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BACHELOR THESIS

Healthy lifestyle: A linear programming approach

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BACHELOR THESIS ASSIGNMENT

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Business Administration

Thesis title

Healthy lifestyle: A linear programming approach

Objectives of thesis

Objective of thesis: how to be fit with least cost?

These days, times are tough and money's tight. And as you look for ways to cut back on expenses, the high cost of your fitness regime may be the first to go. But don't let the poor economy effect the way you exercise. You can still stay fit without busting your budget.

Therefore, the subobjectives of the thesis are:
-to identify the spending on healthy lifestyle;
-to analyze different types of workout, summarize benefits from them;
-to find practical application of the proposed programs in the fitness clubs and gyms;
-to find the best least cost opportunity to get fit.

Methodology

To solve the problem of least cost way to get fit and to elect the best variant from proposed, it can be used linear programming approach.

The method of data analysis employed in this study was Linear Programming (LP) model. The model was designed to reflect various workout combinations used by actual consumer's spendings, current market prices, nutrient composition and together with the power load to obtain a least-cost ration.

There must be a linear relationship between the output and the total quantity of each resource consumed. If the objective function is not linear, the technique will not be applicable.

The objective is to minimize consumer's spendings on getting fit.

The proposed extent of the thesis

40 pages

Keywords

Health, linear programming, approach lifestyle, fitness, leisure, get fit, gym, yoga, stepping, physical exercises.

Recommended information sources

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Declaration

I declare that the Bachelor thesis called "Healthy lifestyle: A linear programming approach" was written by me as the result of my own personal research and all sources which I have used are listed at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any other person.

In Prague on ______________________________

Kateryna Marchuk

Acknowledgement

In the first instance, I would like to thank my family who gave me the huge possibility to study and live abroad, especially they have been supported me during writing this thesis. Moreover, I am particularly grateful to Ing. Petr Procházka, MSc, Ph., for his assistance, patience and valuable advices. As well, I wanted to thank all professors for their invaluable experience and important knowledge that they shared with us.

Healthy lifestyle: A linear programming approach

Zdravý životní styl : Přístup lineárního programování

Summary

The main purpose of the thesis is to define the best optimal solution of minimizing cost spend on healthy food and visiting gym or fitness club. The goal was achieved using a linear programming model and simplex method for diet and gym problem.

This case consists of two main parts. The theoretical part contains information about food production, prices, diversity of food, the meaning of healthy lifestyle, different types of workout. It maintains the data of undernourishment and overeating, the scarcity of food in all over the world. Furthermore, this part comprises information about the linear programming method and data, which allows you to eat healthy food and visiting gym without spending a huge amount of money on.

The practical part includes the understanding of diet and gym problem, constructing the linear programming models using constrains and given variables by a menu of healthy and proper nourishment. The duality problem for diet model was considered, besides, sensitivity report was analysed and recommendations were given. The gym problem was analysed through two models using different constraints, with the aim of comparison the final optimal solution.

All the data used in the thesis was collected, analysing and distributed using previous scientific researches, online sources and own computation.

Keywords: health, linear programming, approach lifestyle, fitness, leisure, get fit, gym, yoga, stepping, physical exercises

Souhrn

Základním cílem této práce je určit nejlepší optimální řešení k minimalizovaní náklad na zdravé stravování a návštěvu posilovny nebo fitness klubu. Dosažení cíle bylo provedeno pomocí modelu lineárního programování a simplexní metody pro stravu a posilovnu.

Táto práce se skládá ze dvou hlavních částí. Teoretická část obsahuje informací o produkcí potravin, cenách, různorodostí potravin, významu zdravého životního stylu, různých druzích cvičení. Zahrnuje údaje o podvýživě a přejídání, o nedostatku potravin v celém světě. Kromě toho, táto část obsahuje informace o metodě lineárního programování a udají, které se vám umožnují zdravě stravovat a chodit do posilovny, aniž byste museli utratit obrovské množství peněz.

Praktická část obsahuje podstatu problémy diety a fitnessu, vybudování modelů lineárního programování pomocí omezení a proměnných získaných na základě menu zdravé a správné výživě. Byl posouzen problém duality pro model diety, kromě toho byla analyzovaná zpráva o citlivosti a vydaný doporučení. Problém posilovny byl rozebrán při použiti dvou různých modelů, s cílem srovnání konečných výsledku optimálního řešení. Veškeré udají použité v diplomové práci byly shromážděný, analyzování a distribuování pomocí předchozích vědeckých výzkumů, online zdrojů a vlastních výpočtů.

Klíčová slova: zdraví, lineární programování, životní styl, fitness, volný čas, dostat se do formy, tělocvična, jóga, krokování, tělesné cvičení

Table of Contents

List of tables

List of figures

1. Introduction

Nowadays it is a very urgent issue of healthy eating. However, unfortunately, due to life circumstances, not all people have the resources and time correctly, and most importantly, for healthy eating. Due to work commitments, lack of money or simply a reluctance to look after themselves, many people forget about the good old saying "In a healthy body - healthy mind".

The most important reason for non-compliance with a healthy diet is, first, the lack of sufficient financial resources.

Today, in the conditions of millionth megacities, people began to save on everything, it also related to mealtime and food quality. Due to lack of time, many people have switched to fast food, and completely forgotten about healthy wholesome food.

It is very important to keep up to a certain extent in terms of saving. At first, people need to determine their willingness and ability to design the desired result. Without the right goals, the result will be distorted or not reached at all. To avoid overeating or undernourishment, and thus satisfy yours desires, you need to make a list of the correct diet.

Therefore, in my Bachelor thesis I want to identify and understand how to use the knowledge of economics and linear programming approach for achievement balanced results, namely to satisfy human desires and do not harm a health.

2. Thesis Objectives and Methodology

2.1 Objectives

The aim of this work, primarily, is the compliance of a healthy lifestyle using the linear programming method.

That is, the object of study is precisely the possibility of a healthy diet and exercise, taking into account all the factors of the modern world. These factors can be expressed in different forms, such as lack of time, money, desire or simply ignorance of the laws of economics.

Therefore, in this thesis, I would like to highlight such goals as:

-to identify the spending on healthy lifestyle;

-to compare different types of workout, summarize benefits from them;

-to find practical application of the proposed programs in the fitness clubs and gyms;

-to find the best least cost opportunity to get fit.

2.2 Methodology

To solve the problem of least cost way to get fit and to choose the best variant from proposed, can be used linear programming approach.

The method of data analysis employed in this study was Linear Programming (LP) model. The model was designed to reflect various workout combinations used by actual consumer's spending, current market prices, nutrient composition and together with the power load to obtain a least-cost ration.

There must be a linear relationship between the output and the total quantity of each resource consumed. If the objective function is not linear, the technique will not be applicable. The objective is to minimize consumer's spending on getting fit.

2.3 The importance of study

The importance of the work lies in the ability to correctly and efficiently, with the help of economic knowledge and the calculations, find the best option among all of the offers in the market of goods and services. The major case of the study is to search, evaluate, compare and select the optimal option among the proposals.

As an opportunity to find new options or create alternatives, based on studies and analysis. With the help of already existing experience, create own combinations of alternative solutions that will exclude the shortcomings that had in the past.

3. Theoretical part

3.1 Food production, prices and diversity

Every day we all process food when preparing a meal for ourselves or our family and virtually all food undergo some form of processing before they are ready to eat. Some foods are even dangerous if eaten without proper processing. The most basic definition of food processing is “a variety of operations by which raw foodstuffs are made suitable for consumption, cooking, or storage”. Food processing includes any action that changes or converts raw plant or animal materials into safe, edible and more enjoyable, palatable foodstuffs. Without food, processing it would not be possible to sustain the needs of modern urban populations, and the choice of foods would be limited by seasonality (Henry CJK and Chapman, 2002).

Food processing typically involves activities such as mincing and macerating, liquefaction, emulsification, and cooking (such as boiling, broiling, frying, or grilling), pickling, pasteurization, and many other kinds of preservation; and canning or another packaging (Henry CJK and Chapman, 2002).

Analyzing the work MacEvilly C and Peltola K. it is possible to highlight a certain number of benefits, which are the result of processing raw materials. The first one can be identified as palatability and sensory improvements, which acts in practice like quite elaborate processing of raw products before it becomes palatable. For example, wheat processing consists of a long multi-threaded manufacturing algorithm. First, there is grain harvesting, then removal of the husk, stalk, dirt and debris. The cleaned up grain is usually cooked or milled into flour and then it is often made into another product such as bread or pasta (MacEvilly C. and Peltola K., 2008).

The next benefit of food processing arises preserved and improved nutritional quality. Processing such as freezing preserves the nutrients that are naturally present in foods. Other processes, like cooking, can sometimes improve the nutritional value by making nutrients more available. Moreover, the last one, but the most important advantage of food processing is safety. Many processing techniques ensure the safety of foods by reducing the numbers of harmful bacteria that can cause illness (e.g. pasteurization of milk). Drying, pickling and smoking reduce the water activity (i.e. water available for bacterial growth) and alter the pH of foods and thereby restrict the growth of pathogenic and spoilage microorganisms and retard enzyme reactions (Henry CJK and Chapman C, 2002).

In nature, there are no products that would contain all essential components (except for breast milk, but only for newborns). Therefore, only a combination of different products provides the best delivery of the body with the food it needs nutrients. With a wide variety of products for the body to optimal functioning easier to select the appropriate substance. Above all, it relates to food micro components, such as for example vitamins and minerals. The processes of learning and the exchange of micro elements often dramatically activated in the presence of other nutrients, sometimes several. All this speaks in favor of the diversity of foods in our diet (Chek P., 2004).

A variety of products to some extent provides a hygienic safety. In connection with the development of chemicals used in agriculture and increases, the negative influence of industry on the environment in some areas can accumulate and enter the food different harmful substances (pesticides, lead compounds). Completely eliminated for all products, produced even in the same area, are equally accumulated noxious substances (Chek P., 2004).

