PH.D. DISSERTATION

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Gödöllő, Hungary

2021

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The socio-economic burden of obesity, some ways, and impasses of its prevention

DOI: 10.54598/001220

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2021

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Abbreviations

BMI	Body Mass Index
CES	Constant Elasticity of Substitution
DALY	Disability-adjusted life years
DYNAMO-HIA	DyNamic Modelling for Health Impact Assessment
EPIC	Projecting the Economic Cost of Ill-Health
EU	European Union
FAO	Food and Agricultural Organisation
GBD	Global Burden of Disease
HCSO	Hungarian Central Statistical Office
HIA	Health Impact Assessment
IE	Income Elasticity
LE	Life expectancy
MACTOR	Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations
MHC	Ministry of Human Capacities
NCDs	Non-communicable diseases
OECD	Organisation for Economic Co-operation and Development
QALY	Quality Adjusted Life Years
SCS	School Catering System
UN	United Nations
VLO	Value of Lost Output
VSL	Value of a Statistical Life year
WHO	World Health Organisation
WFP	World Food Programme
YLD	Years lost due to disease-caused morbidity
YLL	Years of Life Lost

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1. **INTRODUCTION**

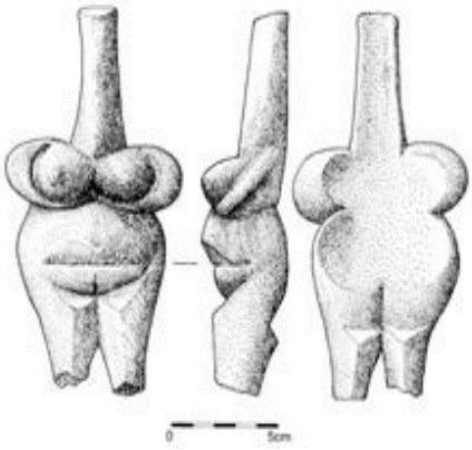
1.1. Obesity as a global problem

Malnutrition and a wide range of diseases, joining to deficiency of food have been the scourge of humankind from its earliest days up to the end of the twentieth century. The cultural significance and aesthetic value of obesity are well–reflected in the female figurines of the Neolithic period, dating back to more than 5 years ago (Figure 1). The oversized bellies and bottom of figures form Cernavoda as well as from Kőrös-kultúra (Kőrös-culture) well represent, which parts of the female body have been considered as important.

Humankind has developed over tens of thousands of years under such conditions when the central problem was getting enough energy from food, and not too much food. The scarcity of food and the periodically returning, severe food shortages have been dominated throughout history. The obtaining of food by hunting, searching for edible resources (foraging), and farming typically required considerable physical efforts. Under these conditions such individuals, who could store excess energy resources as body fat in periods, when food was relatively abandon had an advantageous position. In former periods the overweight status or the corpulent body was associated with healthiness and upper-class position (Gracia-Arnaiz, 2010; Montanari, 2006). Now with abundant food and little need for an extreme physical extension for most Europeans in their work or daily lives, the living conditions have changed dramatically, with practically no change in human physiology.

In the opinion of Caballero (2019), obesity is the result of humans' longstanding efforts to protect themselves against famine and to increase body size, a factor that was a critical source of productivity and military domination for centuries. In the opinion of Beller (1977) 'We *are the victims of ancestral circumstances. For many of us, these circumstances were glacial, and therefore thermally and nutritionally decisive. Our ancestors rose to the evolutionary challenge by genetic instructions for more and better adipose tissue formation; we have inherited this solution in the form of excessive body fat. But every culture, if not every age, has its own ideas of what constitutes an excess; and what may have been too much of a good thing in one time and place may turn out to be a niggardly bare sufficiency in another. In a changing climate and possibly a changing ecosystem, meanwhile, the case against fat and fatness has not been proved*.'

Figurate from the Neolithic period



Women figure from Cernavoda (Romania)

Figure 1. 'The nice body' some thousand years ago

Source: Kalla, 2012; Tornyai Múzeum, 2020

Obesity is one of today's major public health problems in adults, as well as among children and adolescents. The prevalence and incidence of obesity and comorbidities are studied by the world-leading health institutions and organizations, the most important and reliable ones are the World Health Organisation (WHO), Organisation for Economic Co-operation and Development (OECD), and the Obesity Collaborators of Global Burden of Disease Study (GBD). The prevalence of obesity has increased worldwide, obesity has nearly tripled since 1975. In 2016, 40% of women and 39% of men aged 18 and over were overweight. According to expert estimates nearly a third of the world's population could be now classified as overweight or obese. The prevalence of obesity has increased not only among adults, but among children and adolescents, 18% of children and adolescents aged 5-19 were overweight or obese in 2016 (WHO, 2020). Global status report on noncommunicable diseases (2014) indicates that the prevalence of overweight and obesity is highest in the Region of the Americas. In the European Region, over 50% of women are overweight. The age-standardized prevalence of obesity in adults in both genders aged 18 years and over are shown in Figures 2 and 3.

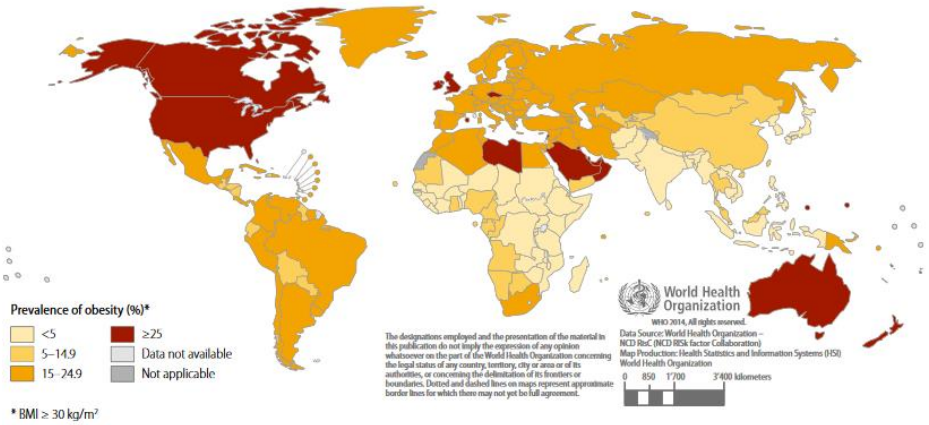


Figure 2. Age-standardized prevalence of obesity in men aged 18 years and over (BMI ≥30 kg/m^2), 2014

Source: Global status report on noncommunicable diseases, 2014

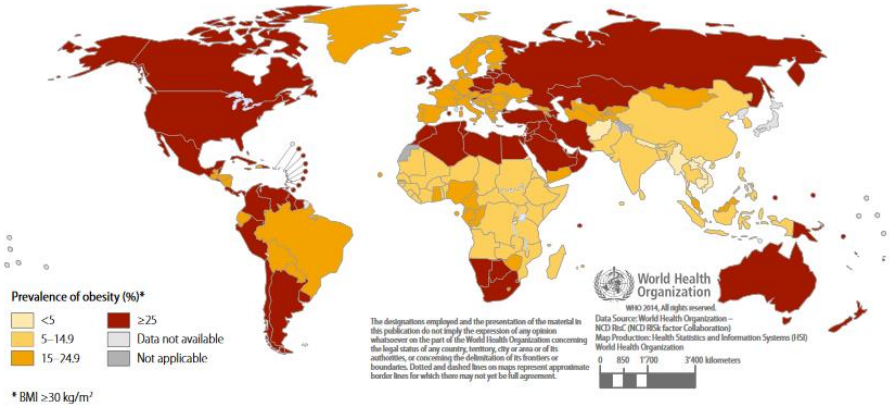


Figure 3. Age-standardized prevalence of obesity in women aged 18 years and over (BMI ≥30 kg/m^2), 2014

Source: Global status report on noncommunicable diseases, 2014

In 2015, the Obesity Collaborators of Global Burden of Disease study estimated that 107.7 million children and 603.7 million adults were obese worldwide. The overall prevalence of obesity was 5.0% among children and 12.0% among adults (GBD, 2017). In 2015, across the OECD, 19.5% of the adult population was obese (Figure 4). In the OECD area, Hungary has the fourth highest obesity rate based on measured height and weight, the obesity rate is more than 30% of the population aged 15 years and over (OECD, 2017).

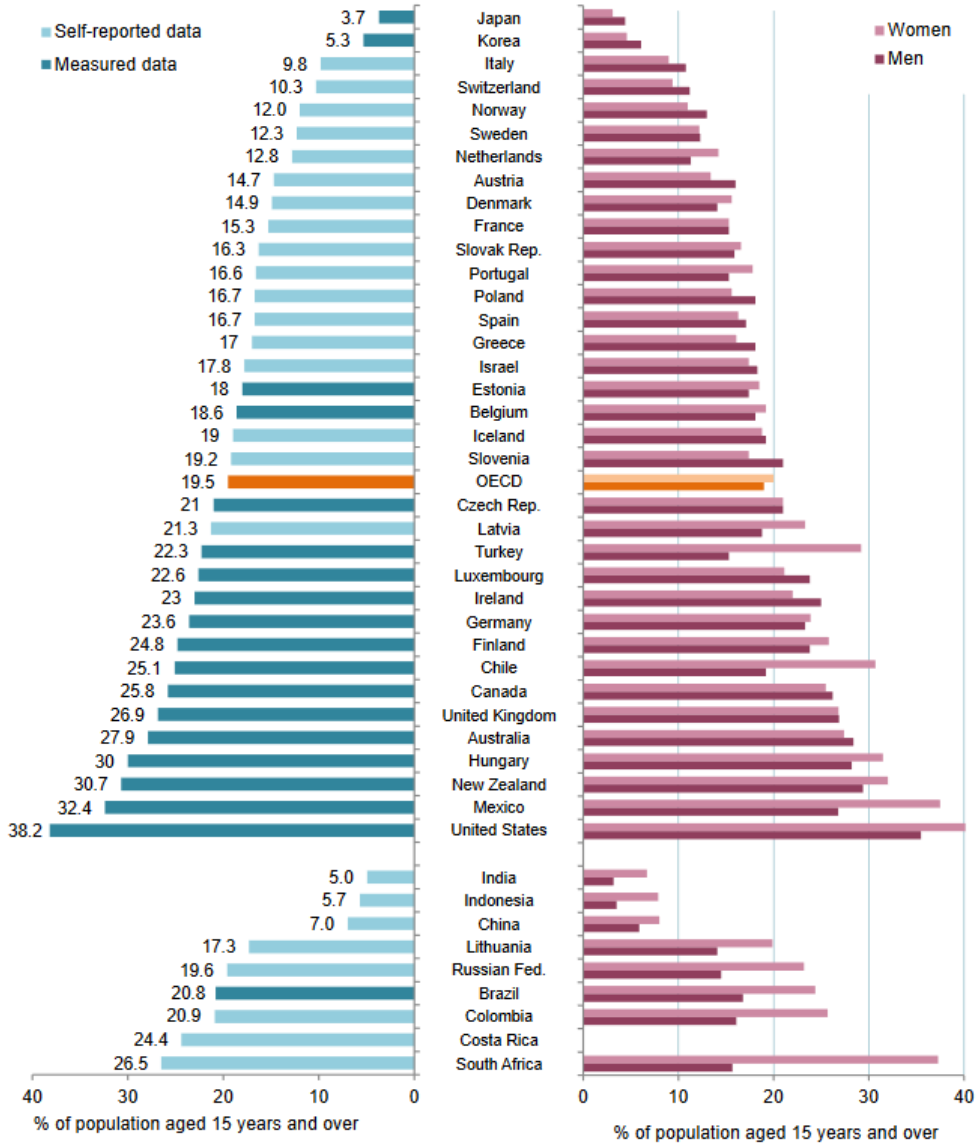


Figure 4. Obesity among adults

Source: OECD Obesity Update, 2017

Obesity has been gaining importance since the last half of the 20th century. Obesity increases the risk for many diseases, including coronary heart disease, stroke, diabetes, and breast, prostate, and colorectal cancers. It is a generally accepted fact, that obesity is not just a medical problem, but has acquired social urgency. Around the second millennium, a consensus has been formulated in academia and health policymakers, that '*obesity should no longer be regarded simply as a cosmetic problem, affecting certain individuals, but an epidemic that threatens global well being*' (Kopelman, 2000). Decreasing obesity and its comorbidities is one of the main priorities of health policies all over the world. The global burden of obesity-related diseases has only recently been defined and estimated. Up to USD PPP, 425 billion per year is spent across OECD, Group of 20, and EU28 member countries on obesity. The total economic burden of overweight ranges from 1.6% to 5.3% of GDP, depending on the country (OECD,

2019). Although an understanding of obesity-related morbidity and mortality is of paramount concern to specialists and policymakers alike, the downstream consequences of obesity burdens are also gaining importance. One way to contextualize the impact of obesity on the socio-economic environment is to estimate the economic consequences it imposes. To make the economic case for investing in obesity prevention and treatment, its impact needs to be quantified.

1.2. Obesity and the food industry

In many ways, the growing prevalence of obesity and overweight is attributable to the unprecedented development of food systems in developed countries. Food became cheap and palatable, is widely available to a wide range of consumers. This fact can be well seen in the example of Hungary: comparing the per capita consumption values of different products based on historical statistics, we can see a drastic structural change in food consumption (Table 1).

Table 1. Long-range changes of yearly food consumption (per-capita) in Hungary

Product categories	**Years**			
	1868	**1938**	**1959**	**2017**
Cereals (kg)	161	147	139.4	67
Meat and meat products (kg)	44.6	33.6	47	51.2
Fat (without butter) (kg)	31.7	16	21.3	11.2
Milk and milk products (kg)	108	123.5	14.4	142
Eggs	54	93	156	133
Sugar (kg)	2.8	10.5	25.9	13.3
Leguminous (kg)	16.7	6.3	3.1	2.1
Potato (kg)	97.7	130	97	25.8
Vegetables (kg)	37.4	50	71	72.4
Fruits (kg)	34.2	45	53.4	34
Wine (l)	28.7	34.8	33	4.2
Beer (l)	4.1	3.1	45	78
Spirituous drinks (l)	13.6	9	7	7.2

Source: Central Statistical Office of Hungary (HCSO, Statistical Yearbooks from different years)

The economics of the food processing and foodservice business make large portion sizes attractive since labour and the general costs (overhead) constitute a large part of the total costs, and this will increase very little with increasing the portion size. For an average Hungarian consumer, who is conditioned to systematically searching for products, optimised to value/cost relationship, such conditions are very appealing for consumers. Rising rates of overweight and obesity are a major challenge to the global food industry. The role of the food industry in possibilities of decreasing the share of obese and overweight citizens is increasing (Koplan &

Brownell, 2010) The European food industry has increased its efforts to promote healthier consumer behaviour in the field of food consumption (Ronit & Jensen, 2014; Timotijevic, Khan, Raats, & Braun, 2019). As it can be seen in Figure 5, health became one of the most important drivers of food innovations.

The basic principles of the European food industry form point of view of healthy nutrition can be summarised in the following points (FoodDrink Europe, 2019):

- The different actions of manufactures to promote balanced diets and healthy lifestyle should be based on sound, accepted evidence,
- The reformulation or fortification of existing products (e.g. decreasing of salt content, or increasing of mineral and/or vitamin content
- Decreasing the intake of salt, fat, and added sugar
- Increasing of consumption of fruit and vegetables,
- Decreasing the exposure to and impact on children of marketing messages, aiming at the boosting of food consumption,
- Increasing the rates of exclusive and continued breastfeeding;
- Reduction of diet-related inequalities.

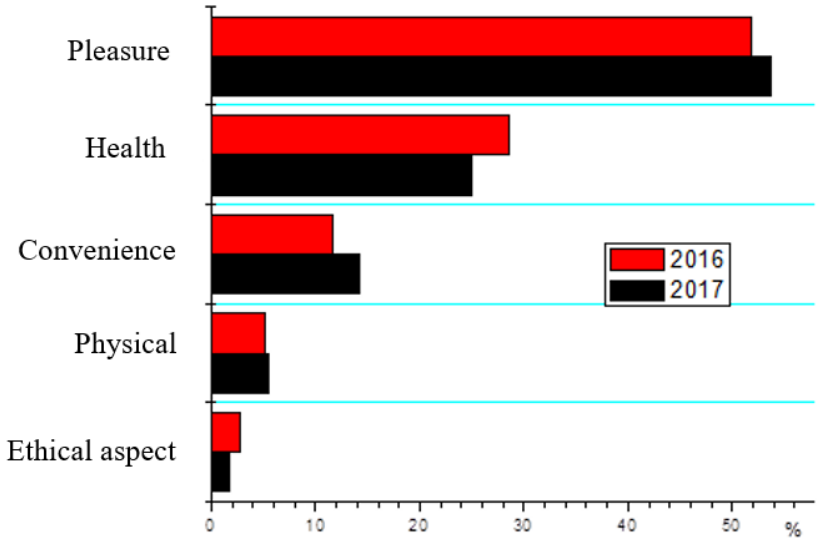


Figure 5. Main drivers of European Food Innovations

Source: Fooddrink Europe, 2018

According to FoodDrink Europe (2018), clear and concise labeling on products should provide all the necessary pieces of information for the consumers on products characteristics with the purpose of promotion of informed consumer choices. On this basis, the consumers are provided nutritional information on reference intakes of different products. Close cooperation is needed with different stakeholders for action on diet and physical activity to promote health. This needs

the involvement of food business operators, from agricultural producers to caterers, consumer organizations, public health and organizations, academic and professional associations.

The Strategy of the European Union on nutrition, overweight and obesity-related health issues (European Union, 2007) focusses on six, closely interlinked area:

1. better informed consumers;
2. making healthier options available;
3. priority groups and settings;
4. encouraging physical activity;
5. developing the knowledge base;
6. developing monitoring systems.

The most important area of nutrition policy of the European Union is the decreasing of childhood obesity. The key possibilities of voluntary actions of member states are as follows:

- Support a healthy start in life;
- Promote healthier environments, especially in schools and pre-schools;
- Make the healthy option the easier option;
- Restrict marketing and advertising to children;
- Inform and empower families;
- Encourage physical activity;
- Monitor and evaluate;
- Increase research.

The European food and drink industry have to constantly research, analyze of and respond to consumer demands by providing a wide range of choice of different products, which satisfy the following criteria:

- nutritious;
- safety;
- high sensory value.

The aim of the voluntary EU Platform for Action on Diet, Physical Activity and Health (European Union, 2019) is to optimize the nutritional content of different products.

In a summary it can be stated, that during the last decades the overweight and obesity have got unprecedented importance in health policy, political and economic decision making as well as in everyday life. Decreasing the prevalence and incidence of obesity, and obesity-related diseases became an important topic of politics and national strategies. From point of view of the food industry, it is a question of vital importance to understand the causes and consequences of obesity, because this will determine the main directions of product development and the economic environment of food-related regulations.

1.3. Research goals and hypotheses development

As I have demonstrated, the socio-economic analysis of obesity is a highly complex issue, which has numerous aspects, from psychology to sociology and cultural anthropology, from micro-to macroeconomics. From this follows, that a Ph.d. thesis should carefully choose the focal point of the dissertation. Considering the most important points of my dissertation, I have determined the focus of my thesis taking into consideration the following aspects:

- Focusing on the most important problems of the current Hungarian socio-economic situation, trying to grasp the key problems of Hungarian society from points of view of obesity; my target groups were the Hungarian adult population and the two most important at-risk populations: children and Roma minority in Hungary.
- Wide-range application of latest, quantitative methods in the analysis of obesity problem, demonstrating the applicability of modern methods in the analysis of obesity as a strategic, complex socio-economic problem. I have applied three quantitative methods to determine the burden and consequences of obesity in Hungary.
- Practice-orientation: beyond a simple analysis of the current situation I have intended to offer practical guidance for decision-makers for planning, preparation, realization, and controlling of workable and effective solutions to decrease the obesity problem in society.
- I have had carefully plan my research because I had to take into consideration the monetary, time, and logistical limits of my research activity: I have had no additional resources for my research, that's why there was not possible to apply some sophisticated methods of primary data collection, e.g. application of modern anthropometric tools (e.g. InBody®) or collection and analysis of nutritional diaries.

In the framework of my Ph.D. thesis, I will analyze the three most important socio-economic aspects of obesity, and the possibilities of its prevention. The logic of the dissertation is presented in Figure 6.

