Linear Programming Model and Dietary Plan for HIV- Infected Children Ages 6 - 9 Years Using Locally Available Foods in Simiyu, Tanzania

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Abstract— Most HIV - infected patients lose weight, and weight loss is linked to mortality in HIV patients. An adequate diet is essential at all times to avoid weight loss, combat infection, and build and retain muscular mass. A linear programming model has been employed to model the diet for HIV - infected children aged 6-9 years to maximize energy intake using locally available foods. Fifty-eight food items obtained from a previous 24 - hours dietary recall assessment was modeled. A food exchange list was used to distribute food items into breakfast, lunch and dinner. Three different dietary plans were formulated from locally available food with recommended amount of energy intake of greater than or equal to 1815 Kcal.

Keywords— Energy intake, HIV - infected children, Linear programming, Dietary plan, Recommended nutritional intake, Ready-to-use formulations, Food exchange list, Optimal.

I. Introduction

THE number of various food groups consumed over a reference period (often 24 hours) is referred to as dietary variety. It is commonly acknowledged as a crucial aspect of diet quality because eating foods from different food groups can potentially meet one's daily nutrient needs. Compared to non-infected persons, people living with HIV/AIDS (PLWHA) need more nutrients to maintain their immune systems. For instance, an adult who is HIV-uninfected needs about 2070 kcal of energy and 57 grams of protein per day, but an adult who is HIV-infected needs about 10 to 15% more energy and 50 to 100% more protein per day in people who are the same age, sex, and level of physical activity, [1].

Globally, approximately 36.9 million people are infected with HIV/AIDS, with 3.2 million being children under the age of 15 years. In Sub-Saharan Africa, 31% of those hospitalized to nutrition rehabilitation facilities had HIV, [2]. Furthermore, Tanzania HIV Impact Survey research funded by UNICEF indicated an HIV prevalence of 0.4% among Tanzanian children under the age of 15 years, [3].

Most HIV patients lose weight, and weight loss is linked to mortality in HIV patients. An adequate diet is essential at all times to avoid weight loss, combat infection, and build and retain muscular mass. Carbohydrates, protein, fats, vitamins, and minerals are all nutrients that the body requires to function effectively. Some of these nutrients (carbohydrates, proteins, and fats) are extremely important, [4].

The amount of energy required depends on the stage of the infection (viral load). Asymptomatic HIV-positive children and adults require 10% more energy than healthy HIV-negative children and adults of the same age, gender, and physical activity. HIV-positive children and adults with symptoms (symptomatic) require 20-30% more energy than HIV-negative children and adults of the same age, gender, and physical activity. Children who are HIV- positive and losing

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weight should consume 50-100 percent more calories, [2], [5], [6]. For example, energy requirements for HIV-positive children between 2 to 5 and 6 to 9 years who are asymptomatic are 1390 and 1815 kcal respectively, [5]. An individual's energy intake is controlled by the role of each nutrient in their diets and how their nutritional needs are addressed, [7]. There is no single food that can provide consumers with the necessary nutrients.

The protein requirement for humans is 12-15 percent of daily energy consumption. Protein is recommended to be consumed at 0.8 g per kilogram of ideal body weight per day by healthy adults, [8]. Protein requirements per kg of body weight per day for children aged 4 to 13 years are 0.95 g per kilogram of body weight per day. According to [4], people living with HIV should consume the same amount of protein as HIV-negative people of the same age, gender, and degree of physical activity. However, as a result of their increased energy consumption, HIV patients may consume more protein, [9].

Dietary fat contains necessary fatty acids and concentrated energy. People living with HIV who do not have fat malabsorption or diarrhea can consume fat to help satisfy their increased energy requirements, [9]. [4], does not recommend that HIV-positive patients have a larger percentage of fat in their entire diet than HIV-negative people. However, the amount of fat required to maintain the amount of energy produced from fat will increase due to the increased energy consumption.