A variety of products, in any case, "dilutes" the concentration of these substances to a safe level. Therefore, variety in the diet is not only a positive effect on the nutritional significance, but also provides better security against harmful substances that could accidentally get into food. The human body has developed a protective reaction on a monotonous diet - "monotony", associated with loss of appetite. On the other hand, many different foods often cause increasing of appetite, rising of the secretion of digestive juices, better digestibility of nutrients. The human shows that a varied diet more accurate, more physiologic (Chek P., 2004).

But how to diversify the food? It depends on the season, from the available options. Ideally, the food should be varied both during the day and during the week. As for the home environment, then there is a very real opportunity to organize "fish", "milk", "vegetable", and similar days. The more imagination you show the preparation of the menu, the better.

Everybody knows that if you want quality and fresh food, then you need to pay a hefty price for it. Nevertheless, does it work in practice? Due to the process of modernization, globalization and the high level of competition, it is not too difficult to find fresh quality products for a good price. Recently, there are such services as delivery of healthy food at home. That to some extent completely excludes any time spent on the purchase and preparation of food.

According to statistic data which provided by Selfmadetrip, we can analyse how can be changed prices for basic products in different countries. It is not a secret, that in well-developed countries salaries are high, respectively the prices for products also will be big. The second table represents the relation between average salary and costs of a product. In this comparison, the smallest salary is in Russia (6007 dollars), but the least amount of cost is in USA (6,5%). So, if we calculate the costs of food for both of these countries it will be 3714 dollars costs on food in the USA with salary 57139 dollars, and 1766 dollars in Russia. The conclusion is, that in proportional comparing costs are related to salaries and standard of living. So, basically, doesn't matter where you live, it is possible to afford normal healthy food with using economics knowledge about savings and rational usage of food (selfmadetrip.com, 2016).

Table 1. Cost of products in developed countries

Country	Cost of product in dollars					
	Milk	Bread	Egg(12pieces)	Cheese(1kg)	Beef(1kg)	Potato(1kg)
Australia	1,14	2,07	3,6	7,2	11,8	2,2
United Kingdom	1,3	1,4	2,9	8,5	12,7	1,7
Germany	0,8	1,6	1,9	8,5	14,3	1,2
Israel	1,5	1,7	1,8	11,4	16,6	1,1
Spain	0,9	1,1	2,9	10,5	12	0,9
Italy	1,3	1,6	2,9	12,7	15,9	1,3
Canada	2,1	1,6	2,6	9,2	11,1	1,9
USA	0,94	2,56	2,73	10,49	11,97	2,61
France	1,1	1,4	3,1	14,7	19,1	1,6
Russia	0,7	0,5	1,1	6,6	4,6	0,2

Source: The data obtained from statistical reports available on selfmadetrip.com, 2016

Table 2. Relationship between average salary and costs on food

Country	Average salary, dollars per year	Costs on food, %
Australia	51 148	10,6
United Kingdom	41 659	8,7
Germany	43 872	10,6
Israel	29 635	17,8
Spain	36 013	13,4
Italy	34 744	14,2
Canada	48 164	9,6
USA	57 139	6,5
France	40 828	13,6
Russia	6007	29,4

Source: The data obtained from statistical reports available on selfmadetrip.com, 2016

3.2 Healthy lifestyle

3.2.1 Undernourishment and overeating

Food costs - one of the main components of the articles of human costs. It is, therefore, necessary to make a rational power not only in terms of biology, but also economy. Overeating is harmful to the body, as well as malnutrition, so we should find a "middle ground", which allows providing a person with everything he/she needs at the lowest cash costs. We do not want to save on our own stomach, but the power to make rational we can (Merrick and Israeli, 2013).

Overeating - eating disorder, the characteristic features of which are the absorption of excessive amounts of food and can not be stopped at the right time. It is consumption of nutrients which are in food to some particular amount, when it can be dangerous for people's health (Merrick and Israeli, 2013).

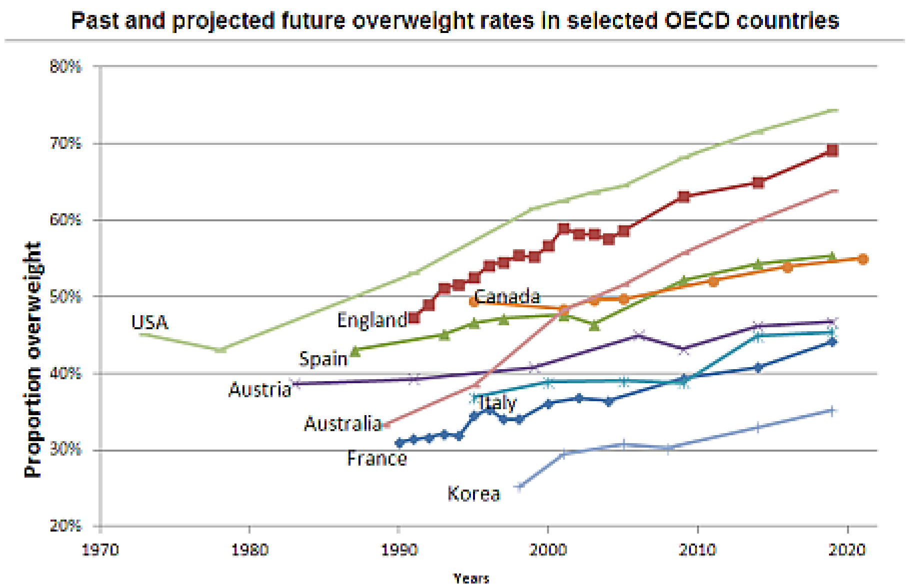
Based on the data below, the problem of obesity nowadays is obvious. Obesity has become a serious problem in the United States. There are millions of people in the country, different ages, who are overweight. Statistics just underlines how problematic this condition is in different countries (Jensen, 2012).

Every third adult person is obese. Unfortunately, two of three are overweight, which shows a trend in the future only to increase the data rate. This problem is related not only to adults, but to children as well. More than 16 percent of children in every country from the list suffer from obesity. Moreover, a person who suffers from obesity or overweight, will tend to have other additional medical problems in the future. They can be expressed in such forms as heart diseases, heart attacks, problems with sleeping (Jensen, 2012).

The main form of avoiding the obesity is to do physical activities and follow healthy balanced nourishment. The best way to obey these simple rules is to monitor the consumption of calories, the allowable and needed amount of micro and macro element included in food, make a proper choice with a frequency of doing physical exercises (Jensen, 2012).

For example, in modern world, there are plenty of food planning diets for those who has a lack of time. A person who wants to lose weight and eat healthy balanced food can start to prepare food ahead of time.

Figure 1. World obesity situation by countries in 2015



Source: The data obtained from the report available on statistics.ge, 2017

According to publication of J. Ross “The diet cure” there are some most common causes of overeating:

1. First of all: the human stomach is insensitive to small changes in the quantity of food (especially to its caloric content) and is able to stretch. The result - a feeling of satiety comes to us only after 15-20 minutes after we ate (Ross, 1999).

2. Secondly, people have lost their selectivity with respect to food and, unlike animals, are guided in choosing food criteria such as appearance, availability, speed, and ease of preparation, flavor (often caused by artificial flavors). In addition, its influence on the subconscious provides television and other advertising (Ross, 1999).

3. Third: hunger is often a manifestation of the need for water (thirst) or additional nutrients: vitamins, amino acids, trace elements and other useful substances, which is almost no in fast food (Ross, 1999).

4. Fourth, the food often plays not only in the role of famine quenchers, but also in different roles. For example, a business lunch in the restaurant means that everyone will be there, regardless of whether they are hungry or not. Furthermore, in catering typically fed large plates, so much easier to overeat. Similarly, some women "seize" stress or bad mood, not even realizing this (Ross, 1999).

How to avoid overeating without applying to this some special physical and mental efforts, while eating properly and not expensive? Answers and recommendations are written in book “Nutrition” by Insel, Turner and Ross:

1. Start the meal with a large glass of water. Water satisfy the thirst and fills the stomach, blunting hunger, and sensitivity to alcohol. Then drink a glass of water between each alcoholic drink, because alcohol dehydrates the body. In the water, there are no calories, while in alcoholic drinks (especially cocktails) they can be very much (Insel, Turner and Ross, 2004).

2. Start a meal with fresh vegetables, avoid dressings and sauces. After several kinds of vegetables, the stomach is full of water (which is contained in high amounts in vegetables) and fiber. Fiber promotes good digestion and gives a feeling of fullness. Now you can try something nutritious, but a little. Keyword - a little (Insel, Turner and Ross, 2004).

3. There slowly, carefully chewing each piece. Then our body gets the signal of satiety time, not when we have overeaten dramatically. The time between the saturation point and the signal of it - 20-30 minutes, sometimes longer (Insel, Turner and Ross, 2004).

4. Do not miss a moment of fullness. It comes naturally, when, during the meal, we omit the equipment and do an involuntary pause. And it's - the natural signal to the brain that the body has enough food. Soon formed the habit of overeating and natural satiety signal to the body sounds quieter, because it used to be ignored (Insel, Turner and Ross, 2004).

5. Observe the size of the servings. Healthy diet secret is not depriving you of a product, but eaten in moderation. Recommended by the "right" size portions for lunch or dinner: meat with the volume from the smartphone, the carbohydrate side dish (rice, potatoes, pasta, etc.) with a volume of a computer mouse and the volume of meat and vegetables with a side dish. Just think how the recommended amount different from what is served today in many homes and restaurants (Insel, Turner and Ross, 2004).

6. Do not buy unnecessary and harmful food. So, what now packed our fridge and kitchen cupboard, tomorrow or the day after will certainly be eaten. Before you buy something, it is worth considering whether we bring this food benefit and pleasure. But not in the momentary sense of these words, and in the future (Insel, Turner and Ross, 2004).

Undernourishment - generic term that combines a number of conditions caused by poor or inadequate nutrition (incomplete or partial starvation). As a rule, we are talking about the lack of food in the diet, at least - a violation of digestion and absorption in the gastrointestinal tract, or excessive loss of nutrients. Prolonged malnutrition threatens depletion (Arcand, 2001).

