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Optimizing Dietary Plan to Develop Brain Functions

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ABSTRACT

The purpose of this paper is to show how linear programming model can help to design dietary plan in developing brain functions for the children undertaken by dietician in health care. For the development of the whole body and mental development, child nutrition is very important. In this paper, the constraints of problem, specified objective, structured mathematical model are detailed. The required data are sought and systematic review was done by searching engine with words like nutrition, food, diet, etc. In this paper, food items such as fish, egg, tomato, orange, peanut and oats corresponding to the nutrients are considered and calculated. Excel Solver is used to solve the LP model. From these results, the children can achieve by following the dietary plan.

Keywords : Dietary Plan, Health Care, Linear Programming, Maximization, Minimization, Operations Research

I. INTRODUCTION

Operations Research is applied to problems that concern how to conduct and coordinate the operations (i.e. activities) within an organization. Linear programming is an optimization technique for a system of linear constraints and a linear objective function. In general, the issue of solving the maximum or minimum value under linear constraints is collectively known as linear programming problem. The solution to meet the linear constraints is called feasible solution. In linear programming, there are the decision variables, the constraints and the objective function. In statics, linear programming is a special technique employed in operations research for the purpose of optimization of linear function to linear equality and inequality constraint. An objective function defines the quantity to be optimized and the goal of linear programming is to find the values of variables that maximize or minimize the objective function [1]. The objective of this paper is to identify the linear programming method to optimize the dietary plan using nutritional restrictions in the field of healthcare, to minimize the daily cost for diet and to decide how each child may have the dietary plan. In this paper, six food items (salmon, egg, tomato, orange, peanuts and oats) with respect to nutrients are demonstrated.

II. METHODOLOGY

A. Linear Programming

Linear Programming (LP) is the general technique of optimum allocation of ‘scarce’ or ‘limited’ resources, such as labour, material machine, capital, energy, etc. to several competing activities, such as products, services, jobs, new equipment, projects, etc. on the basis of a given criterion of optimality. Out of several courses of action available, the best or optimal is selected. A course of action is said to be most desirable or optimal if it optimizes (maximizes or minimizes) some measure of criterion of optimality such as profit, cost, rate of return, time, distance, utility, etc [2].

B. **Steps of Linear Programming Model**

There are the steps to formulate mathematical model.

- Step 1: Defining decision variables to express each constraint which is of the form, ≥, or of the form, ≤, or = and to express the objective function.
- Step 2: Formulating all the constraints imposed by the resource availability and express them as linear equality or inequality in terms of decision variables defined in step 1. These constraints define the range within which values of decision variables can lie.
- Step 3: Defining the objective function that determines to maximize or minimize. Then express it as a linear function of decision variables multiplied by their profit or cost contributions.

1) A Standard Form of the Model: The general linear programming problem with n decision variables and m constraints can be stated in the following form:

Find the values of decision variables $x_1, x_2, \ldots\ldots, x_n$ so as to

Optimize (Max or Min)

$$Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n \qquad (1)$$

Subject to the restrictions

$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \ (\le, =, \ge) b_1 \qquad (2)$$

$$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \ (\le, =, \ge)\ b_2 \qquad (3)$$

$$\vdots \qquad \vdots$$

$$\vdots \qquad \vdots$$

$$\vdots \qquad \vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n \ (\le, =, \ge)\ b_m \qquad (4)$$

and

$x_1 \ge 0, x_2 \ge 0, \ldots\ldots, x_n \ge 0,$

C. **Assumptions of Linear Programming**

- Proportionality assumption: The contribution of each activity to the value of the objective function Z is proportional to the level of the activity x_j, as represented by the c_jx_j term in the objective function. Similarly, the contribution of each activity to the left-hand side of each functional constraint is proportional to the level of the activity x_j, as represented by the $a_{ij}x_j$ term in the constraint [3].
- Additivity assumption: Every function in a linear programming model (whether the objective function or the function on the left-hand side of a functional constraint) is the sum of the individual contributions of the respective activities [3].
- Divisibility assumption: Decision variables in a linear programming model are allowed to have any values, including noninteger values, that satisfy the functional and non-negativity constraints. Thus, these variables are not restricted to just integer values. Since each decision variable represents the level of some activity, it is being assumed that the activities can be run at fractional levels [3].
- Certainty assumption: The coefficients in the objective function c_j , the coefficients in the functional constraints a_{ij}, and the right hand sides of the functional constraints b_i . The value assigned to each parameter of a linear programming model is assumed to be a known constant.