The aim of my work was threefold:

1. Determination of current and prognostic burden of obesity in case of Hungarian adult population, quantification of macro-economic consequences of obesity and their prognosis for the next one hundred years (three-generation period).

2. Determination of prevalence of obesity, current and prognostic burden of obesity in case of Hungarian Roma population. Guided by this goal, preparation of a forecast for the prevalence of obesity and its burden in case of Roma population, and estimation of efficiency of intervention programs, different in intensity; preparation of quantitative models to a comparative analysis of different type intervention programs, based on changes in nutritional status and prevalence of co-morbidities of obesity.

3. An in-depth analysis of an actual government-level project aiming at the prevention of childhood obesity: the investigation of socio-economic causes, leading to introduction and modification of 37/2014. (IV. 30.) Ministerial Decree on the nutritional standards of public catering.

Based on these considerations, I have formulated the research hypotheses as follows:

H1: Based on the system dynamics method a more robust and flexible model can be constructed, than the algorithms, generally applied for analysis and prediction of the burden of obesity.

H2: Combining the system dynamics approach with the Solow model of economic growth it can be proven, that obesity causes considerable health and economic burden in Hungary, the importance of which will be increasing, hindrance the economic development.

H3: The prevalence and incidence of obesity and obesity-related diseases in the Roma minority are an especially severe epidemiologic problem. In the lack of complex, high-intensity obesity prevention and intervention programs, parallel with the increasing number and average age of this segment of the population, obesity and obesity-related diseases will be one of the main causes of deteriorating health conditions of the Roma population.

H4: The importance of prevention is increasing in general, and in childhood in particular. An important part of these efforts is the reform of school catering in Hungary, but this must be based on a wide-range social consensus and concentrated efforts of different stakeholders.

Introduction		
Obesity as a global problem and obesity from point of view of the food industry		
Research goals		
Forecasting and estimate the socio-economic burden of obesity in the Hungarian adult population	To determine the current and future prevalence of obesity and to estimate the effect of prevention programs in the Hungarian Roma population	Analysis of the Hungarian school catering system as a possible obesity prevention program
Literature review		
Obesity in the Hungarian adult population	Obesity in the Hungarian Roma population	Obesity in children and the Hungarian school catering system
Methodology		
Application of system-dynamics in modeling obesity	Application of Markov-chain in modeling obesity	The MACTOR method: description and analysis of social bargains
Results and discussion		
The socio-economic burden of obesity measured in years of life lost and long-range macroeconomic burden	The current and future prevalence of obesity and obesity-related diseases, effective obesity prevention programs	The reform of school catering: anatomy of a Health-Education Attempt
Summary		

Figure 6. Structure of the dissertation

2. LITERATURE REVIEW

2.1. The obesity

It is generally acknowledged, that '*obesity is a complex, chronic medical condition with a major negative impact on human health*' (Hu, 2007). Obesity is a complex multifactorial disease, overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2020). Upadhyay, Farr, Perakakis, Ghaly, and Mantzoros (2018) cite a long range of lists of American professional associations which consider obesity as a disease. At the same time, the authors cite the position of the American Association of Clinical Endocrinologists and American College of Endocrinology which concluded that a '*more medically meaningful and actionable definition of obesity*' was needed, and hence these organizations advocating for use of the word '*adiposity based chronic disease or ABCD*'.

There is a wide range of indicators and methods of measurement of obesity (Katzmarzyk et al, 2018; Lee et al, 2018). Body mass index (BMI) is generally used to characterize the nutritional status (Table 2). According to generally accepted categorizations, if the weight is measured in kilograms, and the height in meters, the ratio of weight and the squared height are used to identify obesity. For adults, a BMI of 25.0 to 29.9 kg/m^2 is considered overweight and a BMI of 30 kg/m^2 or higher is defined as obese (Apovian, 2016). The application of BMI in the case of children and adolescents age 2 to 18 years is a highly debated issue: instead, it is recommended that a percentile scale based on the child's sex and age be used. In this population, overweight is defined as a BMI in the 85th to 94th percentile, and obesity is a BMI at or above the 95th percentile (Aggarwal & Jain, 1017).

Table 2. International classification systems of nutritional status (for adults) according to BMI

Classification	**BMI (kg/m^2)**		**Risk of comorbidities**
	Principal cut-off points	Additional cut-off points	
Underweight	<18.50	<18.50	Low
Severe thinness	<16.00	<16.00	
Moderate thinness	16.00 – 16.99	16.00 – 16.99	
Mild thinness	17.00 – 18.49	17.00 – 18.49	
Normal range	18.50 – 24.99	18.50 – 22.99	Average
		23.00 – 24.99	
Overweight	≥25.00	≥25.00	Mildly increased
Pre obese	25.00 – 29.99	25.00 – 27.49	
		27.50 – 29.99	
Obese	≥30.00	≥30.00	

Classification	BMI (kg/m^2)		Risk of comorbidities
	Principal cut-off points	Additional cut-off points	
Obese class I	30.00 – 34.99	30.00 – 32.49	Moderate
		32.50 – 34.99	
Obese class II	35.00 – 39.99	35.00 – 37.49	Severe
		37.50 – 39.99	
Obese class III	≥40.00	≥40.00	Very severe

Source: WHO, 2021

At the same time, it must be highlighted, that the estimation of nutritional status is an extremely complex problem. Gielen and Sandri (2013) emphasize, that it is highly questionable '*the uncritical acceptance of the paradigm that BMI accurately measures obesity in both health and disease and the current lack of interest in accurately measuring fat depots, adipocyte metabolic and endocrine function, and their complex pathological actions in prospective studies in both health and disease*'.

2.2. Causes of obesity

Different historical records show a continuous increase in BMI in the past three hundred years and there is a consensus in the literature, that the causes of obesity are different (Wright & Aronne, 2012), but the relative importance of factors of obesity is a highly debated issue. Some authors highlight the energy imbalance between nutrition and physical activity (e.g. Sallis & Glanz, 2009), others emphasize the direct and indirect genetic effects (Johnson et al, 2013), gene-environment interactions (Phelan & Link, 2005), or social determinants (Arroyo-Johnson et al, 2016). The odds of obesity are six times higher in the case of people in lower socioeconomic status than in the case of the upper classes of the society. According to Kopelman (2000), obesity is a consequence of the combination of genetic susceptibility, increased availability of high-energy foods, and decreased requirement for physical activity.

Besides the discussions on obesity in public life and the political sphere, there is a discussion in everyday life on obesity. In the opinion of Barry, Brescoll, Brownell, and Schlesinger (2009), these metaphors are

- obesity as sinful behavior (e.g., sloth, gluttony),
- obesity as a disability,
- obesity as a form of eating,
- obesity as a food addiction,
- obesity as a reflection of time crunch,
- obesity as a consequence of manipulation by commercial interests,
- obesity as a result of a toxic food environment.

Effertz, Engel, Verheyen, and Linder (2016) summarise the main cause of obesity: *'Despite the complex matter of interplays of different factors contributing to obesity and its evolvement paths, it is mostly agreed that the majority of obesity cases result from a persistent unbalanced positive energy account, mostly due to the consumption of non-core food high in salt, sugar or fat.'* As we see, the causes of obesity are a highly complex issue. It would be very luring to analyze in detail the factors that can influence obesity in Hungary, but this would be the topic of another research. That's why I did not want to go into detail on the analysis of the causes of obesity in Hungary.

2.3. Socio-economic burden of obesity

There are several approaches to quantify the impact of overweight on population health and the economy. The study of OECD (2019) provides an overview of the burden of obesity on population health and the wider economy, but to the best of my knowledge, there is no comprehensive review on the economic consequences of obesity. I have summarized previous studies that estimated the impact of obesity on the wider economy based on the OECD health policy study (Table 3).

Table 3. Estimation of the impact of obesity on the wider economy

Country	**Source**	**Economic losses attributable to obesity**	**The approach used to estimate the economic burden of obesity**	**The total cost of obesity (% of GDP)**
Australia	Access Economics, 2008	carer cost and foregone taxes	value of a statistical life	0.9
Canada	Anis et al, 2010	carer cost, long-term disability, and morbidity	human capital approach	0.8
France	Caby, 2016	welfare payments, lost productivity and employment	human capital approach	0.8
Germany	Lehnert, Streltchenia, Konnopka,	mortality, early retirement,	human capital approach	0.4

	Riedel-Heller, and König, 2015	absenteeism		
Germany	Effertz et al, 2016	mortality, early retirement, absenteeism, unemployment	bottom-up approach	1.6

Source: own construction based on OECD, 2019

Most of the studies applied the human capital approach to estimate the economic burden of obesity among the approaches to model the non-healthcare costs associated with obesity. Among the studies, aiming to model the economic burden of obesity, there is considerable heterogeneity in methodological approaches, target populations, study time frames, and perspectives. Because of the heterogeneity of the studies, an informative comparison between most of the studies is difficult. Specifically, there is a great variety in the included obesity-related diseases and complications among the studies.

Overweight and obesity affect population health, increasing the risk of diseases attributable to obesity like type 2 diabetes and cardiovascular diseases. Treatment of obesity and obesity-related diseases increases health expenditure and also affects an individual's productivity and workforce participation. Thus, at a macroeconomic level, obesity has an impact on the wider economy of a country. Figure 7 provides an overview of the burden of obesity at a macroeconomic level.

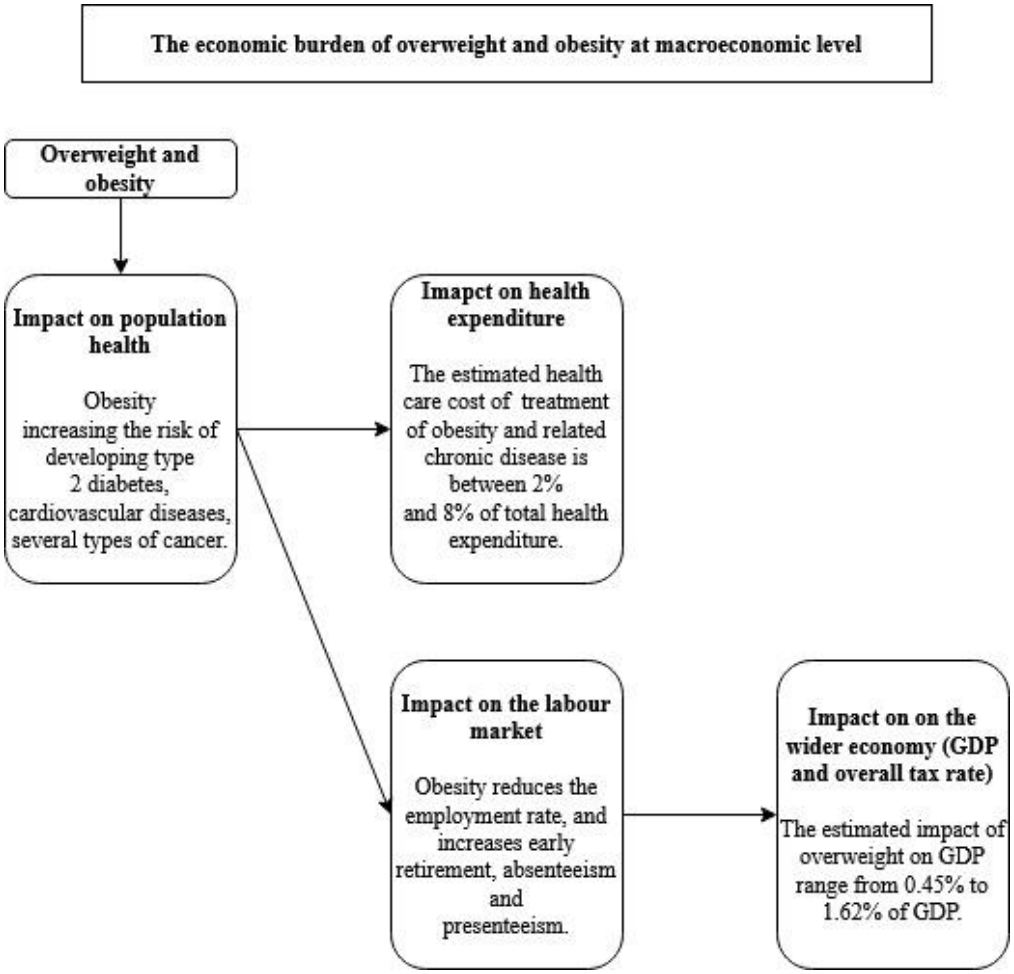


Figure 7. The economic burden of overweight and obesity at a macroeconomic level

Source: own construction based on OECD, 2019

In the later part of my dissertation, I will present the mathematical models, aiming to determine the socio-economic consequences of obesity, and show, why these methods are not applicable at the time of preparation of this thesis. It can be stated that there is a need for public health measures to prevent obesity and international consensus is required on standardized methods to calculate the cost of obesity to improve homogeneity and comparability.

The literature on the value of human life is extremely rich and mushrooming. From this follows, that there is a high need for systematic surveys. One of these has been realized by Schlander Dintsios, and Gandjour (2018). According to their typology, there are different approaches to the value of a statistical life year. These are as follows:

- Human capital approach
- Revealed Preferences approach
- Stated preferences approach
- Contingent valuation
- Discrete choice experiments

- Willingness to pay research

Based on an in-depth analysis of 120 economic studies, published on the value of a statistical life year, published between 1995-2015, the mean values of a statistical year are 223˚428 Euro (lower bound 182˚042 and upper bound 272˚092) determined by the nonparametric bootstraps method. The Value of a life year is tightly connected to the GDP. The median value of a statistical life year has been 5.1 in Europe, 5.2 in Asia, and 6.9 in North America.

In the literature there is a wide choice of different indicators, intending to quantify the effect of ill health. The most important indicators are depicted in Figure 8.

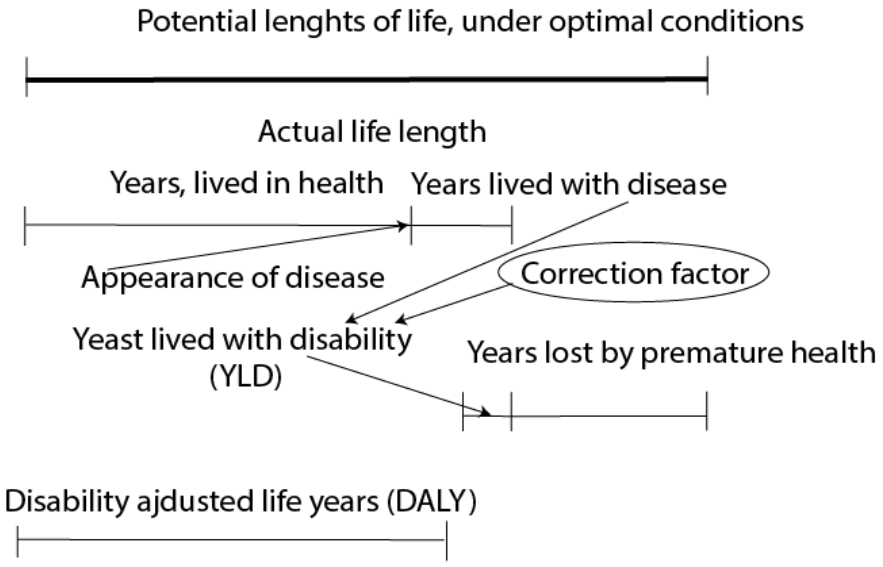


Figure 8. Interpretation of different health-loss indicators

Source: own construction

Results of GBD data are expressed as Disability-adjusted life years (DALY) and Quality-adjusted life years (QALY) values. This is a generally accepted measure of disease burden, integrating the quality and the quantity of the life lived. One QALY equals one year, lived in perfect health. If the individual's health is below the optimal (maximal) value, the increase of QALY will be lower than one. Since its introduction (Klarman & Rosenthal 1968, Fanshel & Bush 1970) there have been numerous improvements to determine the appropriate weights for QALY values. Publication of calculations, based on DALY are general in such high-prestige journals, like The Lancet or The New England Journal of Medicine. Leading international organizations-e.g. WHO and the World Bank widely apply these measures. At the same time, it should be noted, that DALY is a widely debated concept. The most important counter-arguments are as follows: (1) DALY is a negative gap-measure, '*the basic unit of measurement*

for DALY is lost years of healthy life'. (2) DALY is measured on a scale with interval-scale properties (Reidpath, Allotey, Kouame, and Cummins, 2003).

According to the result of Cai (2013), the cost of disability-free life years in the US has been 71000$ in the case of a 65+ population, with just small differences between gender and racial/ethnic groups. In the opinion of Finkelstein et al (2010), obesity increases annual medical expenditure by 147 billion USD in the United States. This is more than 9% of the total medical expenditures. A former paper has estimated just half of these medical care costs.

Considerable attention has been paid to the economic and econometric analysis of age effects in the case of economic valuation of life. Theoretically, if capital markets were perfects, then the statistical value of life would steadily decline with age, as a consequence of the decreasing life expectancy.

2.4. Costs of obesity

According to the generally accepted definition of the WHO Health impact Assessment (HIA) is '*a combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population*' (Andersen, 2019). The basis of HIA models is the DALY concept which has been developing rapidly since the 1980s (Watts et al, 2018). DALY can be expressed as a sum:

$$DALY = YLL + YLD$$

Where YLL expresses the life lost due to disability and YLD expresses the years lost due to disease-caused morbidity (Solberg, Norheim, & Barra, 2018).

It is a complex question, how can be compared the YLL values for different years. In line with the suggestion of Leksell and Rawl (2001) it can be applied the method as follows:

$$YLL_{a,t} = \int_{a}^{LE} e^{-r(x-a)} dx$$

Where

a-age of death

LE- life expectancy

x age-integrated over years of life lost (YLLs)

r-discount rate.

If we accept the proposition, that the statistical value of life varies with age, then we have to estimate the value of statistical life. To achieve this, following the logic of Murphy and Topel (2006) we have to determine the peak value of a statistical life year (VSL_p) for a given country (e.g. Hungary).

Here the following formula can be applied:

$$VSL_{p,HU} = VSL_{p,US} \cdot \left[\frac{YC_{HU}}{YC_{US}}\right]^{IE-VSL}$$

Where

$VSL_{p,HU}$ –the peak value of a statistical life in Hungary

YC-GDP per capita in the US

IE-VSL- income elasticity of VSL

To estimate the effect of different diseases (e.g. obesity-related diseases) on economic performance during 2020-2010 we used a modified version of the WHO EPIC (Projecting the Economic Cost of Ill-Health) model (Alkire, Peters, Shrime, & Meara, 2018). This model quantifies the changes in a country's labor force and capital stock due to disease that would be exercised to the country's gross domestic product (GDP).

The key assumptions of the model are as follows:

The Aggregate output can be expressed by a Cobb-Douglas function:

$$Y_{i,t} = \gamma_{it} A_{it} K_{i,t}^{\alpha} L_{it}^{\beta}$$

where

Y- output (expressed as the gross domestic product);

A- total factor productivity;

K- physical capital stock;

L- labour force;

α- output elasticity;

β- output elasticity of labour;

$\gamma_{i,t,}$ scaling parameter

i- country

t- year

The model assumes a constant return to scale, that's why:
$\alpha + \beta = 1$

The calculation of VLO (Value of lost output) is based on the equation as follows:

$$VLO_i = \sum_{d \in D} \sum_{t=2018}^{2100} Y_{cf,d,t} - Y_{sq,t}$$

where

d- the additional burden of obesity caused diseases

cf counterfactual scenario,

sq status quo,

VLO value for lost output.

The capital stock accumulation can be expressed by the equation:

$$K_{i,t} = sY_{i,t} + (1-\delta)K_{i,t-1}$$

where

s savings rate and

δ is the capital depreciation ratio.

In line with another model, it can be supposed, that capital stock is only affected by disease mortality, and not by health expenditures on diseases.

The marginal contribution to the population for each year in the absence of disease can be calculated as:

$MP_{a,s,t} = AM_{a,s,t}\ SR_{a,s,t}$

where

MP – marginal population addition

AM – averted mortality (number of individuals that survive in the absence of the ORD.