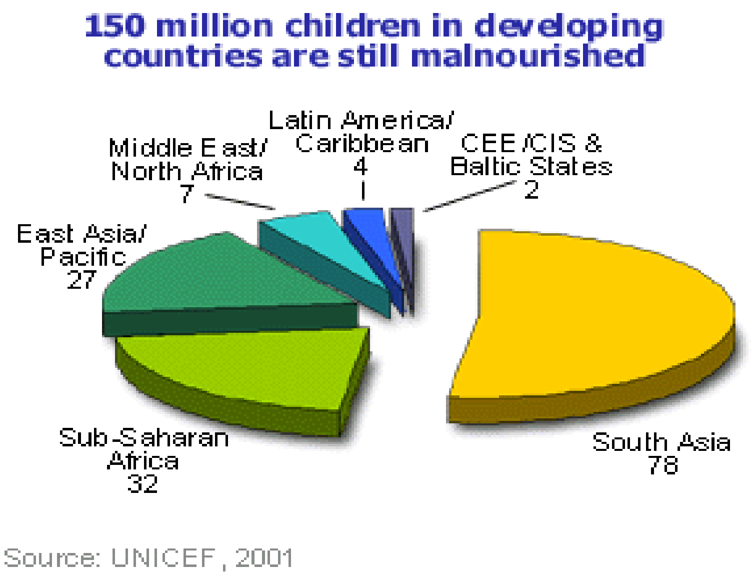
Signs of malnutrition are prolonged weakness, emaciation, anemia, often some puffiness.

Malnutrition, a lack of nutrients to maintain the body's normal functioning, usually associated with poverty in developing countries. However, eating disorders, as a more general term, such as poor nutrition, observed in developed countries, manifesting itself in a growing percentage of people who are overweight (Olson, 1975).

When malnutrition there is a shortage of food energy value (calories), and the man may not have enough protein, vitamins, trace elements. Such violations in everyday life indicate other terms, such as beriberi, or even more narrow, referring expression clinical lack of certain nutrients (Olson, 1975).

In October, people around the world celebrate World Food Day and the fight against hunger. Food - one of the main human needs and there are countries where people eat very badly. In these countries, there is a big problem - the poverty of the population. Poverty and malnutrition are always interrelated, because people are well fed only when he has a steady income and job. Common indicators of the countries that are included in this list, formed through statistics, which revealed the number of children affected by malnutrition, hunger and lack of food supplies (Arcand, 2001).

Figure 2. Children's nourishment in developing countries



Source: The data obtained from the statistical report of Angelfire.com, 2016

3.2.2 Different types of workout

Mankind gradually comes to realize that the main thing in life is health, so a variety of sports techniques and practices are becoming more popular. In addition, maintain a healthy lifestyle today simply fashionable. That is why every year more and more people are paying their attention to fitness. To get fit, actually, it is not enough only to do fitness. In fact, it is a long laborious and systematic process, which manifests itself in such phases as exercises, recreation, proper nutrition, and avoiding harmful habits - in fact it is a special way of life and if you want a special culture. For this fitness does not matter where they are engaged in (at an expensive club, in the park or at home) and what kind of clothes are dressed people, as fitness - it's a definite philosophy of life, which combines health, spiritual qualities and healthy optimism.

Fitness is a set of integrated exercises aimed at improvement of the body. It includes a wide variety of subjects, each of which aims to achieve its objectives, depending on whether a person needs (Shamas, 2008).

The most popular types of fitness according to the book “Fitness” by Mansfield and Stafford are the following areas:

1. Aerobics - a movement to the music that stimulates the cardiovascular and respiratory systems, a great way to set the mood and combat obesity. Aerobics attractive their availability, and the ability to change the emotional content of the lessons according to their interests, physical condition, age, the level of physical fitness of students (Mansfield and Stafford, 2009).

2. Stretching-this set of exercises and postures, designed specifically to give the elasticity of muscles and joints - flexibility and mobility. Stretching classes begin and harmoniously complete the vast majority of health training. The essence of the exercise in stretching is stretching the muscles are relaxed or alternating voltage condition and stretched muscle relaxation. Through regular practice in the muscle fibers increases blood flow and improves the process of metabolism that prevents premature aging (Mansfield and Stafford, 2009).

3. Yoga classes are considered to be one of the most harmonious developments of human systems. In fact, it is a whole philosophy of life. Yoga helps to maintain a good shape and avoid stress, and promotes long years of life. Doing yoga, you can even find hidden reserves of the organism and learn how to use them. Traditionally, yoga classes include a variety of exercises, cleansing the body, the ability to control your breathing and posture, one way or another affecting the vitality enclosed in the human body (Mansfield and Stafford, 2009).

4. Shaping is a comprehensive system that integrates not only the physical exercises and principles of nourishment, but also the art and fashion, the concept of the beautiful appearance. This is purely a women's concept of "life ground", a particular way of life, which, if desired, and the corresponding effort it gives a beautiful half of humanity slender body, spiritual beauty and femininity (Mansfield and Stafford, 2009).

5. Pilates - the system developed by Joseph Pilates, and named after him, is a set of flowing movements designed to improve the flexibility of the body, strengthening the individual muscles and the body as a whole. In the process of working class not only large superficial muscles, but small deep, which require a special approach and specific training (Mansfield and Stafford, 2009).

6. Power training - this is a traditional group fitness, submitted a set of exercises aimed at the development of individual muscle groups. When strength training session is widely used all kinds of sports equipment: trainers, dumbbells, gymnastic sticks, expanders, etc. Through power training, your muscles come in tone, gaining weight, is formed by a sports figure (Mansfield and Stafford, 2009).

From an economic point of view, to engage in fitness and start to eat correctly, meanwhile spend money on the process, you need to understand what purpose it is actually pursued. Based on the book by Bill Pierce, Scott Murr and Ray Moss, can be summed up some of the advantages of fitness, which will help to answer the question: Why fitness is so important in our lives?

Advantages of fitness by Pierce, Murr and Moss:

1. The first fitness advantage is that any exercise is an opportunity to strengthen the body and keep fit. Only regular, permanent and well-dosed exercise provide an opportunity to remove from the body some extra weight and adjust as necessary muscle mass and get a flexible and slender figure (Pierce, Murr and Moss, 2007).

2. By the absolute benefits of fitness should include the fact that any physical activity, especially the well-organized, able to withstand stress and eliminates its consequences, since it is proved that physical exercises stimulate the production of serotonin, which is known as the hormone of joy. Moreover, physical activity significantly slows down the decay of serotonin (Pierce, Murr and Moss, 2007).

3. Another advantage of the fitness facilities, as, indeed, and other physical exercises, is that during activities breathing becomes deeper, which leads to a better blood oxygen saturable (Pierce, Murr and Moss, 2007).

4. Scientists from the US, based on the results of several research projects, confidently assert that such fitness exercises like jogging and aerobics, relieve people from such negative mental and psychological phenomena as insomnia, fear and even depression. Moreover, as the scientists say, people who are engaged in fitness, come out of the state of depression much earlier, uses far fewer antidepressants (Pierce, Murr and Moss, 2007).

3.3 Problems related to food scarcity

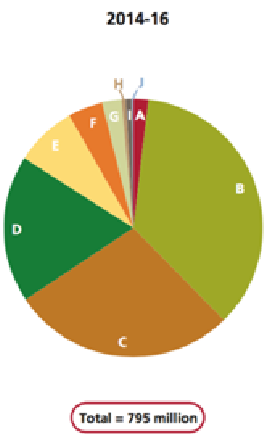
Potential food shortages are perhaps the oldest of all the global challenges that humanity is faced at the present stage of its development - it has been discussed for more than two centuries. Nevertheless, it is possible that now we come to the "point of no return" after the transition through which the cost of overcoming the problems associated with the solution of problems in different countries and continents in the areas of food, would be an order of magnitude higher (Timmer, 2015).

The study of the food problem lies on the border of several economic theories. Firstly, it is the theory of marginal utility, since food production is dependent on the resources which are finite (land and water), and food cost increases due to limited access to these resources (Timmer, 2015).

The food problem is inseparably linked with the effects of the two others, equally global, issues: fresh water scarcity and climate change. It has two important aspects: the limited capacity of the Earth to feed an ever-increasing number of residents and the change of the traditional diet in some regions, which entails an explosive (in historical terms) increase in demand food groups. In addition, if some imbalance between deficit and surplus goods of others can be resolved through redeployment of resources in agriculture, the first, the demographic aspect of the food problem contains a serious challenge to all of the humanity and makes us look for new technologies for the most efficient food production (Timmer, 2015).

The world produces enough food to feed the entire population of the planet, all 8 billion people. Yet one in eight people in the world goes to bed hungry. In some countries, one in three children is underweight. Why is there hunger? There are a number of reasons why in some countries or cities, people are suffering from obesity and excess of food, and in others from lack of food. According to the figure below, the most suffered regions from hunger are Southern Asia, Sub-Saharan Africa and Eastern Asia. These areas are not such developed as Europe, North America, Australia, which affects their standard of living, and especially, the quality of food consumed.

Figure 3. Number of undernourished by group of countries



	Number (millions)		Regional share (%)	
	1990–92	2014–16	1990–92	2014–16
A Developed regions	20	15	2.0	1.8
B Southern Asia	291	281	28.8	35.4
C Sub-Saharan Africa	176	220	17.4	27.7
D Eastern Asia	295	145	29.2	18.3
E South-Eastern Asia	138	61	13.6	7.6
F Latin America and the Caribbean	66	34	6.5	4.3
G Western Asia	8	19	0.8	2.4
H Northern Africa	6	4	0.6	0.5
I Caucasus and Central Asia	10	6	0.9	0.7
J Oceania	1	1	0.1	0.2
Total	1 011	795	100	100

Source: Report made by FAO, 2015

So, there are the reasons why hunger is the number one in the list of global issues:

1. Poverty Trap

   People living in poverty can not afford nutritious food. This makes them weak and reduces their ability to earn money, which would help to break free from poverty and hunger. It is not just an everyday problem: chronic malnutrition and stunting among children may affect their future income, doomed to a life of poverty and hunger. In developing countries, farmers often can not afford to buy seeds, so they can not plant crops, which could provide for their families. Perhaps they will have to grow plants without tools and fertilizers they need. And someone does not have enough land, water or education. In short, the poor are hungry and hunger enters their poverty trap (Thompson, 1994).