A linear programming model has been employed to model the diet for Malaysian boarding school students to minimize the budget provided by the Malaysian government and maximizing the variety of food intake, [10, [11]. Their model also wanted to achieve the maximum nutritional requirement based on the Malaysian Recommended Daily Allowance (RDA) requirements.

[12], developed a linear programming model for instant food formulation for Tanzanian children aged 2 to 23 months. Their model computes the grams of each food type – Quelea mixed with either Green Banana or White Rice or Irish Potato and Onions, Tomatoes, Carrots and Green bell Pepper. When those foods are combined, an instant food complement will be created and entirely satisfy the preset needs of malnourished children.

The study by [13], which combined multiple linear regression models and linear programming models for people living with HIV as well as AIDS patients by considering age, weight, height and gender. The linear programming problem formulated is solved by the two-phase simplex method in MATLAB. Results show that adequate amounts of foods that achieve the recommended nutrients were determined.

[14], created linear goal programming models in five Ethiopian areas for three scenarios (non-fasting, continuous fasting, and intermittent fasting). The models try to minimize a function of deviations from nutrient reference values for 11 nutrients (protein, calcium, iron, zinc, folate, and vitamins A, B1, B2, B3, B6, and B12). 494 Ethiopian women of reproductive age completed two non-consecutive 24-hour dietary recalls (24HDR). In comparison to the current diet, women's mean energy intake was well above 2000 kcal across all socio-demographic groupings. The simulated diets may be realistic for reproductive-age women because they are similar to their existing diets and meet their energy and nutritional requirements.

[15], employed goal programming to balance nutrients in the Thai people's daily diet (19). In North America, [16], used linear programming to create a new nutrition plan for low-income American families (20). Since then, modeling has become more popular across various population groups, [17]. A linear goal programming technique adapted from the model proposed by [18], was employed in the current investigation. Previous research in the Netherlands and Tanzania employed the goal programming technique to optimize individual diets, [19], [20].

The study on solving diet problems using optimization approach as the intervention for menu plans for HIV - infected children has been lacking in Tanzania. Thus, the current knowledge about menu planning and diet problems is expanded for Tanzanian HIV - infected children aged 6 to 9 years that focuse on locally available foods. Therefore, this study aims to develop mathematical model of healthy diet menu plan that maximizes the daily total energy intake, with consideration of recommended nutrient intake (RNI) for Tanzanian HIV - infected children aged 6 to 9 years old.

The following are the remaining sections of this paper: Section 2 describes the materials and methods used in this study. The model analysis is presented in Section 3 of the manuscript. The results are discussed in Section 4. Section 5 presents a summary of the findings, highlights the research contributions, and identifies opportunities for future investigation.

II. Material and Methods

Breakfast, lunch and dinner are the three meals served each day in most of Tanzania. The optimization method was used to address the healthy food menu plan for HIV-infected children, and linear programming was chosen as a technique to formulate a mathematical model for this study.

A. *Developing of Linear programmed dietary plan (LPDP)*

The primary goal of this study is to develop a menu planning model that maximizes total calorie intake in HIV-infected children. This model also attempts to meet the maximum nutritional needs based on Tanzanian RNI guidelines. Table I shows the upper and lower boundaries for four nutrients which are energy, fats, carbohydrates, and protein with the percentage excess for HIV-infected children.

TABLE I. DAILY NUTRIENTS REQUIREMENT FOR HIV - INFECTED CHILDREN 6-9

Nutrients	Lower Bound (LB)	Upper Bound (UB)
Energy (kcal)	1390	1815
Fat (g)	42	46.3
Carbohydrate (g)	130	191.1
Protein (g)	13	52.1

The concept of developing the linear programmed dietary plan was adopted from, [21]. The dietary plan was developed using the food list obtained from a 24-hour recall conducted at the baseline data collection. During the baseline phase, a total of 58 food items that were commonly consumed by children were gathered from their caretakers as shown in Table II.