SR – baseline survival rate in the absence of disease

Additional productivity (AP) for a given country can be calculated on a basis of the equation:

$$AP_{a,s,t} = EF_{\alpha}(AP_{a,s,t} \cdot ER_{a,s,t})$$

where

AL – additional workforce

ER employment rate

and

EF –experience factor, determined on the base of the equation:

$$\frac{EF_a = 0.8 + 0.02(a-15) - 0.002(a-15)^2}{me}$$

The total labour supply is the sum of status quo and obesity free scenarios

A relatively simple way of determining an annualized rate of change (*rc*) would be to apply the traditional formula for each age-group and sex:

$$rc_{a,s} = \frac{\ln\left[\frac{MR_{t+n,a,s}}{MR_{t,a,s}}\right]}{n}$$

Where *n* is the number of years

The mortality rate could be projected to *t* by calculation as follows:

$$MR_{a,m,s} = MR_{t+n} \cdot e^{rc_{a,s} \cdot (m-n)}$$

The age-specific VSL is estimated by the following formula:

$$VSL_a = VSL_p \cdot f(a)$$

Where *a* represents age and *f(a)* which adjusts the peak *VSL* to *VSL* based on the proportion of life lived.

$$f(a) = \begin{cases} if\ \frac{a}{LE} \leq 0.236;\ 19.41(0.236)^4 - 43.17(0.236)^3 + 27.65(2.236)^2 - 4.33(0.236) + 0.44 \\ if\ \frac{a}{LE} > 0.236;\ 19.41\left(\frac{a}{LE}\right)^4 - 43.17\left(\frac{a}{LE}\right)^3 + 27.65\left(\frac{a}{LE}\right)^2 - 4.33\left(\frac{a}{LE}\right) + 0.44 \end{cases}$$

The total welfare losses can be calculated as

$$VLW_d = VSLY \cdot DALY_d$$

I have presented the methodology of calculation of economic losses attributable to non-communicable diseases in a rather detailed way to demonstrate, that this tool would be highly suitable to estimate the economic consequences of obesity in my study. The software for calculation of these losses had been widely applied to estimate of economic consequences of different health-policy decisions (e.g. Alkire et al, 2015; Rudolfson et al, 2018). This tool had been freely available from the website of WHO up to 2017. In 2018 on the same website has been indicted, that the EPIC tool has been removed from there and a new version will be presented in the first half of 2018. In 2019 there has not been any information on the EPIC model (WHO, 2019).

2.5. Obesity in Hungary

Based on a historical analysis of the nutritional status of the Hungarian population in my opinion three big periods can be defined in the last one hundred years. The first period has been ended in the middle of the fifties of the last century. This period can be characterized by a relatively low level of food consumption, determined on the basis of averages. In this period the most important problem has been the supply of the population with an adequate quantity of food. It is well documented, that in numerous cases even the simple energy content of the food has not been enough for the harmonic physical development. These problems are in great detail analyzed not only in rigorous works of nutritional specialists (Sós, 1942) but also in sociological literature of that period. The most important, general problems of nutrition at that time were as follows: (1) low energy intake, (2) low intake of vitamins and proteins, (3) low level of variability. The most important influencing factor of nutrition quality has been the financial position of the citizens (Heinrich, 1938). Under these conditions, obesity has not been a central problem for society, even in the case of the upper class.

In the second period, the average food consumption has increased rather rapidly, but in this period obesity seemed to be manageable (Tarján, Bouquet, Soós, & Walthier,1974). In my opinion the third period of modern Hungarian history of obesity begun in the last quarter of the 20th century. This process went parallel with increases in the average living standard of the population.

This period can be characterized by different factors, contributing to obesity:

1. the relative price of food has been considerably decreasing (Hubbard, Szigeti, & Podruzsik, 2010),
2. the share of ultra-processed food has been increasing (Monteiro et al., 2018),
3. general increasing of consumption of energy-rich products (e.g. energy drinks, refreshing drinks, fruit yogurts (Bíró, 2015)),
4. profound changes in lifestyle .

Currently, there is a wide range consensus among Hungarian specialists, that the obesity level in Hungary is critical. The nutritional status of the Hungarian population was studied by Rurik et al and in the framework of the Hungarian Diet and Nutritional Status Survey. The Hungarian Diet and Nutritional Status Survey examines the obesity prevalence, dietary habits in Hungarian adults. The survey provides national data representative by age and gender, based on anthropometric measurements and international standards. The survey was carried out in 2009 and 2014, according to the results of the Hungarian Diet and Nutritional Status Survey 2014 nearly two-thirds of adults were overweight or obese. 28.2% of men and 31.5% of women were obese (Erdei, Kovács, Bakacs, & Martos, 2017). These results are similar to the result of the work of Rurik et al (2016). The overall prevalence of overweight is more than 40% in the case of men and more than 30% among women. The share of obesity is 32% in men and more than 31% in women. More than one-third of males and nearly two-third of females can be

characterized by abdominal obesity (Rurik et al, 2016). The prevalence of overweight and obesity is increasing among Hungarian adults (Figure 9 and 10).

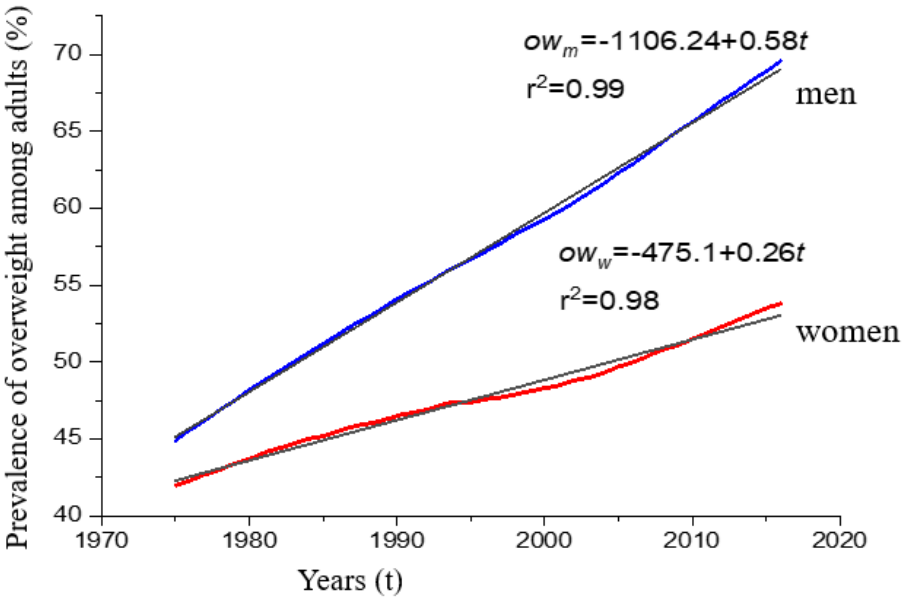


Figure 9. Prevalence of overweight among Hungarian adults (age-standardized values), and the approximation by a linear trend

Source: own construction, based on the electronic database of WHO, 2020

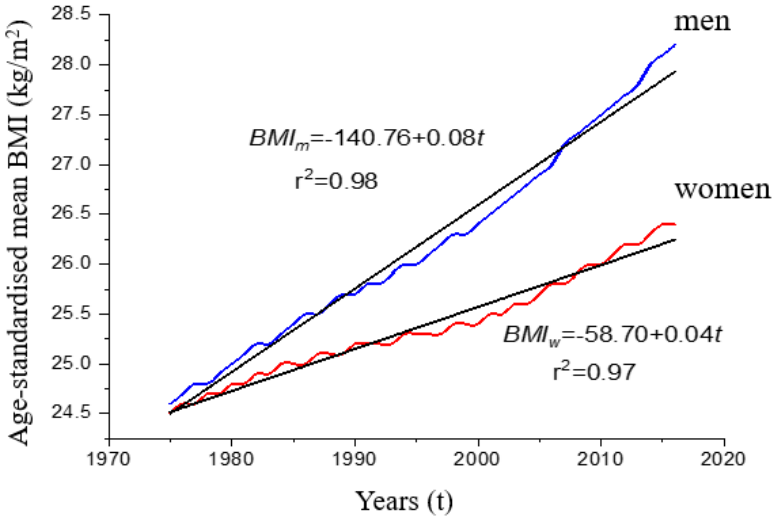


Figure 10. Age-standardized values of BMI among Hungarian adults, and the approximation of processed by a linear trend

Source: own construction, based on the electronic database of WHO, 2020

The obesity problem is especially rapidly increasing among the Hungarian male population. The share of the overweight and obese population is increasing by more than 0.5 percent point in the case of males and 0.26 percent point in the case of the female population. According to the calculation of Rurik, Ungvári, Semánova, and Iski (2020), the total health expenditures of obesity-related diseases have been 58.986 Million HUF. This is nearly one-tenth of the national health service budget and 30% of the total drug reimbursement budget.

2.7. Obesity in the Roma population in Hungary

It is widely accepted, that '*Roma are one of Europe's largest and most vulnerable ethnic minority groups*' (Anghel, 2015; Dimitrova & Ferrer-Wreder, 2017). However, the identification of Roma nationality from point of view of demography is in itself a challenging task (Messing, 2014), the number of this minority is estimated between 10 and 12 million in the European Union (European Commission, 2011). In the Romani language, the Central and Eastern Europe (Practically: the Balkan and the new member states of the European Union) are called 'Kali Oropa' (Black Europa). The former member states of the European Union are called 'Parni Oropa' (White Europa). This distinction shows clearly, where the greatest concentration of Rome people is to be found (Hancock, 2014). The tackling of integration of Roma population concern mainly such relatively lower developed European countries, which have to face the problems of related socio-economic development (Crowe, Kolsti, & Hancock, 2016). The centralized political power in the Communist period has created (relatively) stable workplaces (Stewart, 2014), elementary social security net (Radicova, 2001) for this population which has been characterized by persistence of their own, often tribal traditions (Ruzicka, 2012), and low level of cultural capital (Stewart, 2002). After the collapse of communist regimes, the Roma population in Central and Eastern Europe has got into a vicious cycle. The most important part of this extremely complex question is depicted in Figure 11.

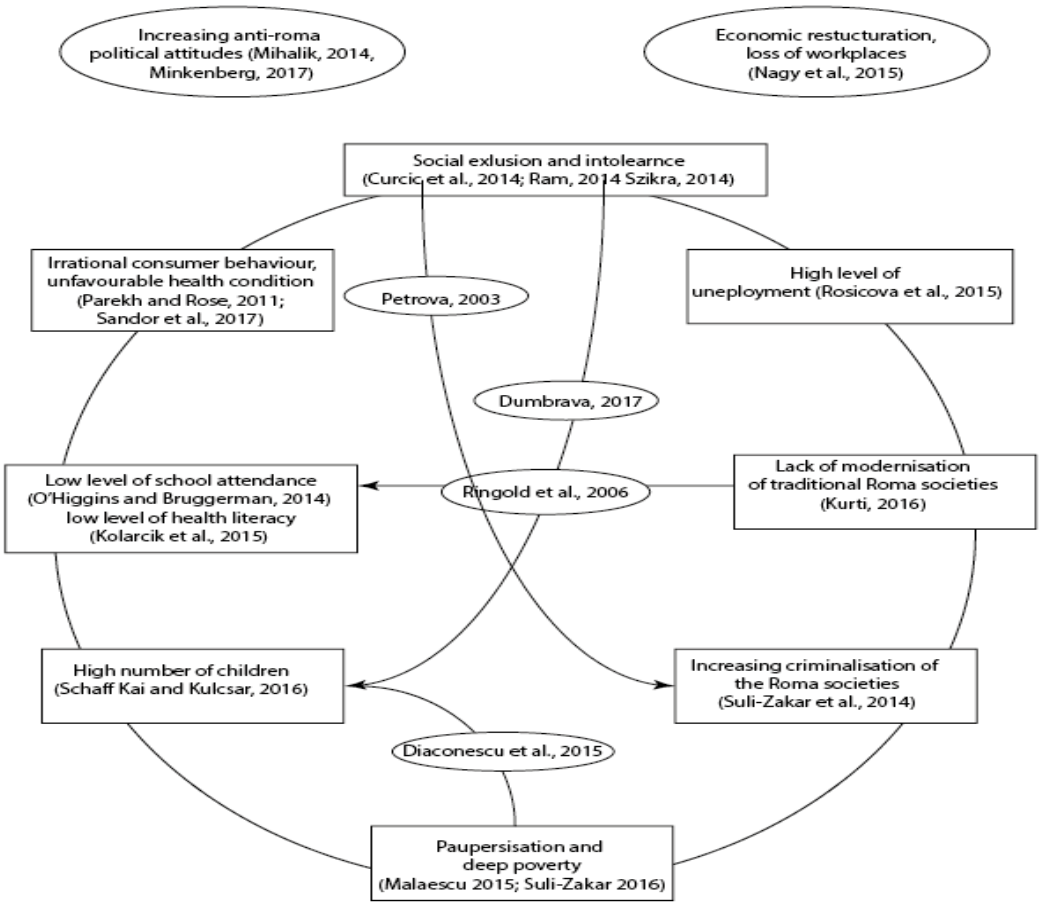


Figure 11. The vicious cycle of the Roma population in post-socialist states

Source: own construction

Roma population is European Union's largest ethnic minority because 10-12 million Roma are living in the EU. There are considerable difficulties in determining the number of Roma people in European countries because they are often reluctant to declare their ethnic origin. For this reason, several methods were developed to estimate the proportion of Roma, e.g. Kemény set up a time variable estimation for the members of the Roma communities, but there is no consensus on the number of Roma ethnic population. Regarding the number of the Roma population in Hungary, the estimates and data are contradictory. The literature reveals in detail that the estimation of the Roma population is difficult, even some authors say it is a hopeless task because the Roma minority itself is extremely heterogeneous, and there are no objective criteria, who is to be considered as Roma and who is not. In the opinion of Ladányi and Szerényi (1997), the question of 'who is Roma?' cannot be answered with scientific precision and, consequently, the number and proportion of the Roma population within the Hungarian population cannot be estimated. In the opinion of other authors, Roma can be well defined as a layer of the population (Havas, Kemény, & Kertesi, 1998). Based on the estimates of Kemény

(2004), the number of Roma living in households was between 520 thousand and 650 thousand at the beginning of 2003. Table 4 shows the number of the Hungarian Roma population based on different sources. Analyzing Table 4, numerous important consequences can drown. The most important of these are as follows:

1. The Hungarian statistical system never has been able to offer a relatively coherent estimation of the number of Roma population, because e.g. the numbers of cases in the second half of the 19th and first decades of the 20th century have shown considerable differences.

2. The official statistical data and expert estimations considerably diverged: e.g. estimations of Csalog in 1980 on Roma population have been higher, than the census-data from 2011.

3. There is a rather rapid, presumably exponential increase in the Roma population. This can be traced back to the base of official census data. E.g. the Roma population has been nearly doubled between 1990 and 2011.

Table 4. The number of the Hungarian Roma population based on different literature sources

Source	**Years**	**Number of Roma population in Hungary (capita)**
National census (2011)	2011	308957
Váradi (2009)	1880	78759
	1890	91603
	1893	243432
	1910	108825
Kemény (2004)	1971	between 270 and 370 thousand
	1993	between 420 and 520 thousand
	2003	between 520 and 650 thousand
Kemény (2000)	1893	280 thousand, 65 thousand cigány élt az ország mai területén
National census (1990)	1990	142683
Csalog (1980)	1979	between 350-360 thousand
Kálmán (1946)	1946	between 80-120 thousand

People belonging to Roma ethnic population are at a greater disadvantage than the overall population in Hungary and Europe:

- Roma face a higher risk of poverty,
- Roma are more likely to be unemployed,
- Roma are less likely to attend secondary or higher-level education,
- Roma have a worse housing situation,

- Roma face more limited access to basic services (electricity, sanitation, and running water)
- Roma are at a higher risk of certain health conditions (obesity, heart diseases).

The extremely negative socio-economic situation of the Roma population is reflected in adverse health status and medical conditions (European Commission, 2014). The Roma population rapidly gains in importance in the social structure of Hungary. It is frequently mentioned in the literature, that the health status of Roma is worse than that of the majority of the Hungarian and the European population. The Roma population suffers from disadvantaged living conditions, food insecurity, high-risk health-related behaviors, as well as discrimination, stigmatization, and barriers to accessing health services all over Europe. These exposures have resulted in a particularly poor health status indicated by the high prevalence of chronic morbidity, non-communicable diseases, as well as an estimated life expectancy. Evidence shows that minorities or populations of low socio-economic status tend to be the most vulnerable to obesity. One adverse consequence of the multiple disadvantageous positions of this minority in one hand food insecurity and the other hand is unhealthy nutrition, which leads to obesity and a high prevalence of its comorbidities. Ciaian, Cupák, Pokrivčák, and Rizov (2018) analyzed the diet quality of Roma in Romania, they concluded that Roma's diet has on average a higher proportion of cereals and a lower proportion of dairy products and fruits and vegetables. In a summary, it can be stated, that the Roma population in Central and Eastern Europe is an extremely disadvantageous segment in terms of health conditions. Obesity is rather general in this part of the population (Table 5).

Table 5. Obesity (in terms of BMI) among Roma population in Europe

Source	**Date**	**Geographic region**	**Results**	
Krajcovicova-Kudlackova, Blazicek, Spustova, Valachovicova, & Ginter	2004	Slovakia	Average for the 18+ population 26.2±5 Share of Roma population with BMI >30: 32%.	
			The man at age bracket 18-24 years	The woman at age bracket 18-24 years
Zajc et al	2006	Croatia	23±4.3	22±4.1
Carrasco-Garrido, López de Andrés, Hernández Barrera, Jiménez-Trujillo, & Jiménez-García	2010	Spain	Share of Roma women with BMI>30 24.45% in Spain, two times higher, than for the average of the population.	
de Courten et al	2011	Slovakia	The average BMI is 31.	
			Adult man	Adult woman
Poveda, Ibáñez, & Rebato	2012	Slovakia	30.59±6.68	30.55±6.89

			Adult man		Adult woman	
Babinska et al	2013	Slovakia	26.79±5.94		26.44±6.01	
			Age bracket	BMI categories	Men	women
			18-34	<25	60.9	69.5
				25-29.99	25.0	16.2
				>30	14.1	14.3
			35-49	<25	30.8	44.7
				25-29.99	40.4	32.9
				>30	28.8	22.4
			50-64	<25	40.9	37.3
				25-29.99	45.5	25.4
				>30	13.6	37.3
			65+	<25	72.7	40.0
				25-29.99	27.3	36.0
Zeljko et al	2013	Croatia		>30	0	24.0
Papon, Delarche, Le Borgne, & Bauduer	2016	Southwestern France	Adult population 30,2±7,05			
			Overweight			24.4%
Llanaj et al	2020	Hungary	Obese			37.5%

From this follows, there is an urgent need for the intervention in the Roma population, because: (1) the number of Roma population is increasing rapidly (HCSO, 2011); (2) the adverse health conditions of the Roma population can be traced back in numerous cases to a high level of obesity (Koupilová, 2001; Dolák, Šedová, Nováková, & Olišarová, 2016); (3) there is a positive correlation between the obesity of parents and their children (Coates & Thoresen, 1978; Lim et al, 2017). Over 60% of children who are overweight before puberty will be overweight in early adulthood. (4) the Roma migration into the cities further increases the prevalence of obesity: in the opinion of Ŝkarić-Jurić et al (2012), the obesity of urban Roma is higher than their rural counterparts. From this follows, that if there won't be efficient measures, a considerable number of obese Roma people will emerge.

2.6. Struggle with obesity in the elementary school: the Hungarian school catering system

Parallel with increasing awareness of the adverse effects of non-communicable diseases, e.g. the effects of obesity and obesity-related diseases on the health status and mortality of the population (Mcpherson, 2014; Nurwanti et al, 2018), the inappropriate diets and eating habits of children and adolescents is a much-debated problem all over Europe (Koletzko, 2016). Growing anxiety concerning the proliferation of the unhealthy eating habits of new generations (Lobstein, 2015), as well as the increasing number of overweight and obese children (Karnik & Kanekar, 2012; Ahrens et al, 2014), has increased attention towards different methods of influencing children's and adolescents' health behaviour (Waddingham, Stevens, Macintyre, & Shaw, 2012). This is an especially important problem in Hungary where the obesity rate is high. The overall prevalence of overweight and obesity among children and adolescents is 40% and 32%, respectively, and in women overweight and obesity are both at 32% (Rurik et al, 2015). According to Jakab, Hidvegi, Illyes, Cziraki, and Bereczki (2018), 13.4% of Hungarian children are overweight and 6.6% are obese in the age group 3-18.

