INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

**ISSN: 2454-132X**
**Impact factor: 4.295**
***(Volume 5, Issue 5)***
Available online at: ww.ijariit.com

# Application of Operations Research in solving malnutrition

*Dhruv Bhatia*
*dhruvgbhatia@gmail.com*
*SVKM's Narsee Monjee Institute of Management Studies, Mumbai, Maharashtra*

*Aryan Manchanda*
*aryanmanchandaa@gmail.com*
*SVKM's Narsee Monjee Institute of Management Studies, Mumbai, Maharashtra*

*Ayush Khandelwal*
*ayushkhandelwal55@gmail.com*
*SVKM's Narsee Monjee Institute of Management Studies, Mumbai, Maharashtra*

*Bhavya Vidyarthi*
*bhavya.vidyarthi@gmail.com*
*SVKM's Narsee Monjee Institute of Management Studies, Mumbai, Maharashtra*

*Dhruv Mahyavanshi*
*dhruv1862000@gmail.com*
*SVKM's Narsee Monjee Institute of Management Studies, Mumbai, Maharashtra*

## ABSTRACT

***In this paper, we solve a diet problem with the goal to find an optimal combination of food items on the condition that the daily nutritional requirements of a child are satisfied. The mathematical model of the problem is formulated as a linear program where the objective function is the number of calories for the proposed menu, on the condition that the constraints regarding the amounts of protein, fats, calcium, carbohydrates and dietary fiber consumed throughout an entire day are satisfied. We solve this problem by using the Solver tool in Microsoft Excel.***

***Keywords***— *Malnutrition, Daily nutritional requirements, Microsoft Excel Solver*

## 1. INTRODUCTION

In India, over the last two decades, the total food production has increased from 198 million tonnes to 269 million tonnes. Regardless of the boost in the food production, the rate of malnutrition still is very high, especially amongst children as the access to rice, wheat and cereals hasn't increased with that. Between the years 1972-73 and 2011-12, the share of expenditure on cereal and cereal substitutes has slumped from 57% to 25% in rural areas and from 36% to 19% in urban areas. It has also been reported, that with the increase in consumption of food items like milk and dairy products, oils and fat, the energy and protein intake from cereals has decreased in both rural and urban India. Add to this, the consumption of unhealthy foods such as fast food, processed food, and sugary beverages is an additional factor for malnutrition. (Shelar, 2019) The Food and Nutrition Security Analysis, India, 2019, a report by the Ministry of Statistics and Programme Implementation and The UN World Food Programme lists a majority states in 'very high' category and few states in 'high' category high levels of malnutrition (stunting, wasting and underweight) amongst children. In fact, child stunting is considered to be a criterion of chronic malnutrition. Further, the report states that by the 2022 deadline, around 31.4% of children will remain stunted. (The Hindu, 2019) To reach the target of 25% by 2022, India will have to aim for a twofold increase in its rate of progress. Malnutrition can be reduced with an efficient programme design, management and operations techniques. If applied correctly, they can help in decreasing childhood malnutrition and mortality. A superior but underutilized decision-making tool is 'operations research' (OR). OR can be effectively used to keep a tab and strengthen the delivery and implementation of a health or food-assisted programme and assess the quality of nutrition.

It can ascertain the transformation of research into action. Simple quantitative data collection approaches that include structured interviews or observations, and standard qualitative methods that include in-depth interviews and focus group discussions are used in OR. (Ruel, 2005) The Central Government allocates huge amounts of funds for health or food-assisted program. The budget allocated for the Core Integrated Child Development Scheme (ICDS) or Anganwadi services has increased to ₹23,234 crores for the financial year 2019-20 from the revised estimate of ₹20,951 crores for the financial year FY 2018-19. (Ramani, 2019) Operations research helps to meet the goals such as that of improving the efficiency and application of such programs. A successfully implemented programme can help to speed up the results aimed at improving child nutrition, health, and survival. In spite of programs aimed to resolve malnutrition, such as creating Integrated Child Development Services and provision of mid-day meals all over the country, India still continues to face the challenge of a high rate of malnourished children. Improving nutritional intake