D. Simplex Method (Minimization Case)

The steps of the simplex algorithm to obtain an optimal solution to a standard linear programming problem are as follows:

- Step 1: Determining the entering basic variable by selecting the variable (automatically a nonbasic variable) with the negative coefficient having the largest absolute value (i.e. the 'most negative' coefficient).
- Step 2: Determining the leaving basic variable by applying the minimum ratio test.
- Step 3: Minimum Ratio Test
  - Picking out each coefficient in the pivot column that is strictly positive (> 0).
  - Dividing each of these coefficients into the right hand side entry for the same row.
  - Identifying the row that has the smallest of these ratios.

- The basic variable for that row is the leaving basic variable, so replace that variable by the entering basic variable in the basic variable column of the next simple tableau.

III. PROCEDURAL OVERVIEW

In this section, the effectiveness of the linear programming model is demonstrated and it is applied to the dietary plan for children aged from 4 to 8 years to develop brain functions. The entries of food items and corresponding nutrients are used. There are 6 food items and 12 nutrients to formulate linear programming model. The objective function is to minimize the daily cost of the food items and nutrients.

A. Procedure with Data

This section explains the procedure with a corresponding data set so as to better work. The required data set are sought. There are 6 top brain food items, nutrients which are 7 minerals and 5 vitamins in each food and contents in each nutrient for children. Top brain foods for children are salmon, egg, tomato, orange, peanut and oats. Salmon is a good source of omega-3 fatty acids that are needed for brain growth and function [4]. Eggs are important for memory development. Peanut butter protects nerve membranes. Oats and oatmeal are excellent sources of energy and brain fuel [5]. Minerals are calcium, iron, sodium, zinc, magnesium, potassium and phosphorus. Vitamins are vitamin A, vitamin C, vitamin D, vitamin E and vitamin K. The food items, nutrients and daily requirements are presented in Table 1[6][7][8].

B. Calculation

1) Daily Requirements:

The quantity of calcium = 1000mg
The quantity of iron= 10 mg
The quantity of magnesium= 130 mg
The quantity of phosphorus =500mg
The quantity of potassium= 3800mg
The quantity of sodium= 1900mg
The quantity of zinc= 5mg
The quantity of vitamin A = 8000IU
The quantity of vitamin C= 26mg
The quantity of vitamin D= 20mcg
The quantity of vitamin E= 7mg
The quantity of vitamin K= 55mcg

2) Decision Variables

x_1= cost of fish per food item,
x_2= cost of egg per food item,
x_3= cost of tomato per food item,
x_4= cost of orange per food item,
x_5= cost of peanuts per food item,
x_6= cost of oats per food item,

3) Objective Functions:

The objective function for this problem is to minimize the total diet cost. The minimize Z function is the linear function of cost of fish (x_1), cost of egg (x_2), cost of tomato (x_3), cost of orange (x_4), cost of peanut (x_5), and cost of oats (x_6). To get the total minimum cost, the function Z is the summation of the total variables for food items. The cost of each food item is: 200kyats for salmon fish in 25g, 150kyats for egg in 50g, 150kyats for tomato in 50g, 150kyats for orange in 50g, 150kyats for peanut in 28.4g and 200kyats for oats in 28.35g respectively. The summarized objective function is as followed.

$$Minimize\ Z = 200x_1 + 150x_2 + 150x_3 + 150x_4 + 150x_5 + 200x_6 \tag{5}$$

4) Subject to the restrictions:

Calcium restriction:

$$9x_1 + 28x_2 + 2.5x_3 + 70x_4 + 16.44x_5 + 15.59x_6 = 1000 \tag{6}$$

Iron restriction:

$$0.14x_1 + 0.88x_2 + 0.23x_3 + 0.8x_4 + 0.45x_5 + 1.13x_6 = 10 \tag{7}$$

Sodium restriction:

$$12.5x_1 + 71x_2 + 21x_3 + 2x_4 + 1.7x_5 + 189x_6 = 1900 \quad (8)$$

Zinc restriction:

$$0.25x_1 + 0.65x_2 + 0.7x_3 + 0.11x_4 + 0.79x_5 + 0.91x_6 = 5 \quad (9)$$

Magnesium restriction:

$$7.5x_1 + 6x_2 + 4x_3 + 14x_4 + 43.5x_6 = 130 \quad (10)$$

Potassium restriction:

$$106x_1 + 69x_2 + 106x_3 + 196x_4 + 200x_5 + 189x_6 = 3800 \quad (11)$$

Phosphorus restriction:

$$61x_1 + 99x_2 + 14.5x_3 + 22x_4 + 80.5x_5 + 126.5x_6 = 500 \quad (12)$$

Vitamin A restriction:

$$25x_1 + 270x_2 + 748x_3 + 125x_4 = 8000 \quad (13)$$

Vitamin D restriction:

