrate or fat nutrients is uncertain and assume as fuzzy numbers. The diet planning is design based on a female, 30 years old with the value body mass index is 24.99kg/m². However, this paper only showed the table of nutritional requirement per day for a specific individual and it is more meaningful if the researcher showed the list of food that healthy food to consume with fulfil nutrient daily intake.

4.0 CONCLUSION

Menu planning has been design based on the problem that faced by individual. Some of the individual want to lose weight and interested with simple healthy lifestyle. Some individual faced chronic illness such as diabetes mellitus, hypertension, eczema, and others which they need special menu planning for them that will fulfil the daily nutrient intake to help them cure the illness instead of depending on the medicine that suggested by the doctor. Optimization approach has been widely applied in solving the menu planning problem. Optimization also has been applied another field such as for construction, determine the suitable time to sell the pig and others. The optimization approach able to improve the dietary adequacy that fulfill the nutrient intake of the menu planning. In addition, goal programming is one of the optimization approach that been applied in the Urban transportation planning at Istanbul which the mathematical modelling has become compulsory in this field in order to achieve many goals at the same time. In solving menu planning problem, some of the researcher only concerning about the portion of the menu planning that fulfil the nutrient intake without considering the cost of the portion. The cost of the portion also important which help the individual to prepare the food itself that fulfil the daily nutrient intake. Optimization approach also improve the nutritional advisor's work and also avoid making the mistake during design the manual planning.

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