TABLE II. FOOD REQUIREMENTS WITH THEIR NUTRIENTS

S/N	FOOD SAMPLE	ENERGY (Kcal)	PROTEIN(g)	FAT(g)	CARBOHYDRATE (g)
1	Rice burn	416.2	4.7	11.1	73.7
2	Bread, white	249	7.7	1.9	48.8
3	Buns (mandazi)	306	7	6.8	52.8
4	Fresh milk (whole)	60	3.2	3.3	4.5
5	Mashed potatoes	106	2.5	0.2	22.8
6	Fried sweet potatoes	248	3.1	13.9	25.3
7	Fried Egg	223	13.1	17.9	2.5
8	Boiled egg	155	12.6	10.6	1.6
9	Meat samosa	443	18.8	22.2	40.5
10	Pancakes (chapati za maji)	270	8.3	8.5	39.2
11	Rice porridge with sugar	94.6	0.6	0.1	23
12	Maize porridge with sugar	94	0.0	0.4	22.7
13	Cassava boiled	131	0.0	0.3	31.9
14	Sweet potatoes fried	146.1	0.0	5.1	24.3
15	Rice boiled with oil	199.9	5.6	0.6	30
16	Rice with milk	176	3.9	5.7	27.2
17	Sorghum, grain, red flour	366	9.3	3.5	59.9
18	Banana with meat	77.4	2.7	3.6	9.4
19	Potato, Irish peeled boiled	105	2.4	0.1	22.7
20	Maize and sorghum ugali	110	3	0.9	24.7
21	Sweet potatoes boiled, drained	101	1.7	0.4	20.8
22	Yam, white, boiled drained	118	2	0.2	24.9
23	White chapati	413	7.3	22.9	40.9
24	Rice flour porridge	56	0.6	1.3	10.2
25	Cassava flour ugali	186	1.1	0.3	43.7
26	Whole maize flour ugali	141	3.3	1.8	26
27	Refined maize flour ugali	148	3.4	1.9	27.3
28	Cassava and red sorghum ugali	116	2.1	0.8	23.4
29	Sorghum, millet and cassava porridge	46	0.5	0.1	10.2
30	Pilau	213	6.9	9.4	24.8
31	Boiled rice	138	2.7	2	27.3
32	Potatoes in rice	111	2.2	1.9	21.1
33	Beans kidney dry unsoaked boiled	70	4.9	0.5	9.4
34	Sweet potatoes with peanut butter	89	22	4.4	9
35	Dehulled maize and beans	161	5	5.9	19.8
37	Amaranth	23	8.5	0.5	8.5
38	Pumpkin leaves boiled	35	4	0.7	2.1
39	Sweet potatoes leave	35	4.8	0.3	6.4
40	Spinach leaves	33	3.5	0.4	1.4
41	Mlenda	59	3.4	2.3	5.4
42	Pigeon peas, boiled	95	6.5	0.7	12.1
43	Lentils, unsoaked, boiled	75	6.7	0.2	9.7
44	Cabbage	19	1.1	0.1	2.2
45	Fish smoked	306	66.4	2.5	0
46	Stewed dried fish	330	25.7	23.2	3.9
47	Pork, meat, boiled	374	29.1	28.6	0
48	Sardine dried stewed	180	8.8	13.3	6.0
49	Chicken boiled	226	23.7	14.6	0
50	Sardine fried	450	19.2	39.3	4.6
51	Fish boiled	76.5	8.2	4.5	2.4
52	Fish relish with oil	253.6	21.2	17.9	2.2
53	Yoghurt, cow milk whole plain	85	2.9	3.1	11.3
54	Baobab pulp	305	4.2	1.3	77.8
55	Banana ripe	89	1.1	0.3	22.8
56	Avocado	160	2	14.7	8.5
57	Sunflower oil	900	0	100	0
58	Groundnut	593	20.1	48.4	15

[22], Extracted from Tanzania food composition table 2008

To achieve the required energy intake to meet the energy needs of asymptomatic HIV-infected children aged 6-9 years, a 10% increase in energy intake was used. The linear programming model under consideration aims to maximize energy intake by optimizing the consumption of carbohydrates, proteins, and fats.