$$18.5x_2 = 20 \quad (14)$$

Vitamin E restriction:

$$0.35x_1 + 0.525x_2 + 0.7x_5 + 0.1x_6 = 7 \quad (15)$$

Vitamin K restriction:

$$0.05x_2 + 3.25x_5 + 0.65x_6 = 55 \quad (16)$$

Vitamin C restriction:

$$0.25x_1 + 8x_3 + 35.5x_4 = 26 \quad (17)$$

IV.RESULTS

To solve the problem, Simplex Method or Excel Solver can be used. Since this model has 6 variables represented for food items and 12 constraints for nutrients, Excel Solver is used. Solving problem gives the following feasible solution:

Minimum cost per day for each child is 1124.47553 kyats.

Balanced diet is:

1. Needed weight of egg = 1.08108*50 = 54.05400g per day
2. Needed weight of tomatoes = 2.35820*50 = 117.91000g per day
3. Needed weight of oranges = 0.27978*50= 13.98900g per day
4. Needed weight of peanuts = 0.40078*28.35= 11.36211g per day
5. Needed weight of oats = 2.53250*28.35= 71.79638g per day

This paper can help to develop brain functions for children who are between the ages 4 and 8 years.

The summarized results are shown in Figure 1.

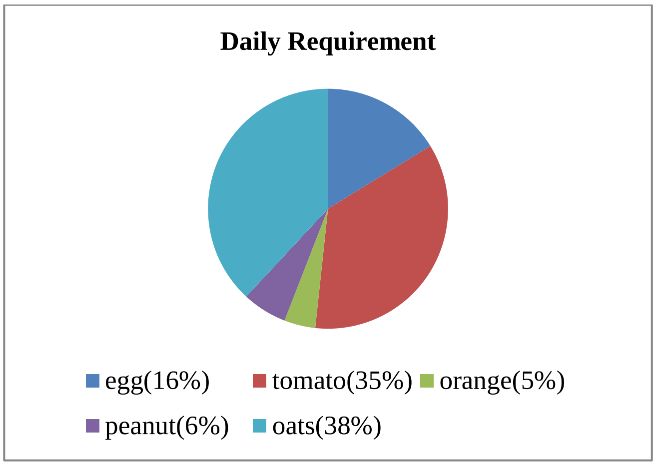

Figure 1: Daily requirement for food items.

V. CONCLUSION

There is no doubt the importance of nutrition during the early years of children development, but nutrient deficiencies can lead to low intelligence. Growth and intelligence of the children depend on nutrition with dietary plan. In the case of the intelligence, there is a third factor that play a very important role which is genetics inherited from parents. The effects of nutrition on intelligence development with the controlling of genetics factors are needed to explore. Thus, the obtained results in this paper show how to manage the dietary plan to develop brain functions for children.

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VII. REFERENCES

[1]. https://brilliant.org/wiki/linear-programming

[2]. J.K. Sharma, Operations Research, Theory and Applications.

[3]. Frederick S. Hiller, Introduction to Operations Research, Seventh Edition (Stanford University), January, 2000.

[4]. https://en.m.wikipedia.org /wiki / linear-programming.

[5]. https://www.onhealth.com/content/1/kids_brain_ foods

[6]. https://www.nutritionvalue.org/nutritioncalculator. Php

[7]. https://www.webmd.com/ add-adhd/ childhood-adhd / features /brain-foods-kids

[8]. https://health.gov/dietaryguidelines /2015 /guidelines/appendix-7

TABLE I
FOOD ITEMS AND NUTRIENTS

Nutrients	Food Items						
	Salmon (25g)	Egg (50g)	Tomato (50g)	Orange (50g)	Peanut (28.4g)	Oats (28.35g)	Daily Requirement
Calcium(mg)	9	28	2.5	70	16.44	15.59	1000
Iron(mg)	0.14	0.875	0.23	0.8	0.45	1.13	10
Sodium(mg)	12.5	71	21	2	1.7	189	1900
Zinc(mg)	0.25	0.645	0.7	0.11	0.79	0.91	5
Magnesium(mg)	7.5	6	4	14	0	43.5	130
Potassium(mg)	106	69	106	196	199.9	189	3800
Phosphorus(mg)	61	99	14.5	22	80.5	126.5	500
Vitamin A(IU)	25	270	748	125	0	0	8000
Vitamin C(mg)	0.25	0	8	35.5	0	0	26
Vitamin D(mcg)	0	18.5	0	0	0	0	20
Vitamin E(mg)	0.35	0.525	0	0	0.7	0.1	7
Vitamin K(mcg)	0	0.05	0	0	3.25	0.65	55

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