2. The lack of investment in agriculture

   Many developing countries lack the basic agricultural infrastructure, such as not enough roads, warehouses and irrigation systems. As a result, we have high transport costs, lack of storage facilities and unreliable water supply. All this limits the productivity of crops and access to food. Investments in land management, more efficient use of water and the creation of more sustainable seed can bring noticeable improvements. Research of the Food and Agriculture provided by Organization of the United Nations (FAO) show that investment in agriculture is five times more effective in reducing poverty and hunger than investments in any other sector (Thompson, 1994).

3. Climate and weather

   Natural disasters such as floods, tropical storms and prolonged droughts are becoming more frequent, and all bring disastrous consequences for the hungry poor in developing countries. The drought - one of the most common causes of food shortages in the world. In 2011, recurrent drought caused crop failures and heavy losses of livestock in Ethiopia, Somalia and Kenya. In 2012, there was a similar situation in the Sahel region of West Africa.In many countries, climate change is exacerbating already adverse natural conditions. Increasingly, fertile lands are threatened by erosion, salinization and desertification. Deforestation man accelerates the erosion of land which could be used to grow food (Thompson, 1994).

4. Unstable markets

   In recent years, food prices have been very volatile. food price fluctuations make it difficult to access to nutritious food for the poor. The poor people must have access to nutritious food all year round. price jumps can make food available, and that can have far-reaching consequences for young children. When prices rise, consumers often turn to cheaper and less nutritious foods, increasing the risk of micronutrient deficiencies and other forms of malnutrition (Thompson, 1994).

5. Food waste

   A third of all manufactured food products (1.3 bln. tons) is not consumed. This food waste is a missed opportunity to improve global food security in a world where one out of eight starving. Manufacture of food also spends precious natural resources, we need to feed the planet. Each year, the production of food, which has not consumed, consumed volume of water equivalent to the annual flow of the river Volga. Manufacture of food also adds 3.3 bln. tons of greenhouse gasses into the atmosphere, which entails consequences for the environment and, ultimately, for the production of food (Thompson,1994).

3.4 How to eat with least-cost and satisfy wishes

It is widely believed, that high-quality and harmless food is very expensive for the health, but this is nothing but a myth, it is easy and simple to create a balanced diet, without distracting the big money. Of course, some of the products will cost a certain amount of money, but it is not necessary to buy them on a daily basis, such product as saltwater fish, seafood, turkey, rabbit. From time to time, enough to enrich them eating habits, not exceeding the norms of the family budget. Save on food - not to use substandard or expired products. Savings in the diet means to include natural products.

- Eat at home. Firstly, the daily visit restaurants and cafes include consumption decent amount of money. Secondly, in the field of catering, you can not keep track of calories, control of how fresh and quality products they are cooked. Find a way out of this situation is simple:

be engaged in the preparation of food at home and then take it with you to work (Southgate, Graham and Tweeten, 2007).

- Simple package. Do not pay attention to the products with beautiful and colourful packaging. The quality of such products will not be anything different from the goods in a modest wrapper. Remember, that for the "brands" have to pay (Southgate, Graham and Tweeten, 2007).

- Exclude from the diet tasty, but harmful products, or at least seriously reduce their use. These products include sausages, smoked sausage, eggs, sweet pastries, cakes, pies and candy. These products contain a large number of useless calories and fat. When buying them, you not only save money, but also accumulate extra kilos (Southgate, Graham and Tweeten, 2007).

- Drink plenty of fluids. First, a simple mineral water is inexpensive, and secondly, our body is in need of it. Water removes toxins from the body, accelerates metabolism, and improves the flow of biochemical reactions. In the water, there is absolutely no calories (Atkins, 2016).

- Significant savings you will feel if you reduce the purchase of alcohol and alcoholic beverages (beer, vodka, wine, liqueurs, balsams, liqueurs) and carbonated water (Atkins, 2016).

- Vegetables and fruits should match the season. Prices of seasonal products, especially if they are of domestic production is much lower, and the products themselves healthier. Many exotic fruits that you regularly meet at the shop windows, break immature, and they ripen during transport. To preserve their original form, as a rule, they are sprayed with various substances (Atkins, 2016).

- Write a list of products. Making purchases, try to stick to your plan, it will save you from the temptation to buy a nonsense (Clapp, 2012).

- Do not fall into the trap of marketing. Choose foods that are located on the lower or upper shelves, because in front of your eyes are the most expensive products. Remember that the windows in the shops are arranged in such way, that you are sure to pass by that which you are not interested, but still take something from it (Fisanick, 2010).

Watch out for a balance of fat, protein and carbohydrates. Every day, our body should receive 20-30% protein of the total amount of food consumed, 50-70% carbohydrate and 20-30% fat. Carbohydrates are found in fruits, vegetables and grain products. Good carbohydrates are rapidly broken down in the body, maintain the sugar at the proper level, and fiber improves the digestive system. Fats, vegetable oils and animal oils can not be attributed to cheap products, but the daily requirement for them is quite small, so the equivalent price is low. It would be enough to fill salads and ready meals oil. The daily norm of consumption can be considered 1-2 tablespoon of vegetable oil (Royston, 2009).

As you can see, eat high quality and useful food, but inexpensive forces everyone. At the same time, it has an effect of such power and impact on your budget and your health.

3.5 Linear programming model

Every modeling problem, which must be solved, starts from creating it within the linear programming model. There are certain rules that govern the operation of the linear programming model. These rules exist for the purpose of successful achievement of the result (Linda, Volek B., 2014).

There are key points to a linear program - the decision variables, objective, and constraints.

Decision Variables. The decision variables show (unknown) solutions that must be applied. This is opposite to the problem data, which are values that are either indicated, or can simply be calculated from what is specified (Fourer, Gay and Kernighan, 2007).

Objective. Every linear program has an objective. The objective function can be minimized or maximized, it depends on the purpose of the problem. It must have linear character, that means it must be the sum of standings times decision variables (Fourer, Gay and Kernighan, 2007).

Constraints. Each linear program also has limitations that limit visible solutions.

Formulation of the problem in the form of a linear program indicates the movement through the above process to determine the decision variables, objective function and constraints (Fourer, Gay and Kernighan, 2007).

Linear programming models are especially useful, nevertheless, because it is user - friendly to solve with a computer in order to obtain optimal solution. For a model that has only two variables, you can solve the problem without a computer by plotting an acceptable region on the graph and determine how objective is optimized (Gass, 1975).

Every linear program has associated with it another linear programming problem called the dual. One key application of duality theory -- the relationships between the primary problem and the dual problem - is sensitivity analysis. Each associated constraint in the initial problem is a dual variable, which represents the cost of having a constraint in the model. The diet problem has two types of constraints, bounds on the number of servings for each food type and requirements on the allowable levels of each nutrient (Gass, 1975).

Linear programming deals with it another problem of linear programming, called dual programming. One of the main usages of dual problem is to define the relationship the primary problem and the dual problem - is sensitivity analysis. Each associated constraint in the initial problem is a dual variable, which represents the cost of having a constraint in the model. The diet problem has two types of constraints, constraints in the number of servings for each food type and requirements on the allowable levels of each nutrient (Gass, 1975).

3.6 Simplex method

The simplex method is a fundamental case in linear programming. It is a standard method of maximizing or minimizing a linear function of several variables with particular constraints of other linear functions. It is based on a theorem that is called the initial theorem of the simplex method. Among the optimal plans of the problem of linear programming in canonical form, there is necessarily a supporting solution about it's system of constraints. If the optimal plan of the problem is unique, then it coincides with some support solution. The various supporting solutions of the system's constraints are finite (Kong, 2007).

The simplex method is a certain procedure for directional enumeration of support solutions. This method introduces a definite order of both in finding the first (initial) basis solution and in going to other basic solutions (Kong, 2007).

The simplex method ensures that with this new solution the linear form, if it does not reach the optimum, will approach it. With a new admissible basic solution, they deal in the same way until they find an optimal solution (Kong, 2007).

Thus, the application of the simplex method decomposes into two stages: finding an admissible basic solution of the constraint system or establishing the fact of its inconsistency; Finding the optimal solution (Kong, 2007).

4. Practical part

4.1 The diet problem understanding

In order to maintain a healthy heart, brain and active muscles working optimally, you should take care of the following balanced nourishment program that provides the proper nutrients for your body. These supplements provide you with energy and stronger bones, muscles and tendons. Nutrients also help with regulating processes in the body, like blood pressure and digestion. Which nutritious foods have all of these wonderful benefits?

The problem of the proper nutrition intake can not be solved without following the correct balanced and healthy diet. During scheduling and creating feeding program, be sure to pay attention to the right amount of calories per day based on your activity level. The diet is balanced in case of abidance of consuming accurate calories quantity. On a par with, men need about 2,500 calories (10,500 kilojoules) per day, and women need about 2200 calories (8700 kilojoules) per day to maintain a healthy diet.

Most of us eat more calories than we need on a daily basis, so that the power consumption is greater than the output from it. The excess is stored as fat. Make sure that you eat a variety of nutritious foods.

How much fat, protein and carbs should we eat?

Due to the Daily Reference Intakes developed by the Institute of Medicine, this is the percentage of calories from each macronutrient recommended in healthy diets:

- Carbohydrates: 45-65%
- Protein: 10-35%
- Fat: 20-35%

However, the percentages are controversial and determined by different circumstances. There are different people with various lifestyle’s and requirements. Despite this, determined common average balanced diets based on the nutritional requirements, such as calories, protein, carbohydrates and fat. In the table below, you can see the example menu for the day, which is designed in accordance with the required amount of nutrients for the average human being.