 

and managing stunting are two foremost challenges. These can be dealt with an inter-sectoral strategy. Eating a well-balanced diet can help prevent malnutrition. Though it is a very challenging task to put together a meal that has all the required nutrients with inadequate resources on hand. However, an appropriate combination of food items can be served at pre-primary and primary school levels (age 4-6 years and 7-9 years respectively) to achieve the optimal nutritional level of a child. Food security refers to the nutritional security and fulfilment of individual needs. It provides an environment where each person has physical, economic and social access to sufficient, nutritious and safe food. Along with this, food security aims to meet the optimum dietary requirements and food preferences for living a healthy life. Availability, accessibility, and affordability are the three attributes of food security. (Ministry of Statistics and Programme Implementation, GoI, 2019)

Since independence, several schemes and programs have been implemented to achieve food security and eliminate malnutrition. In the 1960s, the Green Revolution was initiated with the aim to increase agricultural productivity and overall food production in the country and thereby address the issue of malnutrition. (Ministry of Statistics and Programme Implementation, GoI, 2019) For the first time ever, India produced a surplus stock of cereals with a national focus on calorie support for all, particularly for individuals from lower-income groups. Hereafter, the economy continued to grow in the decades that followed and there was a major drop in the poverty levels. In spite of this significant achievement, the rate of malnutrition remained and continues to remain high. Because of stunting, around 47 million children, that is, around 4 out of 10 children in India are unable to fulfil their human potential. The Integrated Child Development Services (ICDS) started in 1975 aims to provide nutrition and pre-school education to children. In 1995, the Mid-Day Meals (MDM) scheme and Anganwadi systems were started to provide nutritious meals to children among the age group of 6 to 14 years. Many schemes have been launched in recent years. Based on Zero Hunger framework, in 2016, the government launched a comprehensive Sustainable Development Goals (SDGs) in India. It comprises of 17 goals and 169 targets food security for improving nutrition and promoting sustainable agriculture that is intended to be achieved before 2030.

To improve nutrition, meet the food security targets and attain a malnutrition free country the Government of India has launched many reforms and schemes such as the National Food Security Act, the National Nutrition Strategy and the National Nutrition Mission (POSHAN Abhiyaan). The problem of stunting continues to remain greater than 30% across all states in India, except Kerala. To resolve this malice, the Government of India has challenged itself to reach 25% by 2022 by trying to reduce stunting by at least 2% per annum. Another new noticeable trend is that the daily per capita consumption of energy and protein has been declining in rural areas due to reduced intake of cereals while the per capita daily consumption of fat has been increasing significantly than in accordance with the Recommended Dietary Allowance (RDA). This situation needs urgent nutritional interventions to improve the intake of food items.

### 1.1 Research Objectives

a) To understand the measures taken by the government to ensure food security in India.
b) To understand the application of Operations Research in the food security system.
c) To apply an excel solver to solve a linear programming diet problem.
d) To identify a food menu that will meet the daily optimal nutritional level in children.
e) To suggest the optimal solution as a menu for the Mid-day Meal Programme.

### 1.2 Research Methodology

The research methodology applied here is an analysis of secondary data taken from various published research papers. Data on dietary guidelines and calorie intake was collected from a paper published by the National Institute of Nutrition. The research also involved in-depth analysis of number of papers and articles published by Indian and international authors. A research problem was created after studying various constraints, availabilities, and requirements. Linear Programming was formulated and solved using simplex method. The optimal diet plan was calculated with the help of Microsoft Excel Solver.

## 2. LITERATURE REVIEW

A review of the literature was done to understand the relation between the rate of food production and malnutrition amongst the children in India from various national research papers, journals, reports, and other published material. Food consumption, which largely depends on production and distribution, determines the health and nutritional status of the population. Long-term malnutrition is a great economic loss to the country and undermines development. A variety of foods, which are available and are within the reach of the common man, can be selected to formulate nutritionally adequate diets. The Mid-Day Meals (MDM) scheme addresses the issue of classroom hunger in school-aged children by providing a cooked meal every day. Under this scheme, appropriate combination of food items can be served at pre-primary and primary school levels (age 4-6 years and 7-9 years respectively) to achieve the optimal nutritional level of a child. Food security must be aimed to meet the optimum dietary requirements and food preferences for living a healthy life. The objective of this research paper is to understand the application of Linear Programming in the field of food security. The optimal portion of food items from a pre-decided menu is solved as a Linear Programming Problem. Constrains are developed as the recommended daily values of nutritional contents and are solved using the simplex method to obtain an optimal diet plan. The data on dietary guidelines and calorie intake was collected from a paper published by National Institute of Nutrition. The optimal diet plan was designed with the help of Microsoft Excel Solver. The optimal diet will create a food menu and the same will be suggested for the Mid-day Meal Scheme.