The school catering system (SCS) has a predominant place in the formation of nutrition behavior even if the efficiency of the SCS in the prevention of obesity has not been proven satisfactorily by rigorous, long-range studies (Briggs, 2010). School lunch nutrition standards are the basis for improving the nutritional intake of all schoolchildren. The state of school feeding worldwide is considered a question of strategic importance all over the world (WFP, 2013). All member states of the EU have policies to help schools to provide nutritionally balanced meals (Storcksdieck, Kardakis, Wollgast, Nelson, & Caldeira, 2014) on base of an EU–wide survey. On base of this survey, we have constructed a general, synoptic table (Figure is attached as Appendix 2). The pieces of information, containing in this table have been analyzed by cluster analysis.

In developed countries, there is an increasing tendency to apply the SCS not just as a part of school logistics and the social system, but also as means of health and family-life education. That is why the importance of SCS has increased rapidly. The quality of the Hungarian SCS has been a highly debated issue for generations (Tarján, 1973). Hungary’s SCS is a subsidized system. The meals are offered at a reduced price, the organization of the SCS is the responsibility of municipalities. In some cases (e.g. social position) the school meal is free. The Hungarian National Survey of SCS (called Canteen Panorama) is a regular report of the National Institute of Pharmacy and Nutrition (Martos, 2018). The essential results of the last three surveys are summarised in Table 6. Vending machines and snack bars are not considered as a part of SCS, but the portfolio of products, which they are allowed to sold are strictly regulated.

Table 6. Summary of the surveys of school catering systems.

Characteristic features/indicators	Canteen panorama 2008	Canteen panorama 2013	Canteen panorama 2017

No. of schools (educational institutions)	3099	260 representatively chosen	139 elementary school
Elementary schools in the sample (%)	62	62	100
Secondary schools in the sample (%)	17	31	
Elementary and secondary schools (%)		7	
Schools, offering warm meal at least once in a time (having canteen) (%)	92	: 17	100
School milk program (%)	15	35	72
Free fruits and vegetables (%)	14	78	95
Free drinking water outside the bathroom (%)	36	58	75
Proportion of students eating at the school canteen (in %):			
Primary (7-10 years)	85	87	88
Lower secondary (%) (10-14 years)	47	63	61
Secondary school (%) (14-18 years)	20	27	
Survey of children's satisfaction conducted by the schools (%)	29		
Qualified food catering manager (%)	76.5	83	no data
Food planning with involvement of a dietitian (%)	10	29	38
Energy and nutrients content calculation (%)*	22	57	no data
Net food budget calculated for raw material**	0.72 EURO	1.2 EURO	1.15 EURO
School snack bar in institutions (%)	45	50	44
Vending machines (%)	30	34	no data

* Energy and nutrient content calculation is made based on nutrient and energy content tables. The age-specific menu is calculated on this basis.

**Minimal costs of raw material. Hungarian currency converted to EURO on yearly average conversion rate

Source: own construction, based on Martos, 2018; Bakacs, Schrebiberne-Monlár, & Zentai, 2014; Bakacs, Nagy, Varga, & Zentai, 2018.

The Hungarian SCS is an evolving system, which is characterized by considerable backwardness and delayed development, compared to Western-European school boarding solutions. The national averages hide important regional differences. According to the Canteen Panoramas (Martos, 2018; Bakacs et al, 2014; Bakacs et al, 2018), the school snack bars and vending machines are significant competitors for the SCS and have an improving product portfolio. At the same time, the SCS is not capable of meeting changing demands. A good indicator of this is the rapidly decreasing take-up rate as children's age increases. Another indicator of problems is the fact that according to the school canteen survey (Bakacs et al, 2018), 85% of parents prepared some kind of prepacked food for their children in 2013. Prepacked food was mainly sandwiches, with vegetables (41%) or without vegetables (37%), and refreshing soft drinks (50%).

The Hungarian SCS faces substantial long-standing, unsolved problems, which can be attributed to the lack of monetary resources and the lack of attention from responsible organs. This motivated the government to take action to update the nutrition requirements of the public catering service, including school meals, in 2011. In 2011 the Office of the Hungarian Chief Medical Officer (HCMO) issued the 'Recommendation for Public Caterers' with nutritional standards (HCMO, 2011). This recommendation provided a checklist enabling monitoring the adherence to the recommendations. This document was the basis of the 37/2014 decree of the Ministry of Human Capacities (MHC) on public catering (MHC, 2014).

The school meal provision aimed to reduce the prevalence of obesity and non-communicable diseases (NCDs) among Hungarian children and adolescents, as well as promote healthier environments, especially in schools. The most important elements of the decree are summarised in Table 7. This rather ambitious regulation has tried to increase fruit, vegetable, cereals, and milk consumption and decrease the consumption of fat, sugar, and salt. When comparing the content of the Decree with dietary guidelines of other member states of the EU, our nation's dietary guidelines seem to be in line with the nutrition policy of most EU member states. However, the public acceptance of this new regulation has been mixed, and mainly negative. Overall take-up rates were generally low, according to the comments of school children. Pupils refused the dishes which conformed to the requirements and both children and their parents rebelled against the rules. In 2015 the Hungarian Association of Dietitians carried out a survey among dietitian food-service managers about the practical feasibility of Hungarian Regulation No. 37/2014 on nutrition requirements in the provision of public food services. Of the 56 food-service managers interviewed 19 represented child nutrition institutions. Since the introduction of the regulation in 36 of 56 institutions interviewed satisfaction with nutrition care had decreased. In 13 cases the rate of dissatisfaction was 30% or more, and the amount of daily food waste increased significantly. The majority of catering service providers (62%) requested some alterations to the regulations because the prescribed composition of the food was not in line with children's demands. The greatest cause of dissatisfaction among parents and children derived from the control of salt content, and the attempt to provide the prescribed quantity of dairy products and added sugars (Erdélyi-Sipos, 2016). To date, there is no representative, academically well-founded empirical studies on pupils' consumption of the new school meals. That is why, in 2016, the regulatory framework was changed (MHC, 2016). The

new decree significantly modified the (prescriptions. The most important features of the original and the modified decree are summarized in Table 7.

Table 7. The most important changes in the public catering decrees

	2014 Food-based standards	**Changes in food-based standards since 2016**
Specific foods and food groups have to be provided daily for all age groups (for one person)		
5 meals/day (In a boarding institution the public caterer is obliged to offer main meals three times and two snacks two times.)	4 portions of fruits or vegetables per day, at least one of which should be raw*	
	3 portions of cereals, at least one which should be whole grain	
	0.5 l milk or a dairy product with an adequate amount of calcium	This point has been deleted-
Nursery (1 to <3 years) (In the case of nurseries 75% of the daily energy requirement should be covered by two main meals and two snacks.)	3 portions of fruits or vegetables per day, at least one of which should be raw	
	2 portions of cereals, at least one of which should be whole grain	
	0.4 l milk or a dairy product with an adequate amount of calcium	This point has been deleted-
3 meals/day (If the institute offers a boarding, 65% of daily energy requirement should be covered by one main meal and two snacks)	2 portions of fruits or vegetables per day, at least one of which should be raw	
	2 portions of cereals, at least one of which should be whole grain	
	0.3 l milk or a dairy product with an adequate amount of calcium	This point has been deleted-

1 meals/day (If the institute offers one main meal (dinner) 35% of daily energy content.)	1 portion of fruits or vegetables per day, at least three of which should be raw over a 10-day catering period	
Supplementation		If pre-primary, 5 or 3 meals are provided a day, milk or a dairy product with an adequate amount of calcium should be served every day
Regulations, limitations, and prohibitions of using certain foods and products		
The fat content of milk	-2.8% or 3.6% milkfat milk should be served for age group 1-3 -maximum 1.5% milkfat milk should be served above 3 years old	The fat content of the milk has been increased: -maximum 2.8% milkfat milk should be served above 3 years old
Water	Constant (continuous) access to freshwater (outside of bathrooms), without any limitations (*ad libidum*)	
Added sugar	Free sugar should not exceed 8% of total energy in a 10-day catering period	Free sugar should not exceed 10% of total energy in a 10-day catering period
Salt and free sugar	Salt and sugar should not be placed on the dining table.	Salt or sugar shakers should be labeled: 'Excessive salt intake could cause cardiovascular diseases, obesity, and diabetes!'
Salt content	Daily salt intake should be reduced to 5 g/day up to the 1st of September 2021 At the age bracket 7-10 years salt intake should be reduced to 3.5 g/day up to the 1st of September 2021. If the institute offers one meal/day the salt content of the main meal should be reduced up to 2 g/day at age bracket 7-10 years up to the 1st of September 2021	

* the rationale for the raw fruit /vegetable requirement is not included in the legislation

Source: own construction based on the 37/2014 decree of Ministry of Human Capacities on public catering

3. METHODOLOGY

3.1. Application of system dynamics analysis for forecasting of the social burden of obesity in Hungary

System dynamics is a new, relatively rapidly developing multidisciplinary science. According to the definition of Coyle (1996) '*System dynamics deals with the time-dependent behavior of managed systems with the aim of describing the system and understanding, through qualitative and quantitative models, how information feedback*'. The system dynamics approach is rapidly gaining importance in different fields of natural and social sciences, from climate research to industrial engineering.
According to the seminal work of Sterman (2001) the dynamic complexity of systems arises on a base of ten causes:

(1) Constant changing: the socio-economic environment of eating behavior is changing constantly, there are different consumption patterns;
(2) tightly coupling and strong interactions: the obesity status in t period will influence the nutritional status in t+1 period;
(3) government by feedback: the obesity status will influence the probability of survival;
(4) nonlinearity: their relations between the obesity status of different generations can't be forecasted on the basis of linear models;
(5) history/path dependency: the obesity status of a given generation at a given time will depend on previous obesity status and the number of the given generation;
(6) self-organizing character;
(7) adaptivity;
(8) the important role of trade-offs in timing and intensity of control-mechanisms;
(9) counter- intuitiveness;
(10) policy resistance.

I divided the methodological part of system dynamics analysis into two sections: first, I present the methods I used to estimate the expected prevalence of overweight and obesity as well as the burden of obesity measured in years of life lost in the Hungarian adult population (Figure 12). In the second phase of my investigation, I described the methods of estimation of the burden of obesity in Hungary.

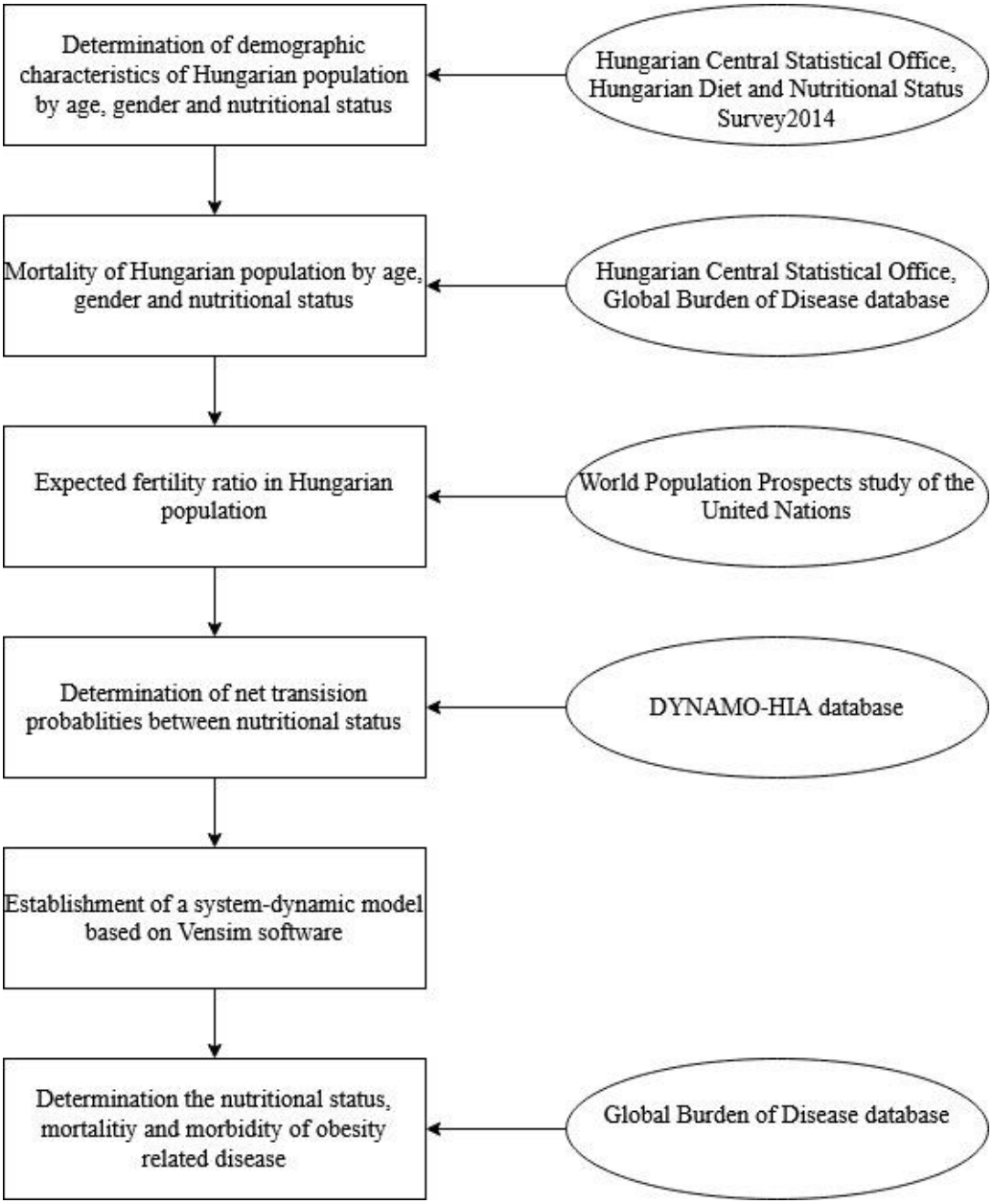


Figure 12. Flowchart of the first phase of the investigation

In my study, I have considered the Hungarian adult population as a system. The time window of investigations was 100 years. I have considered the five-year age cohorts of the sub-system and I have supposed that each member of a given cohort can be divided into three categories, according to his nutritional status: normal, overweight, and obese. One part of each category will exit due to death, another part of the cohort will go into the n+1 cohort. The matrix of transition will determine, the probability of getting from one nutritional category to another. In this way, for each cohort transition nine transitional probabilities should be determined (e.g. from normal to normal, from normal to obese, and from normal to overweight). The building blocks of my model are presented in Figures 13 and 14.

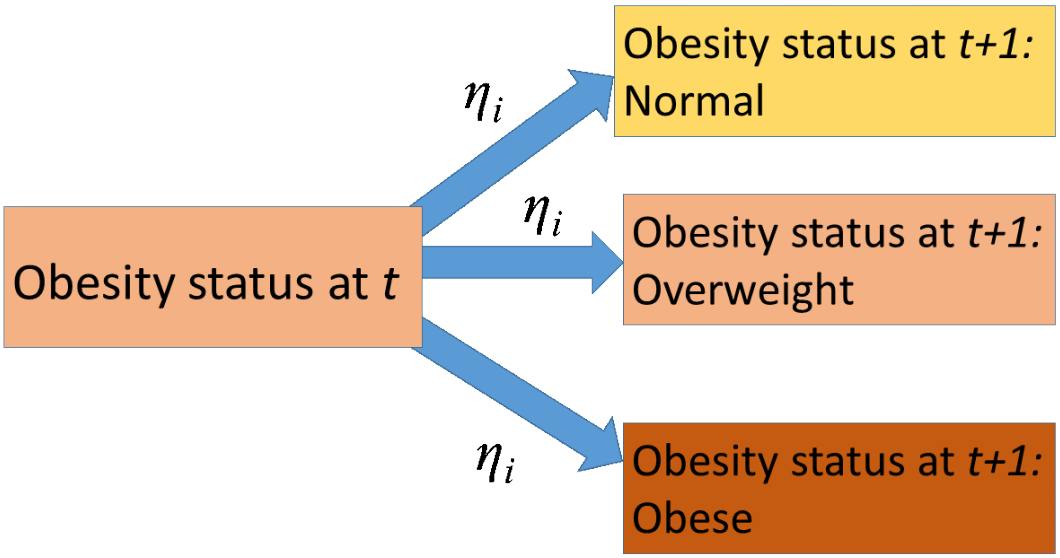


Figure 13. The transition probabilities from one nutritional (obesity) status into another

Source: own compilation

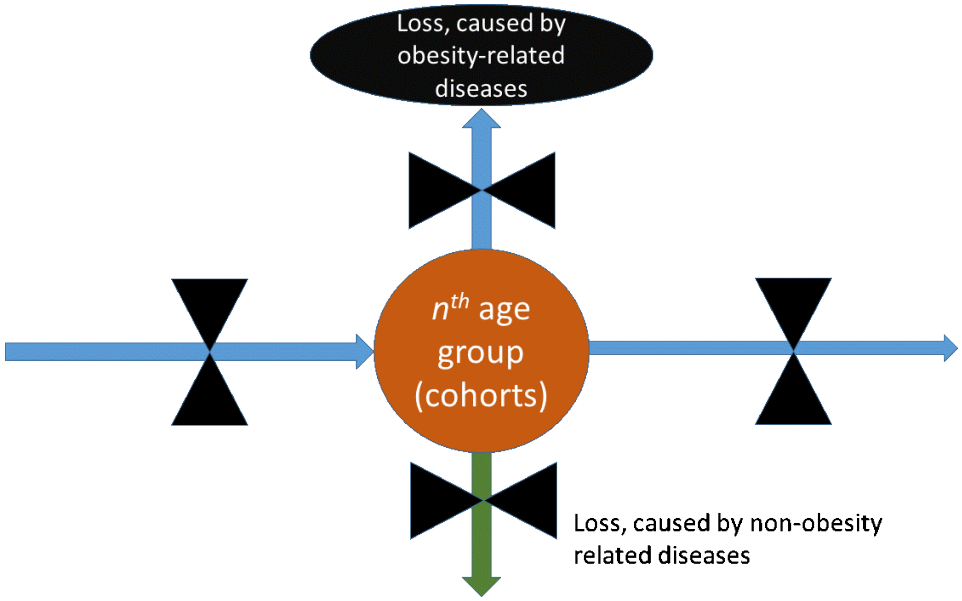


Figure 14. The conceptual model of population flow from and to an arbitrary age group (cohort)

Source: own compilation

For the operationalization of my model, I have applied the following type of data and data sources.

- **Demographic variables**: The input data of demographic variables (size and age of the population) had been based on Official Statistical Yearbooks of the Hungarian Central Statistical Office.
- **The fertility rate** of the Hungarian population: for estimation of future changes in the number of newborn male children I have applied the data source of the World Population Prospects study of the United Nations (UN, 2019).
- **Nutritional status** of the Hungarian population: the current nutritional status of different cohorts have been estimated on the basis of the Hungarian National Nutritional Status Survey (Erdei et al, 2017).
- **Death ratio**: The death ratio in different cohort groups has been determined based on the GBD database (Keating, 2018). The GBD is a systematic, academically well-established, rigorously controlled effort to quantify the comparative magnitude of health loss due to diseases, injuries, and risk factors, according to sex, age, and geographical categories. The GBD system incorporates both the prevalence of different diseases or risk factors and the relative harm they cause. The data offer a general picture of causes of premature death and disability from more than 300 diseases and injuries in 195 countries from 1990 to the present. The GBD integrates mobility and mortality into one indicator, which is called disability-adjusted life years (DALYs). The GDB is the leading source of health-related information for the world's researchers and policymakers. Since 2016 it has been fully aligned with the suggestions in the Guidelines for Accurate and Transparent Health Estimate Reporting statements. The GBD offers comprehensive estimates of over three hundred diseases and risk factors in 199 countries from 1990 to the current date. The DisMod MR (Disease Modelling Metaregression) software offers a possibility to determine the relationship between different causes and deaths by age, sex, year, and country (Peterson & Flaxman, 2013). Based on GBD, we had been able to determine the effect of obesity on different death at different age brackets in various years, according to sexes. However, the GBD results are universally accepted as a primary source of death-risk factors, it should be noted, that this is not suitable for quantification of adverse effects of non-lethal diseases. It is well documented, that e.g. there is a tight correlation between obesity and mental diseases e.g. depression (Minkwitz et al, 2019), but later in most cases is a non-lethal disease, however, it has a significant, negative influence on the quality of life.
- **Base units of investigations**: I have applied a discrete-time approach, that's why I had to determine the base units of investigations. I have divided human life into five-year brackets. Theoretically, a more detailed description would be interesting, too, (e.g. yearly description), but this could not be supported by data, because the data contain a more robust categorize.
- **Transition probabilities**: In an ideal world, the simplest way of determination of transition probabilities from one arbitrary nutritional status into another would be the analysis of individual life histories, but this type of statistical data collection does not exist in Hungary. Thus, we have had to apply another method of estimation of transitional probabilities. In the framework of the Dynamo-HIA project (Fehr, Hurley, Mekel, & Mackenbach, 2012) two detailed probability matrices have been applied: one from England and one from the Netherland. I have determined the average of these

dates and corrugated it with the opinion of five independent experts (Hungarian clinical nutritional specialists).