Table 3. Balanced diet per day for average human being

Food	Serving size	Protein (g)	Carbohydrates (g)	Fat (g)	Calories	Price (czk/1kg)	Price (czk/portion)
Breakfast							
Apple	150 g	0,30	21,90	0,50	81,00	29,75	4,45
Cashews	28 g	5,00	9,00	13,00	160,00	519,00	14,53
Sausage	150 g	36,00	6,00	42,00	570,00	138,19	20,72
Tomato	70 g	1,00	5,70	0,40	26,00	55,25	3,87
AM Snack							
Blueberries	100 g	1,07	21,01	0,48	82,60	320,00	32,00
Egg	3 psc	20,10	3,90	21,90	300,00	32,86 (10 psc)	9,86
Sauerkraut	150 g	1,28	6,18	0,14	31,24	48,30	7,25
Lunch							
Avocados	146 g	2,19	9,34	16,05	175,20	99,40	14,50
Carrots, baby	80 g	0,51	6,59	0,10	28,00	59,90	4,79
Chicken breast	227 g	48,00	0,00	0,00	248,00	109,80	24,92
Olive oil	15 g	0,00	0,00	14,00	120,00	239,90	3,59
Tomato	70 g	1,00	5,70	0,45	26,00	55,25	3,87
Vinegar, balsamic	10 g	0,05	1,81	0,00	9,33	92,10	0,92
PM Snack							
Pear	150 g	0,70	25,10	0,00	98,00	36,90	5,53
Water	237 g	0,00	0,00	0,00	0,00	11,90	2,82
Dinner							
Kale	67 g	2,47	7,32	0,52	36,40	23,30	1,56
Onion	15 g	0,10	0,90	0,00	4,00	13,09	0,19
Zucchini	75 g	0,77	4,72	0,06	19,20	139,90	10,49
Squash	125 g	1,02	10,01	0,40	41,85	39,90	4,98
Tomato sauce	225 g	3,17	18,08	0,49	90,28	109,80	24,71
Turkey Meatballs	175 g	25,00	10,00	10,00	250,00	112,34	19,66
Total	**-**	**149,73**	**173,26**	**120,49**	**2 397,10**	**-**	**215,21**

Source: The data obtained from daily menu available on fitbodybootcamp.com, 2016

The table shows 5 times ingestion with using correct serving size due to a suitable proportion of microelements included in food. The primary aspect of good nourishment is right serving size. It is much healthier to eat more times per day with small portions of food, than one or two times with big and unhealthy portion.

This is a big and complicated menu, as it may seem at first side, but actually, it is worth only 215 CZK per day. In fact, it is quite a small figure for a proper and healthy diet. The main advantage of it is a compliance of all norms of correct feeding namely daily intake of calories, which is 2400 calories and the right amount of all important microelements received from the food.

4.2 Constructing linear programming model

4.2.1 Diet problem statement

The main aim of this chapter is to select a number of products that will satisfy a set of a daily nutritional requirement at minimum cost. The problem defined by linear programming model in which the objective is to minimize cost and the constraints are to satisfy the specified nutritional requirements. The diet problem constraints generally handle the number of calories and the amount of protein, fats and carbohydrates in the diet. In a case of the mathematical drafting is simple, the solution might not be savory! The nutritional requirements can be met without regard for taste or variety, so consider the output before digging into a meal from an "optimal" menu! The nutritional needs can be met without taking into account the diversity of taste and, therefore, consider the results before digging into a meal from the “optimal” menu.

The below table shows a set of products, together with nutritional data for every product, and the cost of food per serving size. The objective of the diet problem is to define the number of portions of each food to buy (and consume) thereby to minimize product cost of food abiding certain nutritional requirements. The nutritional requirements indicated as minimum required level of each nutrient per day. The serving size is limited by a particular amount; it was done with the purpose of menu variety. In reality, we must consider not only minimization cost, but at the same time pay attention to the amount of nutrients in food, which provides the improvement of the quality of the menu.

The linear programming model was constructed using the data from Table 4. Balanced diet per day for average human being. In the first column are shown used products for balanced diet per day. There are four constraints in grams needed per day, such as protein, carbohydrates, fat and calories. Normally, the person on average needs 2300 calories per day, the minimum requirement for protein is 58 g/day, carbohydrates – 259 g/day, fat – 52 g/day. The maximum consumption of fat per day is - 202 g, carbohydrates – 374g/day, fats – 90 g/day, calories – 2500 g/day. The next four column demonstrate constituent of nutrients in each product. In apples with serving size 150 grams, for example, contained 0,30 g of protein, 21,90 g of carbohydrates, 0,50 g of fat and 81 calories. Suppose that the maximum number of servings is 4.

4.2.2 Configuration of food and nutritions

The food we eat should not only satisfy our hunger, but also provide our body with energy resources and the nutrients. The basic microelements and fundamental components, which are necessary for human health, nutrition and correct operation of the body are determined as protein, carbohydrates and fat. However, without a proper number of calories needed per day, the laws of nutrition do not proceed. The proteins, fats and carbohydrates contained in food products perform many very important functions, each of which can not be transferred to anyone else.

Proteins

Proteins are the main functional element in the body. They serve as a building material for cells and tissues, they form immunity, participate in the synthesis of hormones, enzymes, amino acids. Proteins transport other nutrients throughout the body, they support the water balance, provide healing and tissue regeneration and skin elasticity and perform many more functions The protein is found in dairy products, seafood, poultry, eggs, beans and peas, soy products, and unsalted nuts and seeds.

Fats

Fats are a strategic reservoir of water and energy in the body. They serve to maintain the body’s temperature balance, they build cell membranes, they are part of the nervous tissue, in addition, fats are necessary for the assimilation of fat-soluble vitamins (A, E, D). Fats can be presented as plant or animal nature. Fats are contained in oil, butter, sour cream, salmon, chocolate, eggs, sausages etc.

Carbohydrates

Carbohydrates are the fuel of the body. Carbohydrates are divided into fast and slow - according to the rate of their absorption in the body. Slow carbohydrates give a long inflow of energy, splitting gradually over time, and fast give a quick energy boost. Fiber, also related to carbohydrates, which is not digested by the body, it acts as a cleaner, cleansing the body of toxins, removing excess liquid, sugar, cholesterol, facilitating digestion. Carbohydrates are contained in fruits, vegetables, milk products, honey, bread, cereals, pasta, rice, beans and peas.

The Diet Problem can be expressed mathematically as a linear programming problem as shown below.

Table 4. Table of constraints

Constraints	Protein (g)	Carbohydrates (g)	Fat (g)	Calories
Apple	0,30	21,90	0,50	81,00
Cashews	5,00	9,00	13,00	160,00
Sausage	36,00	6,00	42,00	570,00
Tomato	1,00	5,70	0,40	26,00
Blueberries	1,07	21,01	0,48	82,60
Egg	20,10	3,90	21,90	300,00
Sauerkraut	1,28	6,18	0,14	31,24
Avocados	2,19	9,34	16,05	175,20
Carrots, baby	0,51	6,59	0,10	28,00
Chicken breast	48,00	0,00	0,00	248,00
Olive oil	0,00	0,00	0,00	120,00
Tomato	1,00	5,70	0,00	26,00
Vinegar, balsamic	0,05	1,81	0,00	9,33
Pear	0,70	25,10	0,52	98,00
Water	0,00	0,00	0,00	0,00
Kale	2,47	7,32	0,06	36,40
Onion	0,10	0,90	0,40	4,00
Zucchini	0,77	4,72	0,49	19,20
Squash	1,02	10,01	10,00	41,85
Tomato sauce	3,17	18,08	90,28	90,28
Turkey Meatballs	25,00	10,00	250,00	250,00
Left side	75,88	259,00	90,00	2 300,00
Right side (min)	58,00	259,00	52,00	2 300,00
Right side (max)	202,00	374,00	90,00	2 500,00

Source: The research field from Nutritiondata.self.com. (2017) and own computation of results

Sets

F = set of foods

N = set of nutrient

Parameters

$\boldsymbol{a_{ij}}$ = amount of nutrient j in food i, **∀i ∈ F**, **∀j ∈ N**

$\boldsymbol{c_i}$ = cost per serving of food i, **∀i ∈ F**

F $\boldsymbol{min_i}$ = minimum number of required servings of food i, **∀i ∈ F,** $F_{min} \geq 0$

F $\boldsymbol{max_i}$ = maximum allowable number of servings of food i, **∀I ∈ F,** $F_{max} \leq 4$

N $\boldsymbol{min_i}$ = minimum required level of nutrient j, **∀j ∈ N**

$N(protein)_{min} \geq 58,\ N(carbs)_{min} \geq 259, N(fats)_{min} \geq 52,\ N(cal)_{min} \geq 2300$

N $\boldsymbol{max_j}$ = maximum allowable level of nutrient j**, ∀j ∈ N**

$N(protein)_{max} \leq 202,\ N(carbs)_{max} \leq 374, N(fats)_{max}\ \leq 90,\ N(cal)_{max} \leq 250$

Variables

$\boldsymbol{x_i}$ = number of servings of food i to purchase/consume, **∀i ∈ F,** $x_{1-21} \geq 0$

$\boldsymbol{x_1}$ – apple, $\boldsymbol{x_2}$ – cashews, $\boldsymbol{x_3}$ – sausage $\boldsymbol{x_4}$ –tomato, $\boldsymbol{x_5}$ – blueberries, $\boldsymbol{x_6}$ – egg, $\boldsymbol{x_7}$ – sauerkraut, $\boldsymbol{x_8}$ – avocados, $\boldsymbol{x_9}$ – carrots (baby), $\boldsymbol{x_{10}}$ – chicken breast, $\boldsymbol{x_{11}}$ – olive oil, $\boldsymbol{x_{12}}$ – tomato, $\boldsymbol{x_{13}}$ – vinegar (balsamic), $\boldsymbol{x_{14}}$ – pear, $\boldsymbol{x_{15}}$ – water, $\boldsymbol{x_{16}}$ – kale, $\boldsymbol{x_{17}}$ – onion, $\boldsymbol{x_{18}}$ – zucchini, $\boldsymbol{x_{19}}$ – squash, $\boldsymbol{x_{20}}$ – tomato sauce, $\boldsymbol{x_{21}}$ – turkey meatballs.