## 3. FINDINGS AND ANALYSIS

The quantitative approach of data collection and analysis has been used to identify the number of food items to be consumed by children aged 4-9 years in order to maintain the minimum nutritional level. In this situation, we are trying to obtain an optimal diet plan for children studying in pre-primary and primary schools which can be used in the mid-day meal scheme of the Government of India.

 

We have selected 7 food items that will be used to create a diet plan for children in two age groups i.e. 4-6 years and 7-9 years to meet the minimum daily nutritional level of 1690 Kcal and 1950 Kcal respectively. The kilocalories gained by consuming a portion of these food items and respective nutritional benefits are mentioned in the table below.

**Table 1: Nutritional content of food items (National Institution of Nutrition, 2011)**

| | Portion | Kcal | Protein(g) | Fat(g) | Carbohydrates(g) | Calcium (mg) | Fibres(g) |
|---|---|---|---|---|---|---|---|
| Wheat Phulka | 1 | 120 | 3.1 | 3.7 | 18 | 33 | 3.9 |
| Mashed Potato | 1 | 88 | 2 | 4.4 | 18 | 51 | 1.6 |
| Spinach | 1 | 23 | 3 | 0.3 | 3.9 | 324 | 2.5 |
| Rice | 1 | 194 | 4.1 | 0.4 | 42.8 | 33 | 0.6 |
| Moong Dal | 0.3 | 70 | 4.8 | 0.6 | 12.3 | 24 | 4.8 |
| Banana | 1 | 90 | 1.1 | 0.3 | 23.2 | 12 | 2.7 |
| Besan Barfi | 1 | 195 | 3 | 11 | 21 | 0 | 1 |
| TOTAL | | 731 | 17.74 | 20.28 | 130.59 | 460.2 | 13.74 |

In the above table, one portion of Besan Barfi and Wheat Phulka equals to 40 grams. Similarly, one portion of Moong Dal equals to 200 grams. One portion of rice equals 150 grams. For the rest of the food items, one portion equals to 100 grams.

The objective is: To gain 1690 Kcal (4-6 years) and 1950 Kcal (7-9 years) by minimizing the food intake. Subject to constraints shown in the table below:

**Table 2: Recommended daily values (National Institution of Nutrition, 2011)**

| Nutrition Values | 4-6 years (1690 Kcal) | 7-9 years (1950 Kcal |
|---|---|---|
| Protein | 30 | 41 |
| Fat | 25 | 25 |
| Carbohydrates | 253 | 292 |
| Calcium | 600 | 600 |
| Fibers | 21 | 24 |

Corresponding to the total amount of calories:

$$\text{Minimize } Z = 120x_1 + 88x_2 + 23x_3 + 194x_4 + 70x_5 + 90x_6 + 195x_7$$

At the daily level, the constraints that need to be satisfied are:
Protein (g):

$$30 <= 3.1x_1 + 2x_2 + 3x_3 + 4.1x_4 + 4.8x_5 + 1.1x_6 + 3x_7 <= 41$$

Fat (g):

$$3.7x_1 + 4.4x_2 + 0.3x_3 + 0.4x_4 + 0.6x_5 + 0.3x_6 + 11x_7 <= 25$$

Carbohydrates (g):

$$253 <= 18x_1 + 18x_2 + 3.9x_3 + 42.8x_4 + 12.3x_5 + 23.2x_6 + 21x_7 <= 292$$

Calcium (mg):

$$33x_1 + 51x_2 + 324x_3 + 33x_4 + 24x_5 + 12x_6 + 0x_7 <= 600$$

Fibres (g):

$$21 <= 3.9x_1 + 1.6x_2 + 2.5x_3 + 0.6x_4 + 4.8x_5 + 2.7x_6 + 1x_7 <= 24$$

Where $x_1$, $x_2$, $x_3$, $x_4$, $x_5$, $x_6$ and $x_7$ are the amounts of food given in Table 1.

At the daily level, there are constraints that need to be satisfied, regarding the amounts of protein, fats, dietary fiber, calcium, etc. A linear program in an Excel workbook was developed using Solver tool.