Some remarks, concerning the logic and methodology of the research:

1. Fertility shows a decreasing tendency. This hypothesis is well supported by the literature as well as the forecasting of the UN (Figure 15). The UN prognosis calculates by a relatively low rate of fertility, which is not able to cover the simple reproduction of the population. We have not taken into consideration the in-and outbound migration, because this is extremely difficult to forecast and it has a high level of uncertainly.

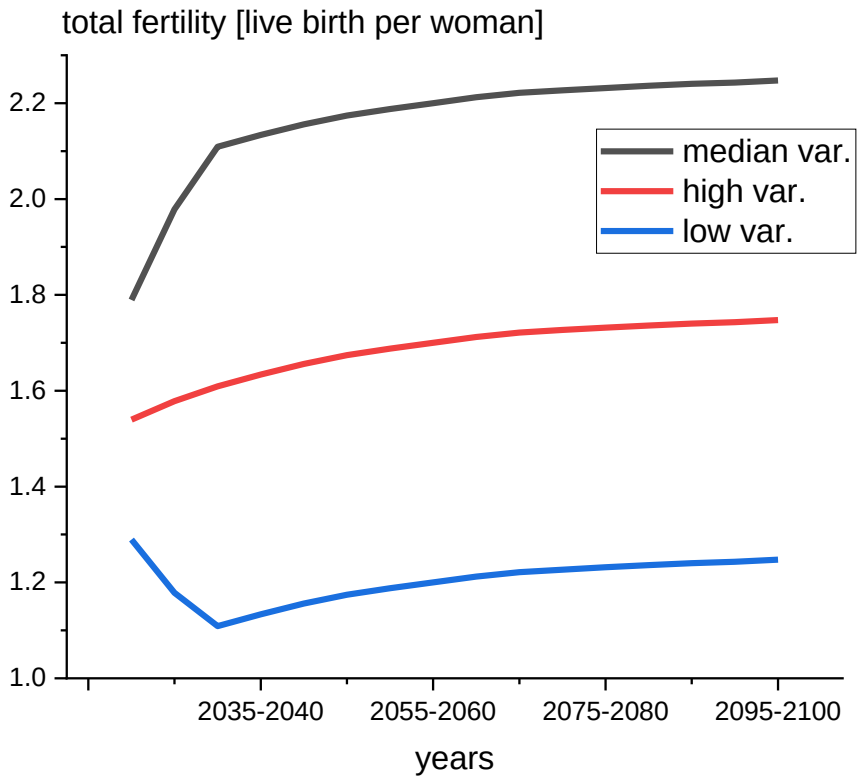


Figure 15. Prognosis of total fertility rate in Hungary

2. The determination of transition between different age brackets was an extremely complex task because in the first phase of investigations we have determined the transition probabilities between different nutritional statuses. The exact knowledge of this variable demands high accuracy, representative, longitudinal series of surveys, reflecting the changes between different nutritional statuses. Currently, to the best of our knowledge, there are just four such types of surveys: in the Netherland, Germany, Denmark in the United Kingdom (UK). We have applied the data from the UK because the nutritional status of citizens in the UK is the most similar to that of Hungarian citizens. The UK data had been accessible on the Dynamo-HIA website (Figure 16 and 17). At the same time, analyzing the UK data we had to see, that these data seem to reflect the current Hungarian reality just partially, that's why we have set up a team to

revise the UK data and estimate the current Hungarian transition probabilities according to age-brackets and genders. Analyzing the UK data it is obvious, that these data suppose a high, rapid change in the first two decades of life and one series of changes in the last period of life. In our opinion, this is not a realistic approach, because e.g. in the case of Hungary the obesity is rapidly increasing in young males from the middle of twenties to the middle of their thirties. That's why we have organized an expert team, to estimate the transition probabilities for different cohorts of the male and female population. The team consisted of seven specialists: five practicing dietitians, one university professor, and me. We have shown the data from the UK to experts, then asked them to estimate the probabilities of transitions from one nutritional status into another, by age brackets and sex. In the next phase, we have summarised the individual estimations, and the pooled results have been presented to the participants. In this phase, the participants had a second chance to modify their guesses. The final results had been accepted by consensus (Figure 18).

3. In the next phase, we have determined the changes in the socio-demographic system, due to mortality as a consequence of obesity. That's why we have calculated the number of normal, overweight, and obese citizens in decades to come, by different age brackets and gender. Following the international practice (e.g. in the case of Dynamo-Hia) we have pooled the data on normal and under-nutritional status.

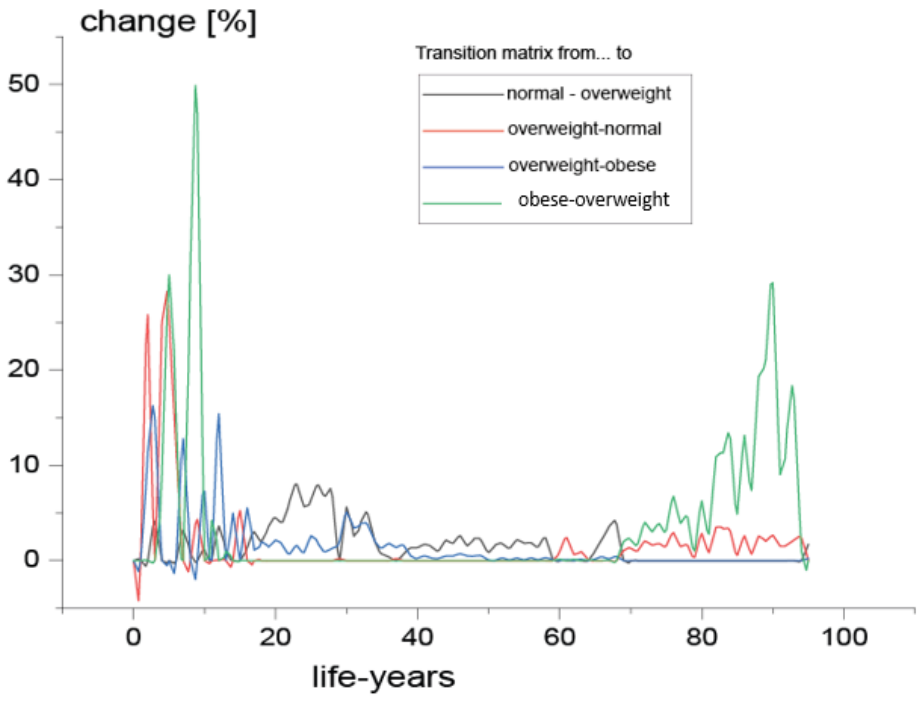


Figure 16. Transition probabilities between different nutrition status in case of UK male population

Source: own calculations based on Dynamo-HIA database

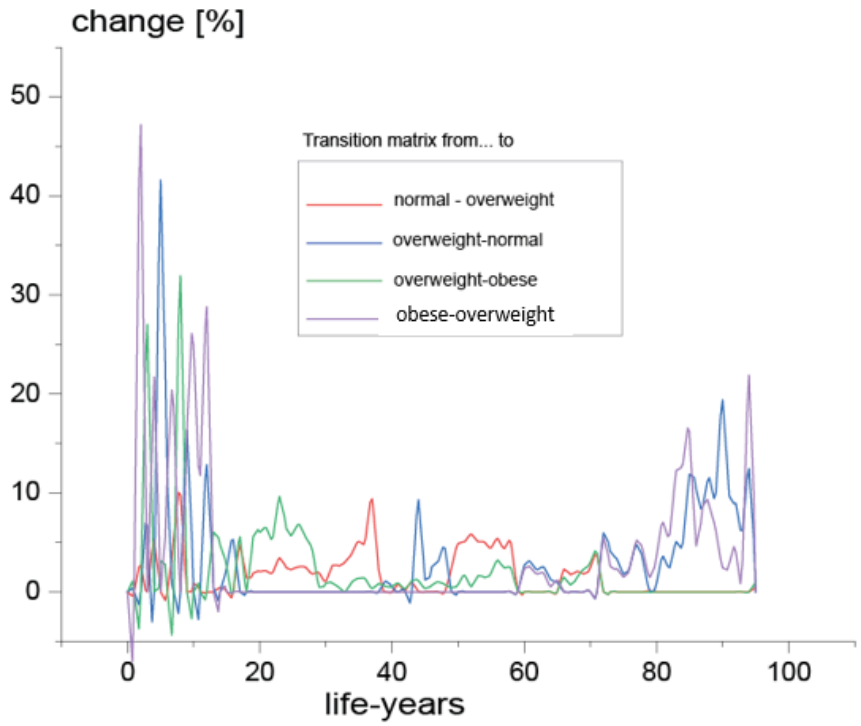


Figure 17. Transition probabilities between different nutrition status in case of UK female population

Source: own calculations based on Dynamo-HIA database

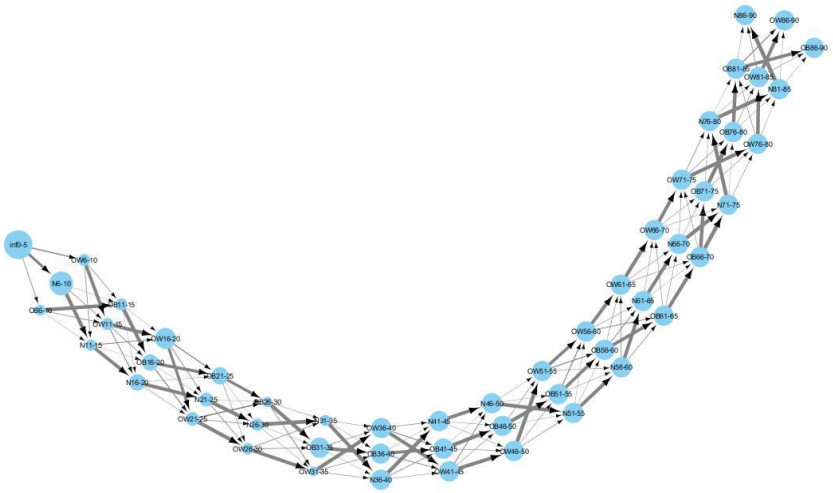


Figure 18. Transitional probabilities in my system, in the case of the male population. The size of different nodes is approximately proportional with the number of populations in the given age–bracket, the size of arrows with transitional probabilities

The flowchart of the second phase of my investigation is depicted in Figure 19.

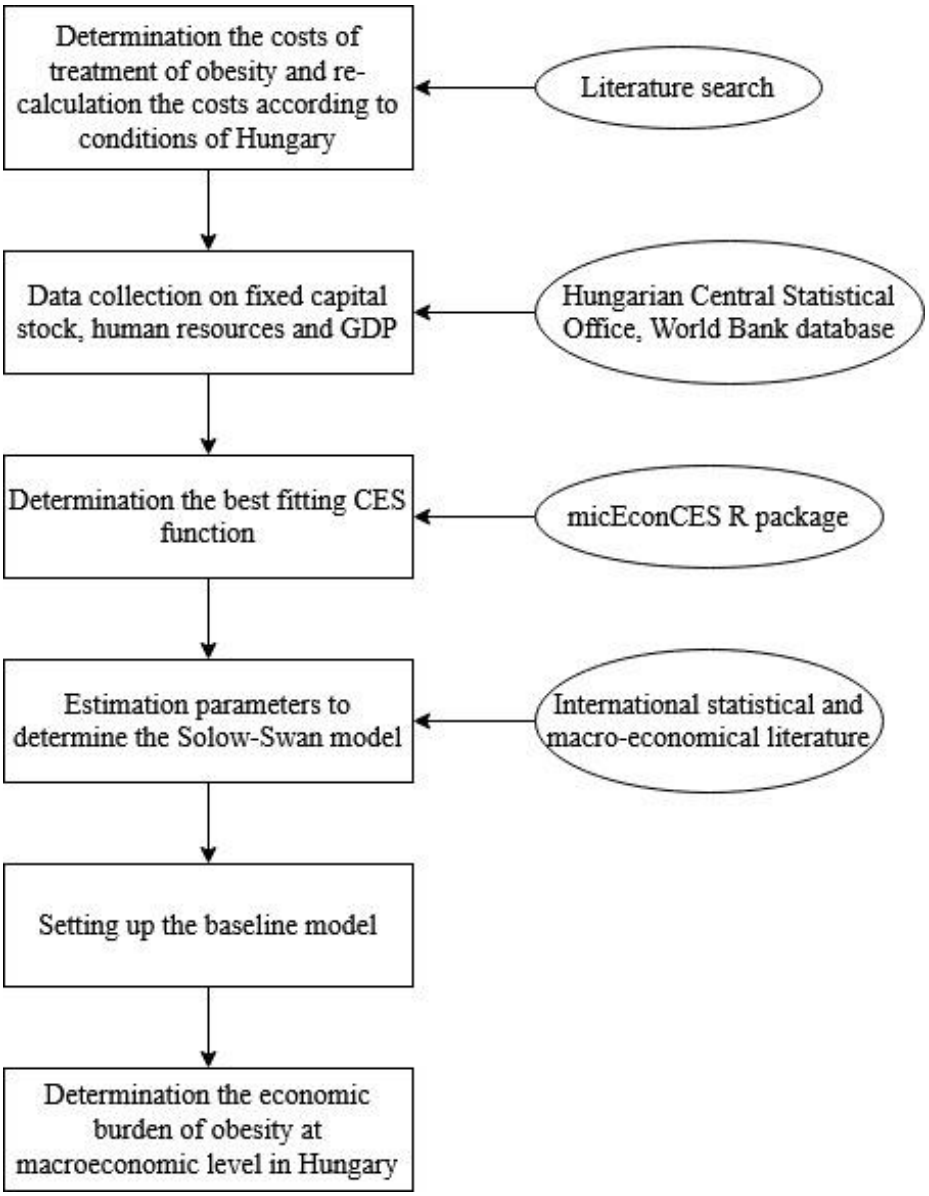


Figure 19. Flowchart of the second phase of my investigation

Following the standard methodology of the modern burden of disease calculation (Abegunde & Anderson, 2006; Gillum et al, 2011) I have tried to fit a standard Cobb-Douglas function to Hungarian data (Figure 20 and 21), but I had to realize, that this approach has considerable simplifications, that's why is hardly applicable to more precise calculations. This can be explained by the singular behavior of the Hungarian economy in the last sixty years, characterized by central planning period (between 1960 and 1967), later on, a relaxed version of a command economy (1968 and 1989), followed by years of deep-rooted socio-economic transition, EU accession (2004), severally damaged by world economic crisis in 2008, but in last decade developing nearly two times rapidly, than the average of Western-European EU

member states. All of these changes can be seen in changing dynamics of fixed capital investment and GDP.

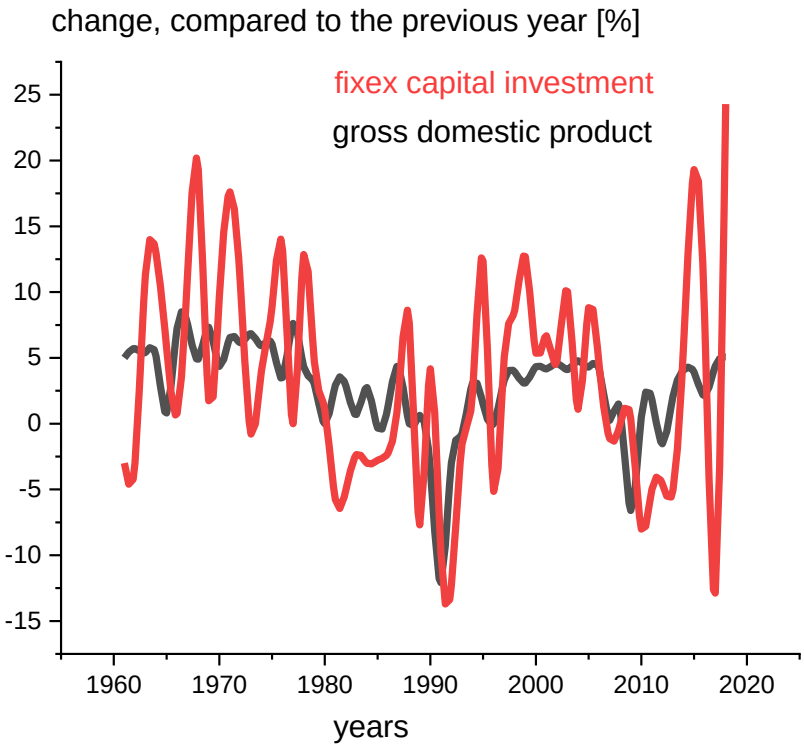


Figure 20. The roller coaster of the Hungarian economy

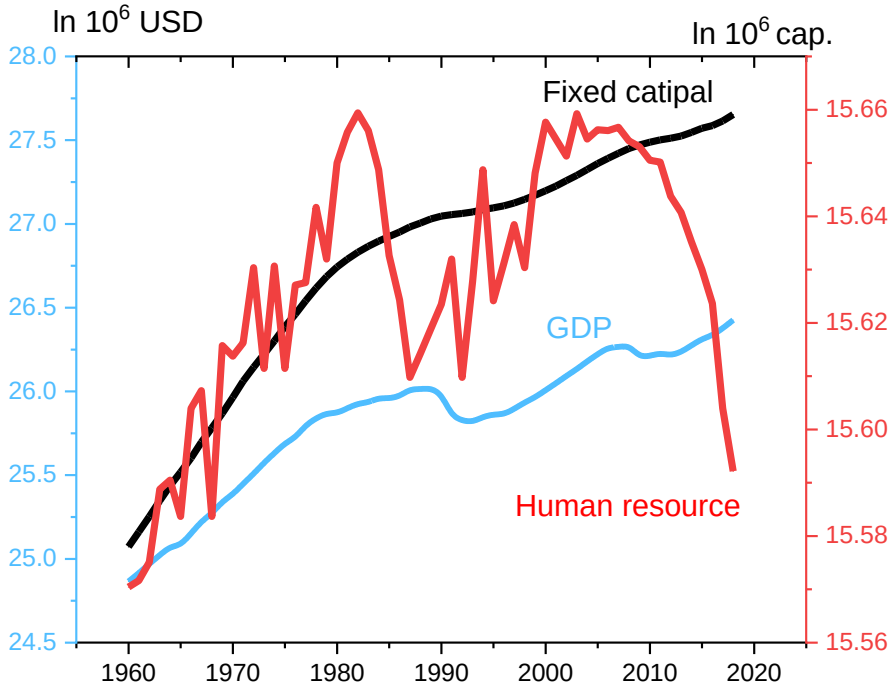


Figure 21. Dynamics of GDP, fixed capital, and human resource stock (number of the population between 20-65 age) in Hungary

After due considerations, the role of human capital has been analyzed by application of Constant Elasticity of Substitution (CES) function, using the R package micEconCes (Henningsen & Henningsen, 2011). This neoclassical production function supposes a constant elasticity of substitution between different production factors. The formula of the function is the following

$$y = \gamma\left(\delta x_1^{-\rho} + (1-\delta)x_2^{-\rho}\right)^{\frac{-\nu}{\rho}}$$

Where

y is the value-added of the national economy,

x_1 and x_2 the production factors (in our case the capital and the labour)

γ,ρ,δ,ν are parameters.

This function is not linear in parameters, and cannot be linearized on base of traditional methods, that's why we had to apply different non-linear least square optimization algorithms.

I have applied different approximations in the determination of constants and parameters of this function. The best results have been achieved by the application of the CES grid function, allowing the changing return to scale.

The best fitting (r2=0,9892) has been achieved by parameters, the summary of model parameters is written below:

γ 1.8406**

ρ 0.200*

δ 0.6877**

ν 0.8486/

*** significant at 0.99 level

** significant at .95 level

*significant at 0.90 level

The results of function fitting show a high level of fitting between the estimated and approximated results (Figure 22).