The objective function of our model was to maximize the total amount of calories (energy) to be eaten per day. We let the food list obtained into, [21]. The development of the linear model involved the objective function utilized in this study was calculated from Kilocalories (Kcal), whereas the constraints were determined based on the individual nutrients, namely carbohydrates, proteins, and fats. These nutrient values were obtained from the Tanzania food composition table, [22]. The models were entered into computerized software and encoded using Lingo version 8.0 software, [20]. These models were then solved to optimize energy and determine the amount of each type of food included in the dietary plan. Subsequently, the acquired values were multiplied by a factor of 100g to determine the accurate gram measurement of the food.

Among 57 list foods, 30 lists of food were obtained from lingo and the food exchange list were used to convert the gram of food selected into food portion size. The meal planning food exchange list is a tool designed to facilitate the substitution of foods within a certain food group. This tool offers consumers the freedom to adhere to their dietary plan for illness management more effectively, [23]. Three dietary plans were formulated from locally available food with a recommended amount of energy intake of 1390 Kcal, [24] as shown in Fig. 1. The initial version was submitted for expert evaluation, and a consultation was conducted with a nutrition specialist from the Tanzania Food and Nutrition Center as well

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as a linear programming expert. Following a comprehensive expert examination, the initial draft was then declared suitable for usage in the field and has thus been accepted as the final draft. The final draft was also pretested to assess its effectiveness.

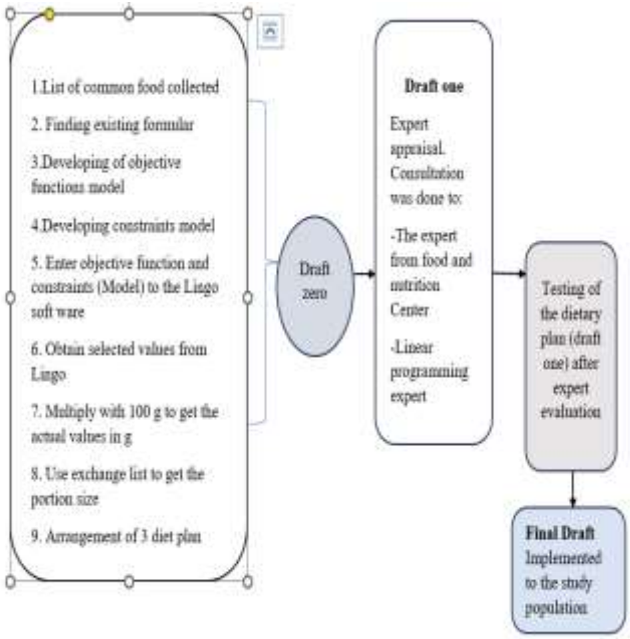

Fig. 1 LPDP developmental framework

B. Model Formulation

Based on the data given in Table I and Table II, a linear programming model is developed. The model should produce 3 menus (breakfast, lunch and dinner) for HIV - infected children.

As previous said, we have 58 types of food available, hence we have 58 variables (x_i) where $i = 1,2,3, \ldots, 58$. Table II shows the available range of selection for each type of food.

C. Objective Function

The goal of this study is to increase the number of kilocalories of the anticipated menu formulation to meet the needs of this group of children. Consequently, the following is the linear programming model for this study:

$$Max\ Z = \sum_{i=1}^{n} e_i x_i \tag{1}$$

subject to;