Taking into account all constraints and data that is presented above, we could make the equations for finding the solution of the minimization cost problem.

Objective Function: Minimize the total cost of the food

Minimize $\sum_{i \in F} c_i x_i$

4,45 $\boldsymbol{x_1}$ + 14,53 $\boldsymbol{x_2}$ + 20,72 $\boldsymbol{x_3}$ + 3,87 $\boldsymbol{x_4}$ + 32,00 $\boldsymbol{x_5}$ + 9,86 $\boldsymbol{x_6}$ + 7,25 $\boldsymbol{x_7}$ + 14,50 $\boldsymbol{x_8}$ + 4,79 $\boldsymbol{x_9}$ + 24,92 $\boldsymbol{x_{10}}$ + 3,59 $\boldsymbol{x_{11}}$ + 3,87 $\boldsymbol{x_{12}}$ + 0,92 $\boldsymbol{x_{13}}$ + 5,53 $\boldsymbol{x_{14}}$ + 2,82 $\boldsymbol{x_{15}}$ + 1,56 $\boldsymbol{x_{16}}$ + 0,19 $\boldsymbol{x_{17}}$ + 10,49 $\boldsymbol{x_{18}}$ + 4,98 $\boldsymbol{x_{19}}$ + 24,71 $\boldsymbol{x_{20}}$ + 19,66 $\boldsymbol{x_{21}}$ → min

Constraint Set 1:

For each nutrient **j ∈ Nj** , at least meet the minimum required level.

∑**i ∈ F,** $a_{ij}x_i$ ≥ N min_j, **∀j ∈ N;** (min: protein – 58 g/day, carbohydrates – 259 g/day, fat – 52 g/day, calories -2300);

Protein (g): 0,30 $\boldsymbol{x_1}$ + 5,00 $\boldsymbol{x_2}$ + 36,00 $\boldsymbol{x_3}$ + 1,00 $\boldsymbol{x_4}$ + 1,07 $\boldsymbol{x_5}$ + 20,10 $\boldsymbol{x_6}$ + 1,28 $\boldsymbol{x_7}$ + 2,19 $\boldsymbol{x_8}$ + 0,51 $\boldsymbol{x_9}$ + 48,00 $\boldsymbol{x_{10}}$ + 0,00 $\boldsymbol{x_{11}}$ + 1,00 $\boldsymbol{x_{12}}$ + 0,05 $\boldsymbol{x_{13}}$ + 0,07 $\boldsymbol{x_{14}}$ + 0,00 $\boldsymbol{x_{15}}$ + 2,47 $\boldsymbol{x_{16}}$ + 0,10 $\boldsymbol{x_{17}}$ + 0,77 $\boldsymbol{x_{18}}$ + 1,02 $\boldsymbol{x_{19}}$ + 3,17 $\boldsymbol{x_{20}}$ + 25,00 $\boldsymbol{x_{21}}$ ≥ 58. Minimum required amount of protein in grams per day.

Carbohydrates (g): 21,90 $\boldsymbol{x_1}$ + 9,00 $\boldsymbol{x_2}$ + 6,00 $\boldsymbol{x_3}$ + 5,70 $\boldsymbol{x_4}$ + 21,01 $\boldsymbol{x_5}$ + 3,90 $\boldsymbol{x_6}$ + 6,18 $\boldsymbol{x_7}$ + 9,34 $\boldsymbol{x_8}$ + 6,59 $\boldsymbol{x_9}$ + 0,00 $\boldsymbol{x_{10}}$ + 0,00 $\boldsymbol{x_{11}}$ + 5,70 $\boldsymbol{x_{12}}$ + 1,81 $\boldsymbol{x_{13}}$ + 25,10 $\boldsymbol{x_{14}}$ + 0,00 $\boldsymbol{x_{15}}$ + 7,32 $\boldsymbol{x_{16}}$ + 0,90 $\boldsymbol{x_{17}}$ + 4,72 $\boldsymbol{x_{18}}$ + 10,01 $\boldsymbol{x_{19}}$ + 18,08 $\boldsymbol{x_{20}}$ + 10,00 $\boldsymbol{x_{21}}$ ≥ 259. Minimum required amount of carbohydrates in grams per day.

Fats (g): 0,50 $\boldsymbol{x_1}$ + 13,00 $\boldsymbol{x_2}$ + 42,00 $\boldsymbol{x_3}$ + 0,40 $\boldsymbol{x_4}$ + 0,48 $\boldsymbol{x_5}$ + 21,90 $\boldsymbol{x_6}$ + 0,14 $\boldsymbol{x_7}$ + 16,05 $\boldsymbol{x_8}$ + 0,00 $\boldsymbol{x_9}$ + 0,10 $\boldsymbol{x_{10}}$ + 0,00 $\boldsymbol{x_{11}}$ + 0,00 $\boldsymbol{x_{12}}$ + 0,00 $\boldsymbol{x_{13}}$ + 0,52 $\boldsymbol{x_{14}}$ + 0,00 $\boldsymbol{x_{15}}$ + 0,06 $\boldsymbol{x_{16}}$ + 0,40 $\boldsymbol{x_{17}}$ + 0,49 $\boldsymbol{x_{18}}$ + 10,00 $\boldsymbol{x_{19}}$ + 90,28 $\boldsymbol{x_{20}}$ + 250,00 $\boldsymbol{x_{21}}$ ≥ 52. Minimum required amount of fats in grams per day.

Calories (g): 81,00 $\boldsymbol{x_1}$ + 160,00 $\boldsymbol{x_2}$ + 570,00 $\boldsymbol{x_3}$ + 26,00 $\boldsymbol{x_4}$ + 82,60 $\boldsymbol{x_5}$ + 300,00 $\boldsymbol{x_6}$ + 31,24 $\boldsymbol{x_7}$ + 175,20 $\boldsymbol{x_8}$ + 28,00 $\boldsymbol{x_9}$ + 248,00 $\boldsymbol{x_{10}}$ + 120,00 $\boldsymbol{x_{11}}$ + 26,00 $\boldsymbol{x_{12}}$ + 9,33 $\boldsymbol{x_{13}}$ + 98,00 $\boldsymbol{x_{14}}$ + 0,00 $\boldsymbol{x_{15}}$ + 36,40 $\boldsymbol{x_{16}}$ + 4,00 $\boldsymbol{x_{17}}$ + 19,20 $\boldsymbol{x_{18}}$ + 41,85 $\boldsymbol{x_{19}}$ + 90,28 $\boldsymbol{x_{20}}$ + 250,00 $\boldsymbol{x_{21}}$ ≥ 2300. Minimum required amount of calories in grams per day.

Constraint Set 2:

For each nutrient **j ∈ Nj**, do not exceed the maximum allowable level. **∑i ∈ F,** $a_{ij}x_i \leq$ N min_j, **∀j ∈ N;** (max: protein – 202 g/day, carbohydrates – 374 g/day, fat – 90 g/day, calories -2500);

Protein (g): 0,30 $\boldsymbol{x_1}$ + 5,00 $\boldsymbol{x_2}$ + 36,00 $\boldsymbol{x_3}$ + 1,00 $\boldsymbol{x_4}$ + 1,07 $\boldsymbol{x_5}$ + 20,10 $\boldsymbol{x_6}$ + 1,28 $\boldsymbol{x_7}$ + 2,19 $\boldsymbol{x_8}$ + 0,51 $\boldsymbol{x_9}$ + 48,00 $\boldsymbol{x_{10}}$ + 0,00 $\boldsymbol{x_{11}}$ + 1,00 $\boldsymbol{x_{12}}$ + 0,05 $\boldsymbol{x_{13}}$ + 0,07 $\boldsymbol{x_{14}}$ + 0,00 $\boldsymbol{x_{15}}$ + 2,47 $\boldsymbol{x_{16}}$ + 0,10 $\boldsymbol{x_{17}}$ + 0,77 $\boldsymbol{x_{18}}$ + 1,02 $\boldsymbol{x_{19}}$ + 3,17 $\boldsymbol{x_{20}}$ + 25,00 $\boldsymbol{x_{21}}$ ≤ 202. Maximum allowable level of protein in grams per day.

Carbohydrates (g): 21,90 $\boldsymbol{x_1}$ + 9,00 $\boldsymbol{x_2}$ + 6,00 $\boldsymbol{x_3}$ + 5,70 $\boldsymbol{x_4}$ + 21,01 $\boldsymbol{x_5}$ + 3,90 $\boldsymbol{x_6}$ + 6,18 $\boldsymbol{x_7}$ + 9,34 $\boldsymbol{x_8}$ + 6,59 $\boldsymbol{x_9}$ + 0,00 $\boldsymbol{x_{10}}$ + 0,00 $\boldsymbol{x_{11}}$ + 5,70 $\boldsymbol{x_{12}}$ + 1,81 $\boldsymbol{x_{13}}$ + 25,10 $\boldsymbol{x_{14}}$ + 0,00 $\boldsymbol{x_{15}}$ + 7,32 $\boldsymbol{x_{16}}$ + 0,90 $\boldsymbol{x_{17}}$ + 4,72 $\boldsymbol{x_{18}}$ + 10,01 $\boldsymbol{x_{19}}$ + 18,08 $\boldsymbol{x_{20}}$ + 10,00 $\boldsymbol{x_{21}}$ ≤ 374. Maximum allowable level of carbohydrates in grams per day.

Fats (g): 0,50 x_1 + 13,00 x_2 + 42,00 x_3 + 0,40 x_4 + 0,48 x_5 + 21,90 x_6 + 0,14 x_7 + 16,05 x_8 + 0,00 x_9 + 0,10 x_{10} + 0,00 x_{11} + 0,00 x_{12} + 0,00 x_{13} + 0,52 x_{14} + 0,00 x_{15} + 0,06 x_{16} + 0,40 x_{17} + 0,49 x_{18} + 10,00 x_{19} + 90,28 x_{20} + 250,00 x_{21} $\leq$ 90. Maximum allowable level of fats in grams per day.