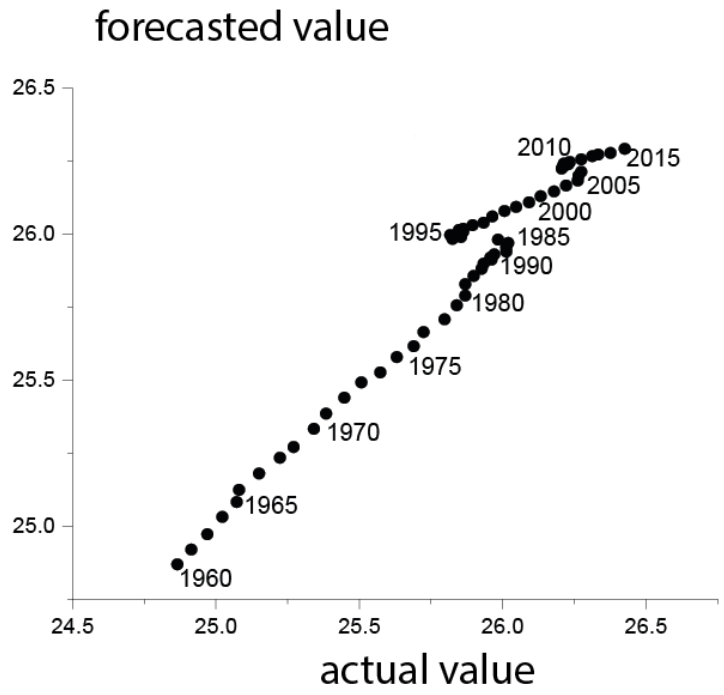


Figure 22. The actual and fitted value of GDP of CES function

Analyzing Figure 22 it can be seen, that there are three different trajectories in the time series. The years of 'socialist development' have been characterized by a relatively low level of utilization of living labor. The years of socio-economic transition can be well seen. The period between 1995 and 2005 is characteristically different from the results of the latest period. I have presented and analyzed the results in such a detailed way, because I would like to demonstrate, that as a consequence of deep-rooted socio-economic changes in Hungary the classic functions of macroeconomics are not applicable due to structural changes and relatively short times of different periods.

Estimation of medication of co-morbidities of obesity

In the second part of the investigation, I have estimated the costs of treatment of obesity-related diseases. These are summarized and attached as Appendix 3. It is a rather difficult question, how to compare the different costs in different countries. I have built my estimations on the international comparison of different health-care services of Koechlin, Konijn, Lorenzoni, & Schreyer (2017). This comprehensive study integrates the results of former comparative analyses (e.g. Lorenzoni, Belloni, & Sassi, 2014).

3.2. Estimation of present and future social burden of obesity in case of Hungarian Roma population

The Health Impact Assessment (HIA) concept is rapidly gaining importance in policymaking. This is an umbrella concept of different procedures, methods, and tools to promote the objective comparison and evaluation of different intervention and/or prevention programs on the health of the population or a targeted segment of it (Nieuwenhuijsen, Khreis, Verlinghieri, Mueller, & Rojas-Rueda, 2019). The basic concept of HIA is the acknowledgment of the fact, that behind the actual health status of the population there are numerous factors, which lay outside the circle of influence of the health care system. These effects the health condition of the population, the management of which is a direct responsibility of the health care system. There are different approaches, how to quantify the policy interventions. The algorithm serves as a modeling tool, which allows for various and multiple chronic diseases and arbitrary risk factors, taking into account the standard causes pathways.

One of the basic assumptions of the standard HIA approach is that there is a causal relationship between the policy intervention and the change of risk-factor prevalence. The decrease in risk-factor prevalence leads to decreasing in disease incidence and –consequently- to disease-related mortality. The objective of HIA is to predict the consequences of different interventions.

In the opinion of Lhachimi et al (2012) a sophisticated tool of HIA should satisfy the criteria as follows:

- Capability to model different populations that vary in age and gender structure.
- Possibility of dynamic projection, because the demographics characteristics of a given population are changing in time, as opposed to theoretic steady-state supposition
- Capability to describe explicit risk-factor states. This means, that different risk-factor states (exposition levels) should be explicitly modeled.
- Robustness. Due to scarcity of resources, there is just a limited possibility to collect a wide range of data, that's why the model should be built on a relatively few variables, mirroring the population data on incidence, prevalence, mortality, and relative risk. This is a rather specific criterion because there are just a few data on incidence, prevalence, and mortality by risk factors. In practice, there are scarce data on the transition between risk-factor states.
- The model should offer a wide range of output, describing different consequences of interventions in the short and long run.
- The tool should be generally accessible.

The DyNamic Modelling for Health Impact Assessment (DYNAMO-HIA) is a high-level, sophisticated tool for the quantification of user-specified policy interventions. The DYNAMO-HIA has been designed to model a closed real-life population (Kooiker & Boshuizen, 2019). The closed population means, that we do not take into consideration the effects of the in-and outbound migration. This population is stratified by sex and age in one-year age categories. There is a zero year for new borne children. The highest life year is 95 years. The dynamic

character of the model means that in one-year time steps it projects the consequences of different interventions over time. DYNAMO-HIA has explicit risk-factor states. This means, that in each time step (year) the members of the population are divided into a specific risk-factor category, offering a low level of bias and high transparency. The parameter estimation module of DYNAMO-HIA is based mainly on the Chronic Disease Model of the Dutch National Institute for Public Health. In this way, just incidence and prevalence of disease should be declared according to age and sex, but there is no need to collect data for each risk-factor state. The module calculates the risk-factor-specific clues, using the relative risk for each risk/factor state.

The mathematical theory behind the model is the Markovian approach of multistate models. The basic assumption of the model is that the change of the state of a given person of the population depends only on current characteristics (age, sex, risk factors, and health status). This multi-state model is implemented as a partial micro-simulation, combining a stochastic micro-simulation to project risk-factor behavior with a deterministic macro approach for the disease life table (Lhachimi et al, 2012). A high number of risk-factor biographies are simulated. Based on transition probabilities between different risk categories (e.g. from normal to obese nutritional status), corresponding to the age and sex category (e.g. 25-years old man) the risk-factor status of every simulated individual is updated for each year of simulation horizon. In the macro module, a separate disease life history is constructed for each risk-/factor biographies. The disease life tables are based on disease clusters. A disease cluster represents one or more diseases. Within the disease cluster, so-called intermediate diseases (practically: diseases that increase the risk of being ill by another disease) can be specified. E.g. there are significant co-morbidities between diabetes and ischemic heart disease. All of the diseases in the database are considered chronic diseases. This means, that excess mortality is dependent on age and sex and not on time since the onset of disease. In case of necessity, acutely fatal and/or cured fraction can be determined by the uses of the DYNAMO-HIA software. There is a certain level of independence between disease clusters, that's why the uses can determine and specify the effect of relative risk in three ways: (1) from risk-factor to disease, (2) from risk-factor to death, and (3) for an intermediate disease to other diseases.

In the DYNAMO-HIA model, a specific risk-factor bibliography (in other words: a disease life table) is calculated. The disease incidence is calculated as a multiplication of the baseline incidence (practically speaking: the transition from a healthy to disease status, without the effect of the specific risk-factor times the relative risk due to the effect of the specific risk-factor). In the case of intermediate disease, we take into consideration the disease status, too (Lhachimi et al, 2012). The transition from healthy to dead status equals the baseline other-cause mortality (without taking into consideration the effect of the specific risk-factors) of the healthy population with the predetermined age and sex characteristics, minus the additional mortality rate of the diseases included in the disease life table, multiplied by the relative risk, attributable to the given risk-factor status on other-cause mortality. Vice versa; the transition from diseased to dead equals the sum of the excess mortality of the disease of the given cohort, taking into consideration the differences between sexes and the baseline (reference) other-cause mortality of the healthy, multiplied by the relative risk in the given risk-factor status. The algorithm considers every distinct cohort with different starting ages. The cohort life tables

consist of a set of individual risk-factor bibliographies, every year a specific cohort is created for newborn children, who follow through the appropriate disease life tables.

The goal of HIA is to compare the presumed efficiency of different policies/interventions/prevention programs on the future health status of the populations. This means, that we choose one epidemiologic status, which is called a reference scenario, and on the basis of results, obtained for prediction of the health status of the population (or a part of it) in the future, we compare the reference scenario with results of the intervention. To achieve this goal, we have two techniques. One approach consists of the definition of an alternative (according to the general prevention terminology: counterfactual) scenario, defining a risk-factor prevalence, which is in most cases equal with the target situation, after the successful accomplishment of the prevalence program. E.g. one prevalence program could be the radical increasing the consumer price of energy-rich products, and this could lead to a decreasing consumption. As a result of this – at least theoretically – a considerable decrease could be achieved in terms of the obesity status of the population. This approach assumes, that the policy will be sustained. The second approach is to alter the transition probabilities between different risk-factor exposures. This method is akin to the general approach of intervention programs because in this way we can model the effect of behavior change interventions of different population groups (e.g. change the nutritional behavior of population by making 'healthy choice an easy choice'). Here the focus on changing the transition probabilities between different health risk-factor conditions. The DYNAMO-HIA software offers the internal estimation of the transition probabilities that keep the age-specific risk-factor prevalence constant, not depending on future cohort effects.

I have applied the DYNAMO-HIA software to estimate the current and future burden of obesity in the Roma population. The initial data of the model was the number of Roma population determined in the national census, in 2011 by the CSO, ie 310 thousand people declared themselves as Roma. The latest representative sociological survey in 2003 estimated the number of Roma to be around 570,000. In lack of another generally accepted source, I have applied the official census data from 2011. At the same time, it must be emphasized, that this estimation has to be conceived as the lowest estimation of the actual demographic processes. Notwithstanding the conservativism of this approach, it is suitable to serve as a stepping stone of investigations, to demonstrate the far-reaching consequences of obesity in this population. In the evaluation of the results, it must be taken into consideration, that these numbers are just the lowest possible (put in another way: the most optimistic) estimations. Based on the population statistics of the CSO, we estimated the demographic characteristics of the Roma population in Hungary. After this, we made a forecast of the expected number of the Roma population in Hungary with the help of the Demographic Analysis and Population Projection System (DAPPS) software. The nutritional status of the Roma population was surveyed on the basis of primary data collection. The time horizon of our research covered from 2020 to 2070. The research framework is visualized in Figure 23.

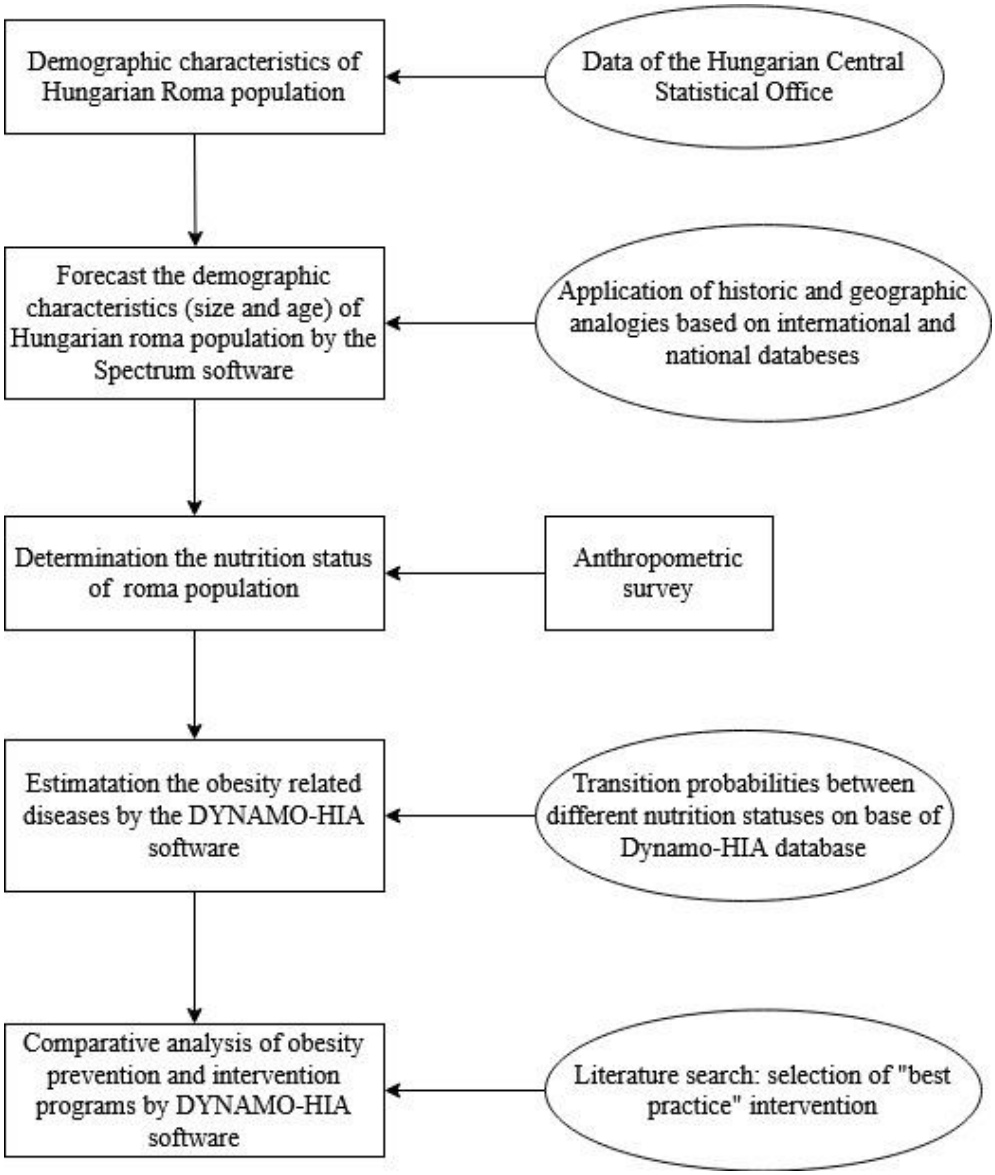


Figure 23. The research framework

The prognosis of the exact number of Hungarian Roma population is a rather difficult task because there are no methodically correct calculations available. That's why I have had to prepare a forecast concerning the Roma population in Hungary. I have applied the Spectrum 5.0 demographic software, which is widely used in demographics calculations (Stover, Brown, Puckett, & Peerapatanapokin, 2017). For an exact forecast, there is a need to apply a wide range of methods and estimations. The socio-economic position and demographic characteristic features of this population are rather specific, that's why there was not possible to apply a historically former period or a geographically similar state. Instead of this, I had to apply a combination of historical and geographical analogies. These were as follows:

We have assumed, that the total fertility ratio of the Roma population will change in a similar way, as in the case of most developed states in the last six decades. I have applied this estimation, because:

The total fertility ratio of the Hungarian population has been influenced by a wide range of political decisions (e.g. 'Ratko' era, the fertility period of the Ratko generation, the introduction of maternal leave allowance, etc) thus, the data on the Hungarian population won't supply a reliable statistical database to forecast the fertility in case of Roma population. In the opinion of Kemény (2004), the total fertility ratio of the Hungarian Roma population is roughly the same, (ca.0.0032), as it has been the average fertility rate in developed states sixty years ago. If we assume, that the economic position and living standard of the Hungarian Roma population will change in a similar way, like the living standard in most developed states (ca.2-3% yearly increasing), after the reconstruction period. This statement does not mean that we expect a similar living standard in the case of Hungary in general and its Roma population in particular like it characterizes the developed states, but we assume, that the rate of development will be similar. In most developed states the total fertility ratio can be approximated by an exponential function, that's why we have assumed a similarly declining rate of total fertility in the next half-century (Figure 24). According to the estimations of Hablicsek (2007), the life expectancy of the Hungarian male Roma population is similar to the Hungarian average at the beginning of the sixties of the last century (ca. 60 years). That's why I have assumed that the average life expectancy will be increasing in a similar way in the period 2018-2068, like the Hungarian male population's life expectance, which had been increasing in the period 1960-2010. In the case of women, my situation has been more difficult, because the life expectancy of women in Hungary in the sixties has been higher, than this indicator at the Hungarian Roma minority. That's why I have applied the life expectancy dynamics of Alban women on base of WHO data. The number of children, according to different age brackets has been estimated on the basis of historic-geographic analogies, because the number of children in the case of the Roma population according to different age brackets are considerably different from values, characterizing the majority of the Hungarian population one hundred years ago. That's why we have here the indicators, characterizing Albania in the 1970s.

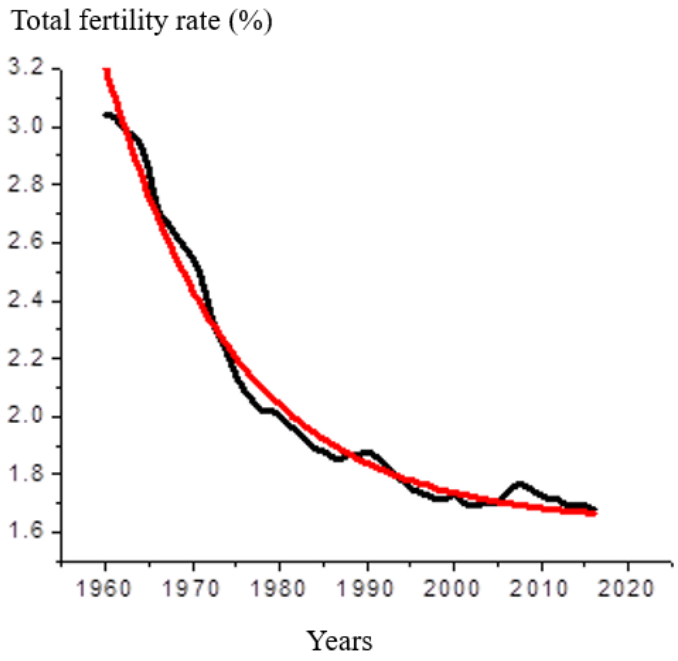


Figure 24. Change of Total Fertility Ratio in developed countries, and its approximation by an exponential function

In the first step of my research, I have phonetized the population number of Hungarian Roma up to the end of the next five decades. I have set up a base version, according to the data and assumptions, demonstrated in the previous chapter. At the same time, I wanted to estimate the uncertainty of my estimations, that's why I have applied some alternative scenarios too. In this way, I had been able to see the sensitivity of the model to the changing of initial conditions and assumptions. In the first alternative scenario, I have assumed, that the total population of the Roma minority is higher than the data, estimated by KSH, in the second alternative scenario I have calculated a 20% higher total fertility ratio. The results of the estimation, based on these three scenarios are demonstrated in Figure 25.

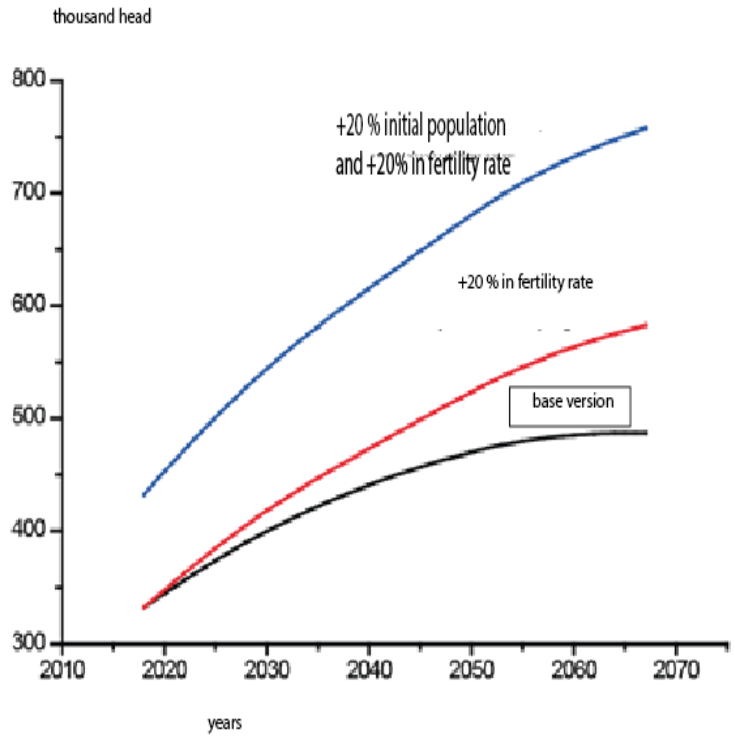


Figure 25. The forecasted number of Roma population, based on three scenarios

Determination of the nutritional status of the Roma population

Data used in this analysis were obtained in a cross-sectional survey carried out between 2015 and 2018, the study population was enrolled from five Roma communities in Hungary. One of them was in Budapest, one in Pest county, two in Szabolcs-Szatmár county, and one in Tolna county. Individuals aged 18 to 64 years, were selected randomly and anthropometric data collection was carried out. The height and weight of the participants were measured for each survey participant by using the European Health Examination Survey protocol (Tolonen, 2016). Generalized obesity and obesity classes were estimated based on body mass index according to WHO criteria. Body mass index was calculated by using the following formula: BMI = weight (kg)/height $(m)^2$. In ethnicity-based studies, the accurate determination of ethnicity is a challenge, self-identification has been widely used to identify Roma in research projects. In the present study, the ethnicity of the participants was assessed by self-declaration, 415 Roma committed to participate in the study. Participants gave their written informed consent in each study population following the Declaration of Helsinki and the Science Ethics Code of The Hungarian Academy of Sciences. The results of the survey were projected onto the entire Roma population.