$$\sum_{i=1}^{n} a_{ij} x_i \geq L_j, \quad j = 1,2,3,\ldots,n \tag{2}$$

$$\sum_{i=1}^{n} a_{ij} x_i \leq U_j, \quad j = 1,2,3,\ldots,n \tag{3}$$

$$x_i \geq 0, \quad i = 1,2,3,\ldots,n \tag{4}$$

where Z is the total energy to be maximized

x_i =Amount in 100 grams of food type i

e_i = The number of calories in 100 grams of food type i

a_{ij} = Amount of nutrient in 100 grams of nutrients j in food type i

L_j = Maximum daily intake of nutrient j in food type i

U_j = Minimum daily intake of nutrient j in food type i

$n =$ Number of foods used in the diet

The sum of equation (1) is the total energy of the food type i to be maximized. Equation (2) is the constraint that ensures that the sum of nutrients in food type i should exceed or equal to the lower bound of the RDA. Equation (3) is an upper bound constraint, which ensures that the sum of nutrients in food type i does not exceed the upper limits of RDA while equation (4) is a non-negativity constraint, which ensures that the values of the decision variable are either zero or positive.

III. RESULTS – DIETARY PLAN FOR HIV INFECTED CHILDREN

The list of 30 foods was obtained and the food exchange list was used to convert the grams of food selected into food portions. Three dietary menus were formulated from locally available food with a recommended amount of energy intake of greater than or equal to 1815 Kcal. Table III shows that each menu includes a variety of items presented in different ways, as well as three sorts of meals: breakfast, lunch, and dinner. All of these items meet the daily dietary needs of HIV-infected children. As a result, all of the meals chosen are nutritious and should be served to HIV-infected children aged 6 to 9 years old.

TABLE III. THREE DIFFERENT DIETARY MENUS FORMULATED

MENU 1	MENU 2	MENU 3
BREAKFAST	**BREAKFAST**	**BREAKFAST**
1 Bun (Andazi)	Rice with milk 1 cup (bokoboko)	Maize porridge with sugar
Fresh milk(whole) , ($^1/_2$ cup) 1 orange	Baobab juice (1 glass)	(2 cups), 1 Boiled egg
LUNCH	**LUNCH**	**LUNCH**
Whole maize flour stiff porridge 2 cups (ugali)	Maize and kidney bean dish 2 cups	Boiled rice (2 cups)
Boiled fish ($^1/_2$ palm)	(Makande), stewed Sardine (1 cup)	Fish smoked ($^1/_2$ palm)
Pumpkin leaves ($^1/_2$ cup)	Mlenda / Sweet potatoes leaves ($^1/_2$ cup)	Amaranth (1 cups)
Yoghurt, cow milk (whole plain) ($^1/_3$ cup)	Avocado (1 piece)	Fresh Milk ($^1/_2$ cup)
DINNER	**DINNER**	**DINNER**
Dried sweet potatoes 2 cups (michembe)	White chapatti ($^1/_2$ piece)	Whole maize flour stiff porridge 2 cups
Chinese leaves (2 cups)	Beans kidney dry unsoaked boiled (1 cup)	(Ugali)
		Beef stew (1 piece)
		Cabbage (1 cup)