Calories (cal): 81,00 x_1 + 160,00 x_2 + 570,00 x_3 + 26,00 x_4 + 82,60 x_5 + 300,00 x_6 + 31,24 x_7 + 175,20 x_8 + 28,00 x_9 + 248,00 x_{10} + 120,00 x_{11} + 26,00 x_{12} + 9,33 x_{13} + 98,00 x_{14} + 0,00 x_{15} + 36,40 x_{16} + 4,00 x_{17} + 19,20 x_{18} + 41,85 x_{19} + 90,28 x_{20} + 250,00 x_{21} $\leq$ 2500. Maximum allowable level of calories in grams per day.

Constraint Set 3:

For each food **i ∈ Fi**, select at least the minimum required number of servings. $x_i \geq$ F min_i, **∀i ∈ F;** (min servings – 0 times for each type of food per day). $\boldsymbol{x_{1-21} \geq 0}$

Constraint Set 4:

For each food **i ∈ F**, do not exceed the maximum allowable number of servings. $x_i \leq$ F max_i, **∀i ∈ F;** (max servings – 4 times for each type of food per day). $\boldsymbol{x_{1-21} \leq 4}$

To solve this linear programming problem, we can use Excel Solver, which is add-ins in Excel program.

The solution is represented in table 6. “Table of function and variables”. The solution can be explained in such way, as final cost of food per day is 101, 86 czk. From this comes up, that using linear programming model in the calculation of the minimum cost of the food used, optimal solution represented by such products:

Apple – 4 times (serving size 150 g);

Egg – 2, 96 times (serving size 3 psc);

Olive oil – 3, 48 (serving size 15 g);

Vinegar balsamic – 4 times (serving size 10 g);

Pear – 4 times (serving size 150 g);

Kale – 4 times (serving size 67 g);

Onion – 4 times (serving size 15 g);

Squash – 1, 93 times (serving size 125 g).

The cost was decreased from initial price of food per day (215,21 czk) to 101,86 czk –obtained result within the usage of the linear programming model. The optimal solution was found and all constraints were followed, that means undoubted usefulness of using this method for minimizing the cost of food.

Table 5. Table of function and variables

Function	
Varibles	Price (czk/portion)
Apple	4,45
Cashews	14,53
Sausage	20,72
Tomato	3,87
Blueberries	32,00
Egg	9,86
Sauerkraut	7,25
Avocados	14,50
Carrots, baby	4,79
Chicken breast	24,92
Olive oil	3,59
Tomato	3,87
Vinegar, balsamic	0,92
Pear	5,53
Water	2,82
Kale	1,56
Onion	0,19
Zucchini	10,49
Squash	4,98
Tomato sauce	24,71
Turkey Meatballs	19,66
Value	101,86

Variables	Values (times)
Apple	4,00
Cashews	0,00
Sausage	0,00
Tomato	0,00
Blueberries	0,00
Egg	2,96
Sauerkraut	0,00
Avocados	0,00
Carrots, baby	0,00
Chicken breast	0,00
Olive oil	3,48
Tomato	0,00
Vinegar, balsamic	4,00
Pear	4,00
Water	0,00
Kale	4,00
Onion	4,00
Zucchini	0,00
Squash	1,93
Tomato sauce	0,00
Turkey Meatballs	0,00

Source: The research field and own computation of results

Moreover, every variable must be hold in allowable required bounds defined by constraints.

That means the following:

Potein (g): the received result is 75,88 g per day, it is more than minimum allowable level of protein per day (58,00 g) and, at the same time, is less than maximum allowable bound of protein (202,00 g).

Carbohydrates (g): the received result is 259,00 g per day, it is equal to minimum allowable level of carbohydrates per day (259,00 g) and is less than maximum allowable bound of carbohydrates (374,00 g).

Fats (g): the received result is 90,00 g per day, it is much more than minimum allowable level of fat per day (52,00 g) and is equal to maximum allowable bound of fat (90,00 g).

Calories (cal): the received result is 2300 cal per day, it is equal to minimum allowable level of calories per day (2300,00 cal) and is less than maximum allowable bound of calories (2500 cal).

4.2.2 Duality problem

From “The Sensitivity report” provided by Excel Solver can be analysed dual values (Shadow Price).

Consider now the three nutrient constraints of protein, carbohydrates, fat and calories.

The level of protein (in the original solution) is 75,88 g, which is between its minimum and maximum allowable levels, and therefore the corresponding dual variable values for both bounds are zero.

The level of carbohydrates (in the original solution) is 259, which is exactly its minimum allowable level, and therefore the corresponding dual variable value for upper bound is zero, but for the lower bound the dual variable value is positive 0,4039, which means that cost of food per day could be decreased if the lower bound would be decreased (it’s supposed only theoretically, in this case can not be applied, because the minimum required amount of carbohydrates is not possible to decrease without a harmful effect on human body).

The level of fat (in the original solution) is 90, which is the maximum required. The corresponding dual variable value for the upper bound on the number of fat is negative 0,0315, which means, that cost of daily menu could be decreases if the upper bound of far would be decreased. (By other words, it means, that cost of menu would be decreased if the upper bound of fat would be decreased).

The number of calories (in the original solution) is 2300, however, which is the minimum required. The corresponding dual variable value for the lower bound on the number of calories is 0,0299, which can be interpreted as the amount by which the objective function will decrease per unit of decrease in the bound. (Actually, it's impossible change, because the minimum required amount of calories per day is 2300 for the normal functioning of the body.

There two more columns are shown – "Allowable increase" and "Allowable decrease" – that is a possible range in minimization cost problem. In fact, this means the objective function can be estimated in that particular range, which includes lower and upper bounds.

With using Calories example (Right side min), could be defined the proper range for estimation the objective function. The lower bound is 417,19 calories, the upper bound is 62,80 calories. Anything outside the proper range would require the re-run of the Excel Solver. In this case, the optimal solution will be different.

Table 6. The Sensitivity report (Constraints)

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$L\$24	Left side Protein (g)	75,8798928	0	202	1E+30	126,1201072
\$M\$24	Left side Carbohydrates (g)	259	0	374	1E+30	115
\$N\$24	Left side Fat (g)	90	-0,031518881	90	18,78473526	3,985686761
\$O\$24	Left side Calories	2300	0	2500	1E+30	200
\$L\$24	Left side Protein (g)	75,8798928	0	58	17,8798928	1E+30
\$M\$24	Left side Carbohydrates (g)	259	0,403913717	259	5,432481386	15,90684932
\$N\$24	Left side Fat (g)	90	0	52	38	1E+30
\$O\$24	Left side Calories	2300	0,029916667	2300	62,80410767	417,1958923

Source: The research field and own computation of results

The next step in analyzing “The Sensitivity report” is to define how does the reduced cost influences the cost of food for daily menu. So, in this case, the column “Reduced cost” is being dissected I following way:

1) If the reduced cost is equal to zero – reached maximum value, it means the allowable amount of resources was used. For example, Egg values have zero in column “Reduced cost”, so the value – 2,956 psc was maximum reached from allowable resources.

2) If the reduced value identified by a negative value, this determines the possibility to reduce the total cost of food for daily menu by increasing the used unit. Let us say, Apple value has negative reduced cost -6,803, which indicates the ability to decrease the final cost of product by 6,803 czk with adding 1 more unit of apples.

3) If the reduced cost has positive value, this symbolizes the probability of increasing the final cost by supplementing one additional unit. For instance, Cashews value has positive reduced cost 6,517, this represents negative relationship between final cost and adding one more unit of product. While 1 unit of cashew added, the objective function is increased by 6,517 czk, what is not advantageous outcome in minimization cost problem.

Table 7. The Sensitivity report (Variable cells)

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
U3	Apple Values	4	-6,803200972	4,45	6,803200972	1E+30
U4	Cashews Values	0	6,517855332	14,53	1E+30	6,517855332
U5	Sausage Values	0	2,567810705	20,72	1E+30	2,567810705
U6	Tomato Values	0	0,80246603	3,87	1E+30	0,80246603
U7	Blueberries Values	0	21,05778519	32	1E+30	21,05778519
U8	Egg Values	2,956629434	0	9,86	0,567462662	2,497324647
U9	Sauerkraut Values	0	3,823629203	7,25	1E+30	3,823629203
U10	Avocados Values	0	5,991923922	14,5	1E+30	5,991923922
U11	Carrots, baby Values	0	1,293693823	4,79	1E+30	1,293693823
U12	Chicken breast Values	0	17,50066667	24,92	1E+30	17,50066667
U13	Olive oil Values	3,476632436	0	3,59	1,03140659	0,2400309
U14	Tomato Values	0	0,789858477	3,87	1E+30	0,789858477
U15	Vinegar, balsamic Values	4	-0,089206329	0,921	0,089206329	1E+30
U16	Pear Values	4	-7,523677824	5,53	7,523677824	1E+30
U17	Water Values	0	2,82	2,82	1E+30	2,82
U18	Kale Values	4	-2,483723946	1,56	2,483723946	1E+30
U19	Onion Values	4	-0,28058146	0,19	0,28058146	1E+30
U20	Zucchini Values	0	8,024571505	10,49	1E+30	8,024571505
U21	Squash Values	1,932981539	0	4,98	1,140330889	0,405577218
U22	Tomato sauce Values	0	17,55188792	24,71	1E+30	17,55188792
U23	Turkey Meatballs Values	0	16,02141646	19,66	1E+30	16,02141646

Source: The research field and own computation of result

4.3 The construction of gym problem

4.3.1 Understanding of relationship between physical activities and calories effect

The main purpose of this chapter is to select activities that will satisfy calories burning according to minimizing the time used in gym, respectively decreasing cost per gym. The problem defined by linear programming model in which the objective is to minimize cost per gym and the constraints are to satisfy calories burning according to physical activities. The gym problem constraints generally handle the number of calories needed to be burnt due to the purpose of getting fit.