**Table 3: Solution generated using Microsoft Excel Solver**

| | Portion | Kcal | Protein(g) | Fat(g) | Carbohydrates(g) | Calcium (mg) | Fibres(g) |
|---|---|---|---|---|---|---|---|
| Wheat Phulka | 0 | 120 | 3.1 | 3.7 | 18 | 33 | 3.9 |
| Mashed Potato | 0 | 88 | 2 | 4.4 | 18 | 51 | 1.6 |
| Spinach | 1.25 | 23 | 3 | 0.3 | 3.9 | 324 | 2.5 |
| Rice | 3.24 | 194 | 4.1 | 0.4 | 42.8 | 33 | 0.6 |
| Moong Dal | 1.84 | 70 | 4.8 | 0.6 | 12.3 | 24 | 4.8 |
| Banana | 3.73 | 90 | 1.1 | 0.3 | 23.2 | 12 | 2.7 |
| Besan Barfi | 0 | 195 | 3 | 11 | 21 | 0 | 1 |
| TOTAL | | 1123.09 | 30 | 3.89845 | 253 | 600 | 24 |

The optimal solution given by the solver in this situation was of 1123.09 Kcal. Now, we search for the nutrient composition of the same diet for the amount of 1690 Kcal and 1950 Kcal.

 

**Table 4: Optimal composition of portions of food items**

| Food Item | Kcal | Portion consumed | Kcal 1123.1 | Portion consumed | Kcal 1690 | Portion consumed | Kcal 1950 |
|---|---|---|---|---|---|---|---|
| Spinach | 23 | 1.25 | 28.67 | 1.88 | 43.14 | 2.16 | 49.78 |
| Rice | 194 | 3.24 | 629.20 | 4.88 | 946.80 | 5.63 | 1092.46 |
| Moong Dal | 70 | 1.84 | 129.14 | 2.78 | 194.32 | 3.20 | 224.22 |
| Banana | 90 | 3.73 | 336.08 | 5.62 | 505.73 | 6.48 | 583.53 |
| | | Total | 1123.1 | Total | 1690.00 | Total | 1950.00 |

This is the optimal composition of portions of food items that will ensure meeting the minimum daily nutritional intake of 1690 Kcal and 1950 Kcal. The quantities of food items were obtained and a diet was prepared that satisfies the minimum number of calories which is 1690 Kcal/day for children aged 4 to 6 years and 1950 Kcal/day for children aged 7 to 9 years. This was done while satisfying the constraints of the daily nutritional requirements of a child. Portions of spinach, rice, moong dal, and banana were calculated using Excel which gave the ideal food menu.

## 4. CONCLUSION

A practical model of linear programming was developed using secondary data. The procedure was adapted to a diet problem, where the variables are food items, the constraints are nutritional requirements and the objective function is to reach a particular number of calories in a day for children. Using Solver in Microsoft Excel we provided a fast way to solve this diet problem and to formulate a food menu that will ensure the fulfillment of the daily nutritional requirements of children.

## 5. LIMITATIONS

While preparing a diet plan for malnourished children, we have to keep in mind the limited options available. When we take into account a selected few items for the menu, the portion size for each increase. This solution obtained is optimal, however, the portion size of some food items can be decreased by adding some new items that will meet the mentioned constraints.
The solver can only find the optimal portion size of each food item. The items have to be selected manually.
When certain food items do not satisfy the constraints, they are discarded by the solver. This increases the portion size of the other food items which gives an unrealistic solution.

## 6. REFERENCES

[1] Cristina-Elena. (2010). A LINEAR PROGRAMMING MODEL FOR A DIET PROBLEM. Suceava, Romania: Journal Food and Environment Safety of the Suceava University.
[2] Ministry of Statistics and Programme Implementation, GoI. (2019). Food and Nutrition Security Analysis, India, 2019. New Delhi: Government of India.
[3] National Institution of Nutrition. (2011). Dietary Guidelines for Indians. Hyderabad: National Institution of Nutrition.
[4] Ramani, V. (2019). Fixing Child Malnutrition in India: Views from a Public Policy Practitioner. The Hindu Centre for Politics and Public Policy, 28.
[5] Ruel, M. T. (2005). Operations Research: How It Can Strengthen. Washington, DC: International Food Policy Research Institute.
[6] Shelar, J. (2019). All you want to know about malnutrition in India. The Hindu, 1.
[7] The Hindu. (2019). 31.4% of Indian children will be stunted by 2022. The Hindu, 1.

 