To quantify the potential effects of various obesity prevention programs we have compared two systems of models (scenarios) by DYNAMO-HIA software. In the case of the first model system, we had been modeling the effects of a hypothetical intervention, focusing just on one influencing factor of food consumption: television (TV), radio, and newspapers advertising of food and beverages high in fat, sugar, and salt. It is well documented, that the promotion of foods high fat-, sugar-, and salt considerably influence food preferences and consumption. People in lower socioeconomic positions have higher exposure to television advertisings because they spend more time watching TV (Brown et al, 2018). Of course, besides the TV promotions, food advertising in printed materials (e.g. newspapers, promotional materials of food chains) and broadcasting play an important role too. In model-intervention, we have supposed the decreasing (limitation) of promotion of foods high in fat-, sugar- and salt in different media: radio, newspapers, and TVs.

In another model intervention we have supposed that there will be a complex project, aiming at total lifestyle-change of the Roma population (increased physical activity, radical changes in food consumption, behavioral therapy). We have supposed that this project will have different components. The basic pillars of this project could be as follows: 60-90 minutes of moderate-intensive aerobic physical activity each week (or equivalent), promotional programs for the re-formation of food consumption, based on latest nutritional recommendations (e.g. Smart PlateTM, developed lately by the Hungarian Association of Dieticians, adapted to specific needs of different age groups), (c) specific project for modification of nutritional habits of Roma population (e.g. projects for enhancement of nutrition literacy).

We have modeled the effects of prevention/intervention programs, focussing on different age brackets. These age categories were as follows: early childhood: 5 years age, prepuberty: 11 years age, middle age: 40 years age; elder: 62 years). All these age brackets have been chosen on the basis of careful analysis of literature. It has been proven, that these age categories offer the possibility of an efficient intervention because they coincide are with the change in lifestyle or the socio-economic status of individuals (Weihrauch-Blüher et al, 2018; Kjøllesdal, Ariansen, & Næss, 2019; Zamboni & Mazzali, 2012).

3.3. The MACTOR method

The fundamental theoretical paradigms of the analysis were institutional economic theory (Dacin, Goodstein, & Richard Scott, 2002), principle-agent theory (Eisenhardt, 1989), and the concept of strategic planning (Mintzberg, 1994). According to the basic theory of the so-called 'French school of strategy', the different social systems can be considered as a playground in which different groups of participants (the actors) take part with the purpose of making their specific interests prevail. In the opinion of (Godet, 1991), if one can adequately simplify the actors and the most characteristic features of their systems of interests and strategies, then it is possible to analyze the chances of different actors realizing their goals. The method of the systematic analysis of social bargaining can be described by using the MACTOR model. One of the key concepts of the model is that actors may influence other actors in terms of their potential to put pressure on other actors directly or indirectly to affect their behavior. The influence of one actor (A) on another actor (C) is the sum of the direct and indirect influences of actor A on actor C.

Based on unstructured interviews, the key actors of the catering system were determined. In the next phase, the intensity of mutual direct influences was characterized using a rectangular matrix offering a good overview of the MACTOR method. The cells of the matrix – by definition – reflect the intensity of the influence of any actor in a row on any actor in a column. The intensity of the direct influence by one actor on another was measured on a 0-4 scale ranging from no influence to absolute influence.

The importance of different goals from the point of view of each actor was expressed by the Matrix of Actor-Objective. This was the so-called 1MAO matrix. Each cell of the matrix contained the attitude of a given actor towards a given goal in the form of a positive, 0, or negative sign. In the second phase, the 2MAO matrix is determined, which contains the intensity of these attitudes determined from the point of view of different actors and quantified on a -4 …+4 scale, where -4 denotes the high importance and total negation of the given goal, and +4 denotes the high importance and total support.

The mathematical methodology of the MACTOR method is presented in the literature (Bendahan, Camponovo, & Pigneur, 2004).

The matrix of direct and indirect influences (MIDI), quantifies the sum of direct and indirect influences for each pair of actors.

$$\mathrm{MIDI}_{a,b} = \mathrm{MID}_{a,b} + \sum_c \left(\min\left(\mathrm{MID}_{a,c}, \mathrm{MID}_{c,b}\right)\right)$$

In this way, the vector influences (I_a) and dependences (D_a) for each and every actor can be determined by the following equations.

$$I_a = \sum_b \left(\mathrm{MIDI}_{a,b}\right) - \mathrm{MIDI}_{a,a}$$

$$D_a = \sum_b \left(\mathrm{MIDI}_{b,a}\right) - \mathrm{MIDI}_{a,a}$$

On basis of the indicators above a normalized value can be calculated for each of the actors.

$$r_a = \left(\frac{\left(I_a\text{-}\mathrm{MIDI}_{a,a}\right)}{\sum_a (I_a)}\right) \cdot \left(\frac{I_a}{(I_a + D_a)}\right)$$

Applying the vector r_a the matrix of influence-possibilities for each of the actors for different issues can be defined.

The importance of each goal from the point of view of different actors was expressed by the Matrix of Actor-Objective. This was the so-called 1MAO matrix, in which the cells of the matrix contained the attitude of an actor towards a given goal in the form of a positive, 0, or negative sign. In the second phase, the 2MAO matrix was determined, which contains the intensity of these attitudes which have been determined for different actors, measured on a -4 …+4 scale, where -4 denotes the total negation of the given goal, and +4 denotes total support.

The 3MAO matrix also takes into consideration the influence-possibilities of the different actors.

$$3\mathrm{MAO}_{\mathrm{a,i}} = 2\mathrm{MAO}_{\mathrm{a,i}} \cdot \mathrm{r}_a$$

This matrix is the basis of most of the analyses proposed by our method because several important values are directly drawn from the 3MAO matrix. The mobilization coefficient quantifies how much the different actors are involved in the system of interests. The agreement and disagreement coefficients indicate how controversial the different issues are for each actor.

$$\mathrm{Mob}_a =\rightleftarrows \sum_i \left|3\mathrm{MAO}_{\mathrm{a,i}}\right|$$

$$\mathrm{Ag}_i = \sum_a \left(3\mathrm{MAO}_{\mathrm{a,i}} \cdot \left(3\mathrm{MAO}_{\mathrm{a,i}} > 0\right)\right)$$

$$\mathrm{Disag}_i = \sum_a \left(3\mathrm{MAO}_{\mathrm{a,i}} \cdot \left(3\mathrm{MAO}_{\mathrm{a,i}} < 0\right)\right)$$

The 3MAO matrix is applied to obtain the convergence matrix (3CAA) and divergence matrix (3DAA). For each actor-pair, these matrices express how much they agree or disagree on different issues.

$$3\mathrm{CAA}_{\mathrm{a,b}} = \frac{1}{2} \cdot \sum_i \left(\left(\left|3\mathrm{MAO}_{\mathrm{a,i}}\right| + \left|3\mathrm{MAO}_{\mathrm{b,i}}\right|\right) \cdot \left(3\mathrm{MAO}_{\mathrm{a,i}} \cdot 3\mathrm{MAO}_{\mathrm{b,i}} > 0\right)\right)$$

$$3\mathrm{DAA}_{\mathrm{a,b}} = \frac{1}{2} \cdot \sum_i \left(\left(\left|3\mathrm{MAO}_{\mathrm{a,i}}\right| + \left|3\mathrm{MAO}_{\mathrm{b,i}}\right|\right) \cdot \left(3\mathrm{MAO}_{\mathrm{a,i}} \cdot 3\mathrm{MAO}_{\mathrm{b,i}} < 0\right)\right)$$

The data collection for the analysis was a multiphase process (Figure 26). In the present study, we applied a self-designed interview method. Besides the analysis of publicly available papers, press releases, newspaper articles, and the blogosphere, face-to-face expert estimations were made with 24 stakeholders related to the field of Hungarian catering. This series of preliminary interviews were conducted to determine the set of relevant actors and interests. The interviews were carried out in 2015 and 2016. This preliminary phase of interviews aimed to outline the most important stakeholder groups and the set of potential objectives of the stakeholders. As a result of these preliminary investigations, a robust and relatively well-manageable set of actors and goals could be identified. In setting up a pool of experts a specific procedure was followed. In this phase, we pursued the following logic. We considered experts to be people (1) who have direct ‘field’ experiences in catering functions as parents or teachers; (2) people whose job directly involves a catering business with relatively long experience in the practice of SCS and whose existence directly depends on this enterprise; (3) independent experts, preferably those

who have been especially active in professional social debates concerning the catering regulations in the printed and electronic media; (4) experts who have been actively involved in the preparation and enforcement of the new regulatory framework of the SCS. The attitude of experts towards school catering has been taken into consideration, neither in the choice of experts nor in the interview phase.

The second phase of research was a semi-quantitative interview. The list of potential participants was collected on the basis of intensive research into publications (including professional conferences, various formal and informal meetings of professional communities, the blogosphere, and the grey literature), membership of professional organizations, and the personal recommendations of other experts.

In summary, the names of 321 experts were collected (not including parents and teachers). Out of these experts we tried to make contact with specialists who supposedly – in the opinion of at least two members of the community of authors – have a more 'holistic' approach to the SCS universe without taking into consideration their attitude to the SCS question. In process of our analysis, we have tried to take into consideration all relevant stakeholders. In this way, 78 experts were selected. We contacted 61 of them; 45 respondents expressed their willingness to participate in the research. Due to time and financial constraints 33 expert-interviews were carried out, all of them face-to-face. Additionally, we interviewed 26 parents and 13 teachers. We have paid specific attention to choose parents and teachers from relatively well-off and lesser developed regions of Hungary (Budapest), cities (Szeged), small-town (Hajós), and villages (Báta). The teachers and parents have been approaches on the basis of personal acquaintance. The characteristic features of interviewees are attached as Appendix 4.

The quantification of the intensity of actor-actor influences, as well as the actor-objective relations, has been developed in a step-by-step manner. As it has been experienced in previous research (Popp, Olah, Fari, Balogh, & Lakner, 2018), filling out the input matrices in the form of MS Excel worksheets for research was a very time-consuming (and in some cases a rather boring) process often leading to internal contradictions because it was very difficult to achieve a general common interpretation of different scales. That is why a semi-structured interview was used (Lindlof & Taylor, 2010). The conversion of the verbal estimations was carried out in the personal interview phase with the help of the researchers. The only task of the researchers was to help to interpret the different scales. This method provided to be an efficient method for achieving internal consistency in the input data for analysis (Kliestik, 2018).

In the framework of the interviews, we asked the respondents to evaluate the bargaining power of each actor in comparison with another actor (e.g. Government vs. teachers, Government vs. Catering service managers, etc…) on a 0-4 scale. The interpretation of this scale was the following:

0 – no direct influence

1 – actor A can eliminate the tactical steps of actor B
2 – actor A can jeopardize/eliminate the projects of actor B
3 – actor A can jeopardize/eliminate the strategic goals of actor B
4 – actor A can substantially influence/dominate actor B

In the second phase of interviews, we asked the interviewees to evaluate the attitudes of actors (stakeholders) towards different elements of a goal set on a -4… 0 … +4 scale. The interpretation of the scale was as follows:

- 4 the objective is against the vital interest/jeopardizes the existence of the actor
- 3 the objective jeopardizes the strategic mission of actors
- 2 the objective jeopardizes the tactical goals of the actors
- 1 the objective jeopardizes the operative goals of the actor 0 the actors' attitude towards the goal is neutral +1 the objective falls in line with the operative goals of the actor
- 2 the objective falls in line with the tactical goals of the actors

  3 the objective considerably supports the strategic goals of the actor

  4 the objective is a vital interest of the actor

The participants received the cumulated input–matrices and their interpretation by e-mail and had the opportunity to suggest some modifications. The results of the MACTOR analysis were discussed in detail with a representative pool of respondents in a group discussion and face-to-face interviews. This phase of the research was an explorative one since our ambition was not to create a representative sample but rather to collect a relatively wide range of opinions.

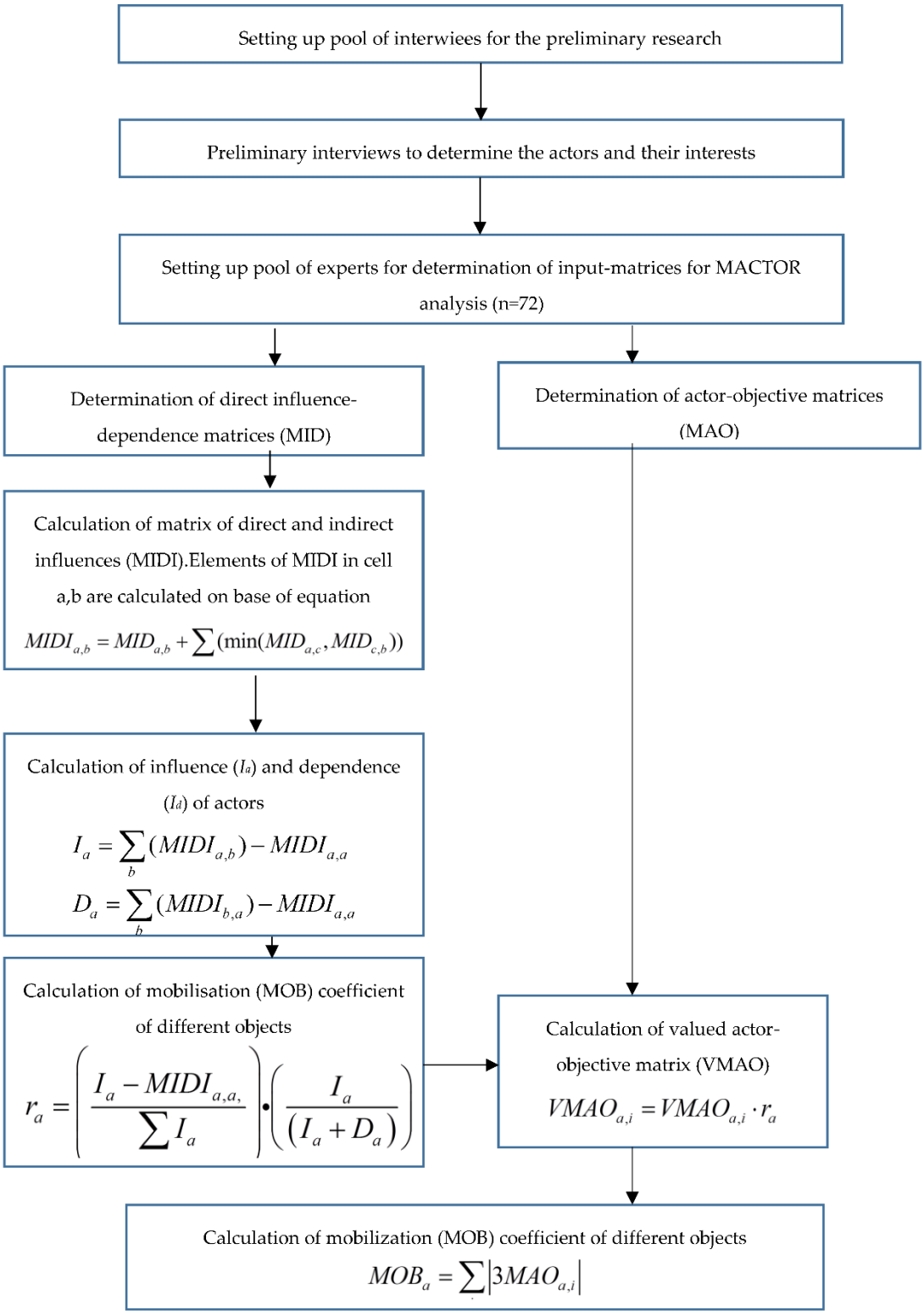


Figure 26. Flowchart of MACTOR –model investigations

4. RESULTS AND DISCUSSION

4.1. Obesity in Hungarian adults

Expected prevalence of overweight and obesity in case of women

The decreasing number of girls in age-bracket 6-10 years from nearly 200 thousand to one hundred thousand in a relatively short period (no more than three generations!) highlights an extremely negative tendency. The nutritional status of young girls shows relatively modest changes in decades to come (Figure 27). The number of overweight and obese girls will be stable (25 thousand and 15 thousand, respectively), and the share of girls in normal nutritional status will be decreasing rather rapidly, from 180 thousand to 100 thousand. This tendency will lead to an increasing share of the obese and overweight population in this age bracket.

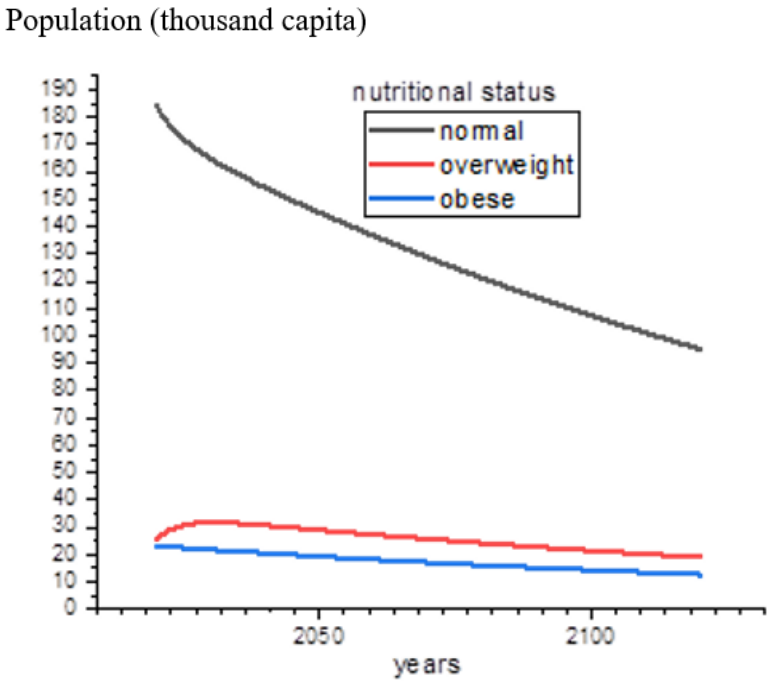


Figure 27. Prognosis of number of girls in different nutritional status at the age-bracket 6-10 years

At the age-bracket 11-15 years similar tendencies can be forecasted (Figure 28). Interestingly, at this age bracket, a short-run increase by 17 thousand in the number of population in normal nutritional status can be expected. As a consequence of the relatively rapid decrease of population in normal nutritional status, the share of overweight and obese girls will be relatively stable, circa 25% of the total investigated population.

Population (thousand capita)

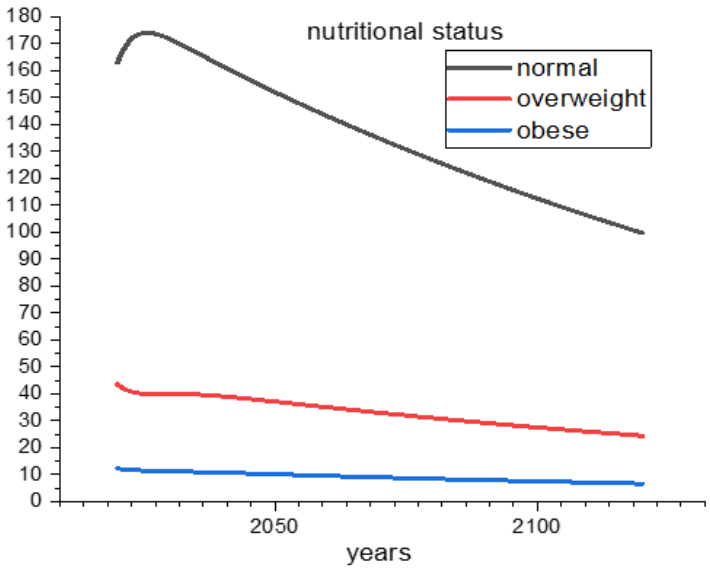


Figure 28. Prognosis of number of girls in different nutritional status at the age-bracket 11-15 years

At the age-bracket 16-20 years, a considerable decrease can be expected in the number of the population in the normal category, from 210 thousand to 97 thousand (Figure 29). At the same time, a very rapid increase in the number and share of the overweight population can be foretold. At the end of the forecasting period, the total share of the overweight and obese population will be nearly 30%. The number of adolescent girls in the obese category will be stable, no more than 5 thousand.