The models were coded in the Lingo version 8.0 software as shown in Fig. 2 and solved to optimal, which gives out the amount of each type of food chosen in the menu for breakfast, lunch, and dinner. Fig. 3 shows the sample model results for one menu. The obtained values were then multiplied by 100g to yield the actual gram of food.

```
Max Z = 245*x1 + 249*x2 + 306*x3+ 150*x4 + 122*x5 + 366*x6+ 341*x7 + 105*x8+ 101*x9 + 118*x10 + 66*x11 + 70*x12 + 159*x13 + 30*x14 + 35*x15 + 43*x16+ 33*x17 + 185*x18 + 36*x19 + 59*x20 + 152*x21 + 330*x22 + 106*x23 + 248*x24 + 326*x25 + 95*x26 + 75*x27 + 73*x28 + 41*x29 + 96*x30 + 374*x31 + 152*x32 + 900*x33 + 413*x34 + 56*x35 + 186*x36 + 141*x37 + 148*x38 +116*x39 + 46*x40 + 223*x41 + 443*x42 + 270*x43 + 213*x44 +138*x45 + 185*x46 + 356*x47 + 85*x48 + 48*x49 + 134*x50. + 331*x51 + 226*x52 + 228*x53 + 166*x54 + 593*x55 + 19*x56 + 402*x57;

Constrain for Protein

13 <= 8*x1 + 7.7*x2 + 7*x3 + 5.6*x4 + 4.4*x5 + 9.3*x6 +10.8*x7 + 2.4*x8+ 1.7*x9 + 2*x10 + 5.6*x11 + 4.9*x12 + 14*x13 + 0.7*x14 + 4*x15 + 2.8*x16+ 3.5x17 + 1.6*x18 + 1.1*x19 + 3.4*x20 + 2.7*x21 + 25.7*x22 + 2.5*x23 + 3.1*x24 + 4.8*x25 + 6.5*x26 + 6.7*x27 + 6.4*x28 + 0.48*x29 + 0.8*x30 + 29.1*x31 + 27*x33 + 7.3*x34 + 0.5*x35 + 1.1*x36 + 3.3*x37 + 3.4*x38 + 2.1*x39 + 0.5*x40 + 13.1*x41 + 18.8*x42 + 8.3*x43 + 6.9*x44 + 2.7*x45 + 3.2*x46 + 25.9*x47 + 2.9*x48 + 11.2*x49 + 12.7*x50. + 16.1*x51 + 23.7*x52 + 24*x53 + 18.6*x54 + 20.1*x55 + 1.1x56 + 31.1*x57>=52.1;
Constrain for Fats

42 <= 1.5*x1 + 1.9*x2 + 6.8*x3+ 0.6*x4 + 0.5*x5 + 3.5*x6+ 3.5*x7 + 0.1*x8+ 0.4*x9 + 0.2*x10 + 0.3*x11 + 0.5*x12 + 7.9*x13 + 0.2*x14 + 0.7*x15 + 0.5*x16+ 0.4*x17 + 19.6*x18 + 1.2*x19 + 2.3*x20 + 3.2*x21 + 23.2*x22 + 0.2*x23 + 13.9*x24 + 13.6*x25 + 0.7*x26 + 0.2*x27 + 0.4*x28 + 0.2*x29 + 0.1*x30 + 28.6*x31 + 4.8*x32 + 100*x33 + 22.9*x34 + 1.3*x35 + 0.3*x36 + 1.8*x37 + 1.9*x38 +0.8*x39 + 0.1*x40 + 17.9*x41 + 22.2*x42 + 8.5*x43 + 9.4*x44 +2*x45 + 5.1*x46 + 28*x47 + 3.1*x48 +8.1*x50. + 28.2*x51 + 14.6*x52 + 14.7*x53 + 8.6*x54 + 48.4*x55 + 0.1*x56 + 30.8*x57 >= 46.3;
Constrain for Carbohydrate

130 <= 49.6*x1 + 48.8*x2 + 52.8*x3+ 30*x4 + 24.5*x5 + 59.9*x6+ 60.5*x7 + 22.7*x8+ 20.8*x9 + 24.9*x10 + 7.7*x11 + 9.4*x12 + 4*x13 + 4.5*x14 + 2.1*x15 + 5.5*x16+ 1.4*x17 + 5.4*x19 + 5.4*x20 + 27.9*x21 + 3.9*x22 + 22.8*x23 + 25.3*x24 + 44.4*x25 + 12.1*x26 + 9.7*x27 + 9*x28 + 8.1*x29 + 22.9*x30 + 40.9*x34 + 10.2*x35 + 43.7*x36 + 26*x37 + 27.3*x38 + 23.4*x39 + 10.2*x40 + 2.5*x41 + 40.5*x42 + 39.2*x43 + 24.8*x44 +27.3*x45 + 31.2*x46 + 11.3*x48 + x49 + 2*x50. + 3*x51 + 3.5*x54 + 15*x55 + 2.2*x56 >=191.1;
```