The Gym Problem can be formulated mathematically as a linear programming problem as shown below. There are demonstrated two models, the main difference between them is different constraint – number of exercises. It was made in order to find different optimal solutions, which depend on a quantity of physical activities.

Model 1

Sets

E = set of exercises

C = set of calories

Parameters

$\boldsymbol{a_{ij}}$ = amount of calories j burnt during doing physical exercises i, **∀i ∈ E**, **∀j ∈ C**

$\boldsymbol{t_i}$ = time in minutes per one exercise i (minutes), **∀i ∈ E**

E $\boldsymbol{min_i}$ = minimum number of required exercise i, **∀i ∈ E,** $E_{min} \geq 0$

E $\boldsymbol{max_i}$ = maximum number of required exercise i, **∀I ∈ E,** $E_{max} \leq 4$

C $\boldsymbol{min_i}$ = minimum required number of calories j, **∀j ∈ C,** $Calories_{min} \geq 700$

Variables

$\boldsymbol{x_i}$ = number of exercise needed to burn calories per day, **∀i ∈ E,** $x_{1-5} \geq 0$

$\boldsymbol{x_1}$ – walking, $\boldsymbol{x_2}$ – swimming, $\boldsymbol{x_3}$ – pushback $\boldsymbol{x_4}$ –exercises, $\boldsymbol{x_5}$ – indoor.

Taking into account all constraints and data that is presented above, we could make the equations for finding the solution of the minimization cost problem.

Objective Function: Minimize the total time spend on exercises

Minimize $\sum_{i \in F} c_i x_i$

10 $\boldsymbol{x_1}$ + 15 $\boldsymbol{x_2}$ + 15 $\boldsymbol{x_3}$ + 20 $\boldsymbol{x_4}$ + 30 $\boldsymbol{x_5}$ → min

Constraint Set 1:

For each exercise **j ∈ Cj** , at least meet the minimum required level of burnt calories. ∑**i ∈ E,** $a_{ij}x_i \geq$ C min_j, **∀j ∈ C ;** (min: calories–700 cal/day);

Calories (cal): 100 $\boldsymbol{x_1}$ + 300 $\boldsymbol{x_2}$ + 500 $\boldsymbol{x_3}$ + 200 $\boldsymbol{x_4}$ + 300 $\boldsymbol{x_5}$ ≥ 700. Minimum required level of burnt calories per day.

Constraint Set 2:

For each exercise **i ∈ Ei**, select at least the minimum number of exercises. $x_i \geq$ E min_i, **∀i ∈ F;** (minimum number of required exercise – 0 times for each exercise per day); $\boldsymbol{x_{1-5} \geq 0}$

Constraint Set 4:

For each exercise **i ∈ E**, do not exceed the maximum allowable number of exercise. $x_i \leq$ E max_i, **∀i ∈ E;** (max number of exercise – 4 times for each type of activity per day) To solve this linear programming problem, we can use Excel Solver, which is add-ins in Excel program.

$\boldsymbol{x_{1-5} \leq 4}$

Table 8. Table of function, values and constraints for solving gym problem (Model 1)

Function	
Physical exercises	**Time (min)**
Walking	10
Swimming	15
Pushback	15
Jogging	20
Exercises	30
Value	21

Variables	Values (times)
Walking	0
Swimming	0
Pushback	1,4
Jogging	0
Exercises	0

Constraints	Calories per hour
Walking	100
Swimming	300
Pushback	500
Jogging	200
Exercises	300
Right side	700
Left side	700

Source: The research field and own computation of result

The solution is represented in table 9. “Table of function, values and constraints for solving gym problem (Model 1)”. The solution can be explained in such way, as the final time needed for burning daily norm of calories is 21 minutes. According to the linear programming calculations, the optimal solution in minimization time spent on the gym is 21 minutes with doing pushback 1,4 times, following the main requirement in burning 700 calories per day.

It was analyzed the second model of solving gym problem. The data remained the same, but for achieving more honest and realistic result (optimal solution) was set up a different constraint for minimum required number of exercises. That means every physical exercise must be done at least 1 time per day.

Model 2

Sets

E = set of exercises

C = set of calories

Parameters

$\boldsymbol{a_{ij}}$ = amount of calories j burnt during doing physical exercises i, $\forall$**i ∈ E**, $\forall$**j ∈ C**

$\boldsymbol{t_i}$ = time in minutes per one exercise i (minutes), $\forall$**i ∈ E**

E $\boldsymbol{min_i}$ = minimum number of required exercise i, $\forall$**i ∈ E,** $E_{min} \geq 0$

E $\boldsymbol{max_i}$ = maximum number of required exercise i, $\forall$**I ∈ E,** $E_{max} \leq 4$

C $\boldsymbol{min_i}$ = minimum required number of calories j, $\forall$**j ∈ C,** $Calories_{min} \geq 700$

Variables

$\boldsymbol{x_i}$ = number of exercise needed to burn calories per day, $\forall$**i ∈ E,** $x_{1-5} \geq 0$

$\boldsymbol{x_1}$ – walking, $\boldsymbol{x_2}$ – swimming, $\boldsymbol{x_3}$ – pushback $\boldsymbol{x_4}$ –exercises, $\boldsymbol{x_5}$ – indoor.

Taking into account all constraints and data that is presented above, we could make the equations for finding the solution of the minimization cost problem.

Objective Function: Minimize the total time spend on exercises

Minimize $\sum_{i \in F} c_i x_i$

10 $\boldsymbol{x_1}$ + 15 $\boldsymbol{x_2}$ + 15 $\boldsymbol{x_3}$ + 20 $\boldsymbol{x_4}$ + 30 $\boldsymbol{x_5}$ → min

Constraint Set 1:

For each exercise **j ∈ Cj** , at least meet the minimum required level of burnt calories. ∑**i ∈ E,** $a_{ij}x_i \geq$ C min_j, **∀j ∈ C ;** (min: calories–700 cal/day);

Calories (cal): 100 $\boldsymbol{x_1}$ + 300 $\boldsymbol{x_2}$ + 500 $\boldsymbol{x_3}$ + 200 $\boldsymbol{x_4}$ + 300 $\boldsymbol{x_5}$ ≥ 700. Minimum required level of burnt calories per day.

Constraint Set 2:

For each exercise **i ∈ Ei**, select at least the minimum number of exercises. $x_i \geq$ E min_i, **∀i ∈ F;** (minimum number of required exercise – 0 times for each exercise per day); $\boldsymbol{x_{1-5} \geq 1}$

Constraint Set 4:

For each exercise **i ∈ E**, do not exceed the maximum allowable number of exercise. $x_i \leq$ E max_i, **∀i ∈ E;** (max number of exercise – 4 times for each type of activity per day)

To solve this linear programming problem, we can use Excel Solver, which is add-ins in Excel program. $\boldsymbol{x_{1-5} \leq 4}$

Table 9. Table of function, values and constraints for solving gym problem (Model 2)

Function	
Physical exercises	**Time (min)**
Walking	10
Swimming	15
Pushback	15
Jogging	20
Exercises	30
Value	90

Variables	Values (times)
Walking	1
Swimming	1
Pushback	1
Jogging	1
Exercises	1

Constraints	Calories per hour
Walking	100
Swimming	300
Pushback	500
Jogging	200
Exercises	300
Right side	1400
Left side	700

Source: The research field and own computation of result

The solution is represented in table 10. "Table of function, values and constraints for solving gym problem (Model 2)". The solution can be explained in such way, as the final time needed for burning daily norm of calories is 90 minutes. According to the linear programming calculations, the optimal solution in minimization time spent on gym is 90 minutes with doing walking – 1 time (10 minutes), swimming – 1 time (15 minutes), pushback – 1 time (15 minutes), jogging – 1 time (20 minutes), exercises – 1 time (30 minutes). The main requirement of burning calories was achieved and the result is 1400 calories per day. That means better achievement of the reaching goal, for those, who want not only burn eaten calories contained in food, meanwhile build their muscles and the keep good physical shape.

Conclusion

The main goal of this work was to find optimal solution of minimizing cost, spending on healthy food and visiting gym. The diet and gym problem were solved with using linear programming model and conducting simplex method. This technique permitted to achieve the desired result, namely minimizing the cost on healthy proper nutrition and visiting gym.

Based on theoretical part, it is important to understand the dependency of food diversity, it's prices and composition of healthy nutrients in it. Moreover, it was analysed the relationship between salaries and costs on food in different countries. It was concluded that people spend money on food according to their incomes. Subsequently, it was deduced such regularity in people's behavior as spending money on junk food, because of lack of bankroll and time for healthy expensive food. Another problem of healthy diet is following all rules and regulations in proper nourishment. As a result, non-observance of these rules can cause the eating disorders, such as overeating and undernourishment. In theoretical part were listed several numbers of gentle recommendations about preventing eating disorders. Another disadvantage of improper distribution of food and non-compliance with the rules of correct nutrition is hunger. The world produces enough food to feed the entire population of the planet, all 8 billion people. Yet one in eight people in the world goes to bed hungry. These problems can be easily resolved by means of planning and respecting a proper healthy diet.

From the practical point of view, there was chosen correct balanced nutritional menu for an average human being per day. The linear programming model was created in accordance with the main nutritional requirements of fats, protein, carbohydrates and calories. Using the least cost method, the cost of menu per day was reduced by half in comparison with the initial data. The Duality of the diet problem deals with the minimum and maximum allowable level of increasing or decreasing cost of food per day. The Sensitivity report (Variable cells) generated by Excel solver showed possible changes in the number of ingredients in menu, which makes it possible to easily evaluate the change in the result (final cost of the menu), when changing the constraints of the model. The gym problem was aimed at reducing time spent on physical exercises to achieve required number of burnt calories in gym. As a conclusion of this thesis, was proved the possibility of keeping healthy diet and doing physical exercises within limited expenses.

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