Fig. 2 Lingo code for the formulated linear programming model

```
Global optimal solution found.
Objective value:              1815.872
Infeasibilities:              0.000000
Total solver iterations:             3
Elapsed runtime seconds:          0.21

Model Class:                        LP

Total variables:              10
Nonlinear variables:           0
Integer variables:             0

Total constraints:             4
Nonlinear constraints:         0

Total nonzeros:               10
Nonlinear nonzeros:            0

      Variable        Value        Reduced Cost
            X3     1.500000        0.000000
            X4    0.5000000        0.000000
           X20     1.374404        0.000000
           X25     2.000000        0.000000
           X37     1.000000        0.000000
           X39     4.448147        0.000000
           X52    0.8000000        0.000000
           X55     1.200000        0.000000
           X56    0.3540980E-01    0.000000
           X58    0.4000000        0.000000

           Row    Slack or Surplus    Dual Price
             1     1815.872           1.000000
             2     0.000000           6.747515
             3     0.000000           9.000000
             4     0.000000           4.131213
             5     0.000000          -20.56064
             6     0.000000          -9.882505
             7     0.000000          -4.878330
             8     0.000000          -6.965606
             9     0.000000          -9.150497
            10     0.000000          -20.91034
            11     0.000000          -43.00636
```

Fig. 3 Lingo solution for one menu

IV. DISCUSSION

This was the first study to explain in detail the dietary menu planning model of HIV-infected children aged 6 to 9 years in Tanzania, as well as to construct a linear programming model that maximized energy intake for this group. Their current supplemental feeding strategies cannot meet the calorie requirements of this group of children.

In contrast to [25] , the method for achieving an ideal nutritional dietary plan via a linear programming model is to substitute nutrient-dense food groups with energy-dense food groups. As indicated in Table I, the majority of the food categories in the optimized dietary menu were energy-dense, with fewer quantities being nutrient-dense. As the most nutrient-dense food, green vegetables and red-yellow vegetables increased the most in quantity, which is challenging for children in this age range to ingest, [20]. The presence of coarse grains (maize flour) in each optimal dietary menu might be substantiated by the fact that coarse grains contributed the most energy and 15 nutrients, [25].

The objective function was to maximize energy intake while reducing deviation from RDA to ensure an optimum nutritional diet that reflected variances in food choices across geographical locations. Higher intakes of wheat maize flour, boiled fish, green vegetables (Pumpkin and Chinese), sweat potato, and milk (fresh and yogurt) are included in Menu 1. As a result, by specifying a goal function such as reduced deviation from RDA, the optimized dietary menu could be nutritionally adequate while still reflecting food preferences based on geographical area.

The nutritional requirements for children under the age of two and those beyond the age of fourteen will differ from those used here, and this will influence menu selection. Each menu contains more than 1815 Kcal of total energy. As a result, we may serve nutritious foods that maximize daily total energy consumption while taking recommended nutritional intake (RNI) into account for Tanzanian HIV-infected children utilizing locally accessible foods. Based on changes in the model's parameters, a strategy based on post-optimality analysis and further translation into the local menu will be developed in the future.

Table III shows how the developed model gives the best menu (breakfast, lunch, and dinner) in three different types of meals. The decision variables, which are the amounts of each type of food displayed in Fig. 3, indicate that the calorie content of diets can be improved as long as the number of servings on each menu is increased. According to the findings, the optimized diets meet the daily energy (1815 kcal) and nutrient requirements of HIV-infected children. The developed dietary menu plan model will need further translation into local menu development and to be experimented with in practice.

V. Conclusion

The study developed three different meal plans that can be used as a guide for HIV-infected children's dietary plans. The model was written in LINGO version 8.0 and optimized. It met all of the study's constraints and provided a promising solution. This study focused on HIV-infected children aged 6 to 9 years in Tanzania. We recommend validation of the nutrient contents and amount of energy by using different methods however the planned menu can be used to address nutrition needs of the group. Thus, to create new ready-to-use formulations, clinical nutritionists might utilize the linear programming methodology presented in this work. Nonetheless, nutritional composition analyses and evaluations of the formulations' acceptability and therapeutic efficacy are the initial steps towards verifying the LP's creations' nutritious content.

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