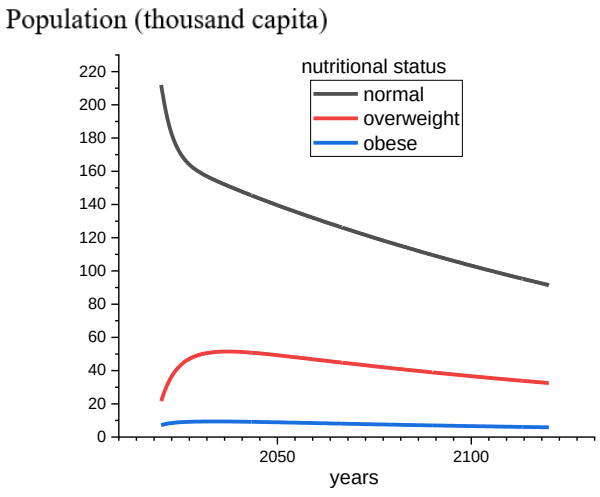


Figure 29. Prognosis of number of girls in different nutritional status at the age-bracket 16-20 years

Tendencies at the age-bracket 21-25 years (Figure 30) are very similar to the previous age-bracket, but in this case, the decreasing of the population in normal nutritional status is even more intensive: in the next three decades, the number of people in normal nutritional status will be just two-third of the current number of young females at this age bracket.

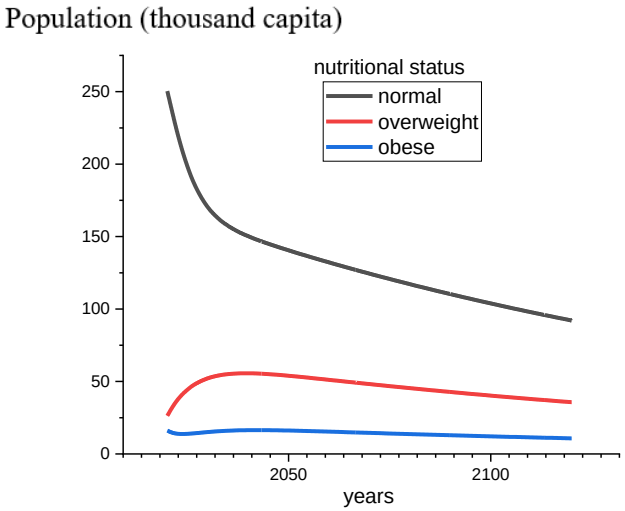


Figure 30. Prognosis of number of women in different nutritional status at the age-bracket 21-25 years

Decreasing the number of normal nutritional status population will be even more intense at the 31-35 years age bracket (Figure 31). The number of population in normal nutritional status is 210 thousand at our days, and this will decrease at the end of the period to 91 thousand. In this population category, a slight increase in the number of overweight population can be expected in the next 30 years.

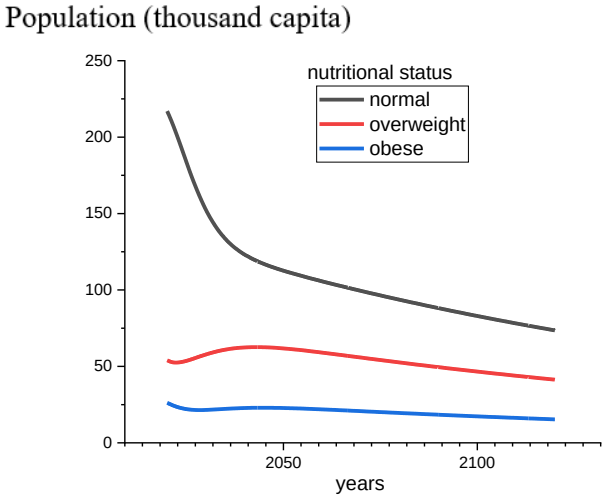


Figure 31. Prognosis of number of women in different nutritional status at the age-bracket 31-35 years

The most intensive decrease of the population in the normal nutritional status can be expected at the age bracket 36-40 (Figure 32). The number of females in normal nutritional status in 2020 is more than 250 thousand, and this value will decrease to 86 thousand in the next one hundred years.

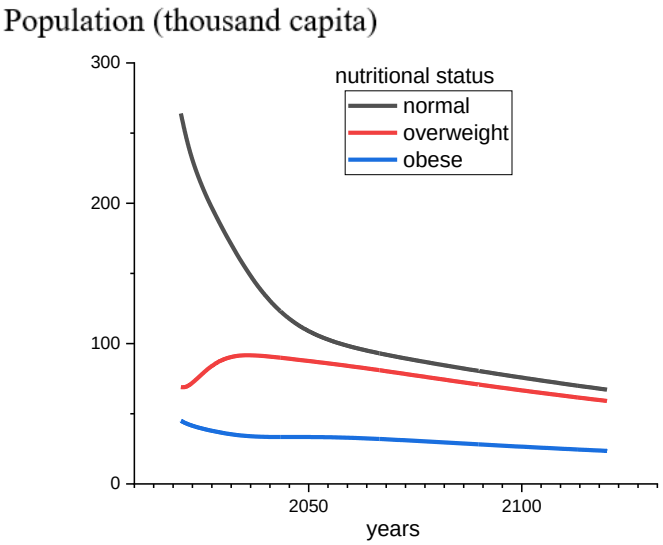


Figure 32. Prognosis of number of women in different nutritional status at the age-bracket 36-40 years

In the case of age bracket 41-45 years the number of population in normal nutritional status will not be higher than the number of women in overweight nutritional status (Figure 33). Decreasing the number of obese and overweight population can be explained by general demographic tendencies.

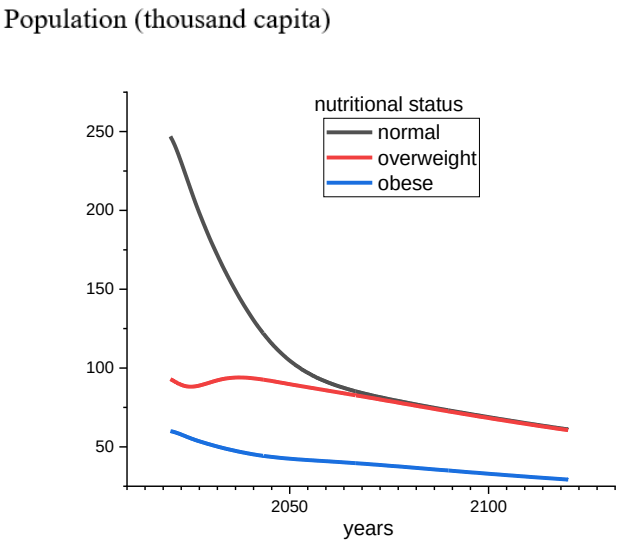


Figure 33. Prognosis of number of women in different nutritional status at the age-bracket 41-45 years

The general tendency of an increasing share of obesity will be even more expressed in the 46-50 years population (Figure 34). In the short run, a rapid increase of the overweight population can be forecasted, parallel with decreasing share of the obese population. The number of population in normal nutritional status will be considerably lower, than the number of population in the overweight nutritional status. This tendency shows a threatening demographic process because the share of the population in normal nutritional status will decrease from 61% to 45%.

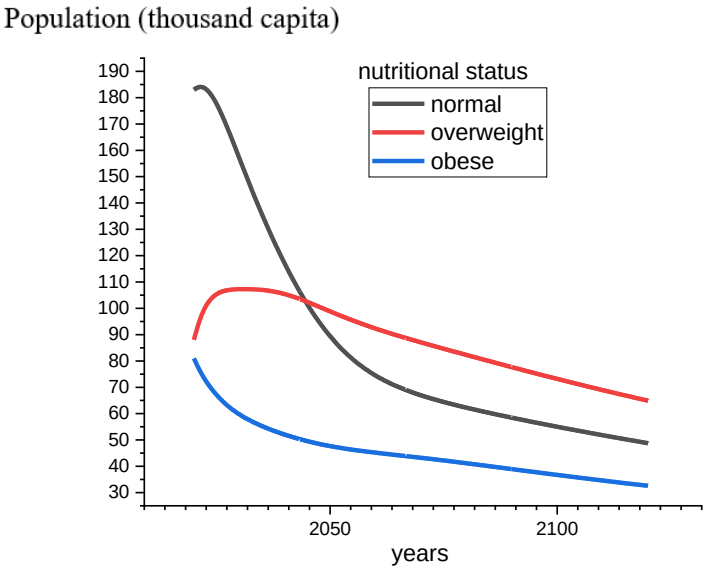


Figure 34. Prognosis of number of women in different nutritional status at the age-bracket 46-50 years

Due to the rapid increase of the overweight population and decreasing number of people in normal nutritional status, at the age bracket 51-55 years the number of women in normal nutritional status will be lower than that in overweight status within two decades (Figure 35). In the long-run, this population group will be dominated by overweight and obese persons. Their number will be 80 thousand and 32 thousand, respectively at the end of the prognosis period. Similarly, to younger cohorts, a considerable decrease of women in normal nutritional status can be forecasted: their share will be just one-third of the population.

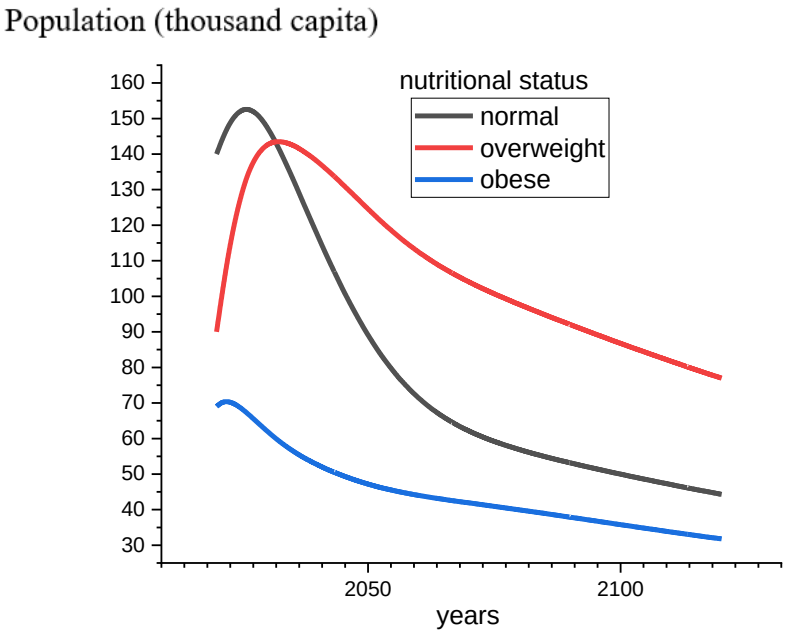


Figure 35. Prognosis of number of women in different nutritional status at the age-bracket 51-55 years

The strengths of the system dynamics approach can be well seen in the example of nutritional status forecast at 61-65 years women. In the case of this population segment, the number of overweight women will be decreasing, from 120 thousand to lesser than 80 thousand between 2040 and 2100 (Figure 36). This is well explainable by the general demographic factors. At this bracket, the relative importance of the obese population will be relatively high.

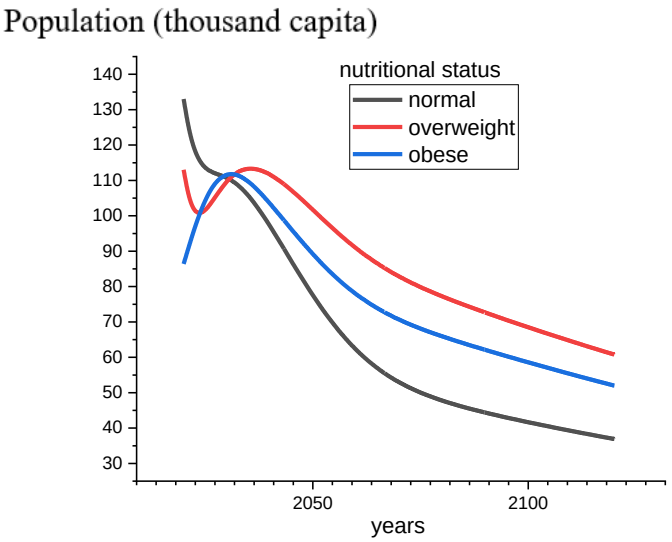


Figure 36. Prognosis of number of women in different nutritional status at the age-bracket 61-65 years

The 65-70 years age bracket is dominated even nowadays by the overweight and obese population (Figure 37), the share of the population in normal nutritional status is no more than 31%. In the long-run, the number of obese women will be higher, than the number of population in the normal nutritional status, but the share of these three nutritional statuses will not be changing considerably.

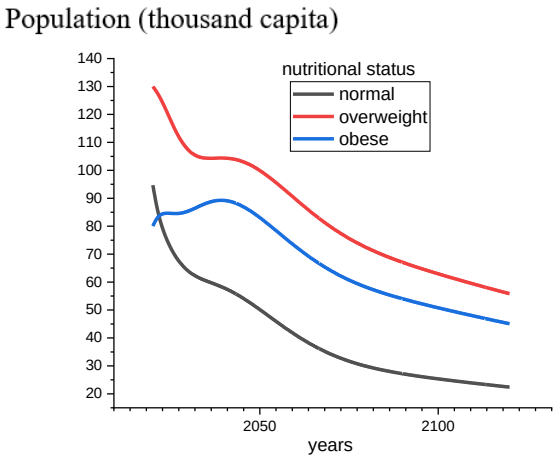


Figure 37. Prognosis of number of women in different nutritional status at the age-bracket 65-70 years

At the age-bracket 71-75, the dominance of the obese and overweight population will be even more expressed (Figure 38), than in the case of younger generations. Share of normal nutritional status is nowadays 26%, and this will be slightly increasing. It is important to highlight the existence of a 'plateau' in the number of obese– and to a lesser degree of overweight persons up to 2050. In this year the number of overweight population will be 120 thousand, the obese nearly 100 thousand people. This fact explains the extremely high share of the overweight and obese population in this bracket, causing a considerable extra burden for the social security system.

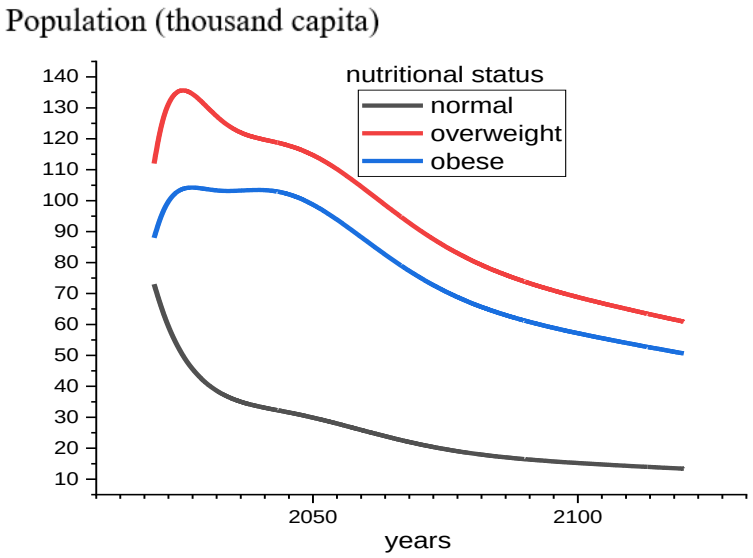


Figure 38. Prognosis of number of women in different nutritional status at the age-bracket 71-75 years

At the higher end of the population pyramid, at the age bracket, 76-80 years the share of overweight and obese women will increase (Figure 39). Share of population in normal nutritional status will be lesser than 50%. This will be an extremely important problem because in the second half of the period under investigation the relative share of this age-bracket will be much higher than in our days.

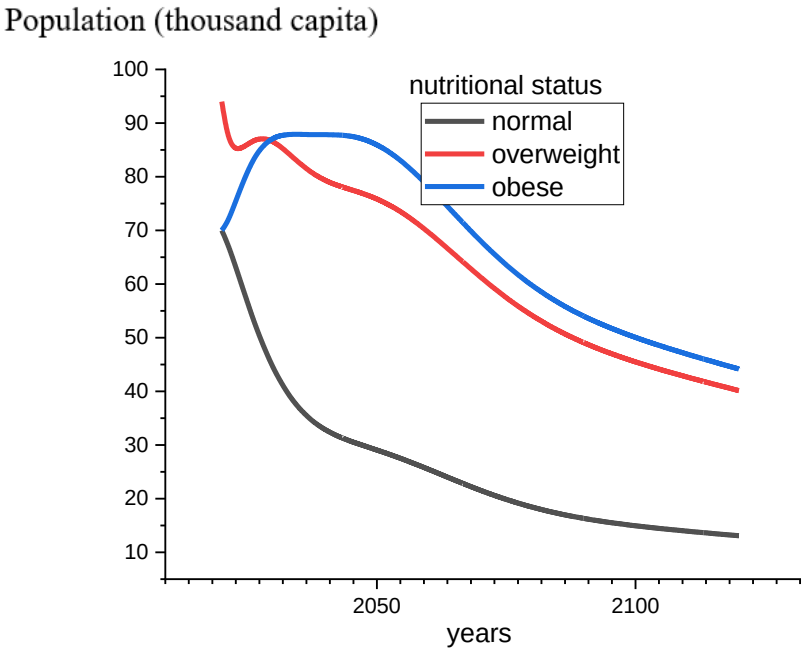


Figure 39. Prognosis of number of women in different nutritional status at the age-bracket 76-80 years

In this period of life, the transition probability from one nutritional status to another is relatively low, that's why the characteristics in the case of age-bracket 81-85 years (Figure 40) are rather similar to the previous one. According to our calculation, the number of women in normal nutrition status will be no more than 15 thousand at the end of the period under investigation.

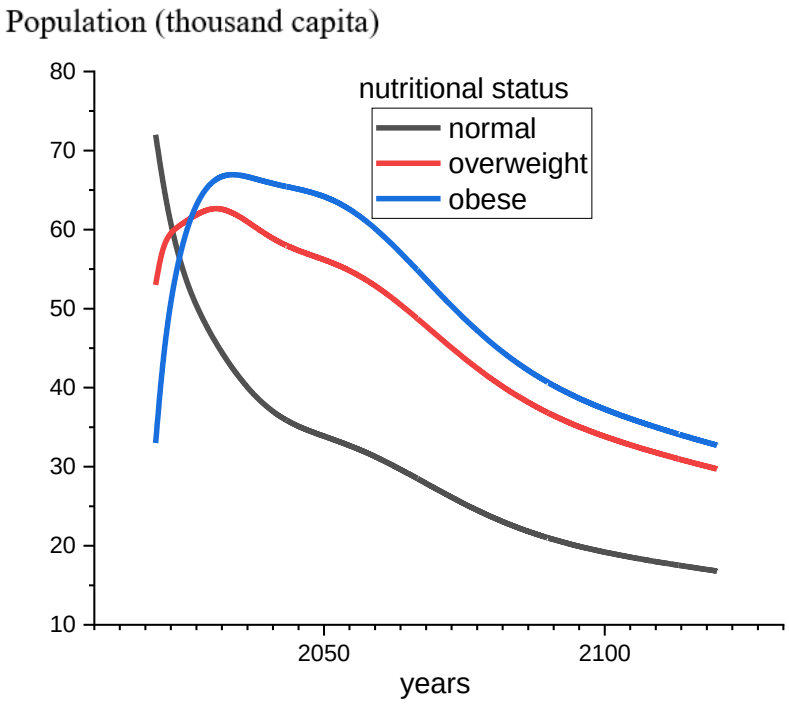


Figure 40. Prognosis of number of women in different nutritional status at the age-bracket 81-85 years

Summarizing the dynamics of changes of the population according to different nutritional status (Figure 41) it can be stated, that the number and share of women in normal nutritional status will be decreasing rapidly, from 2.72 million to 1.21 million, and from 55% to 39%, respectively. In the second half of the period under investigation, approximately two-thirds of the population will be in the overweight or obese status.

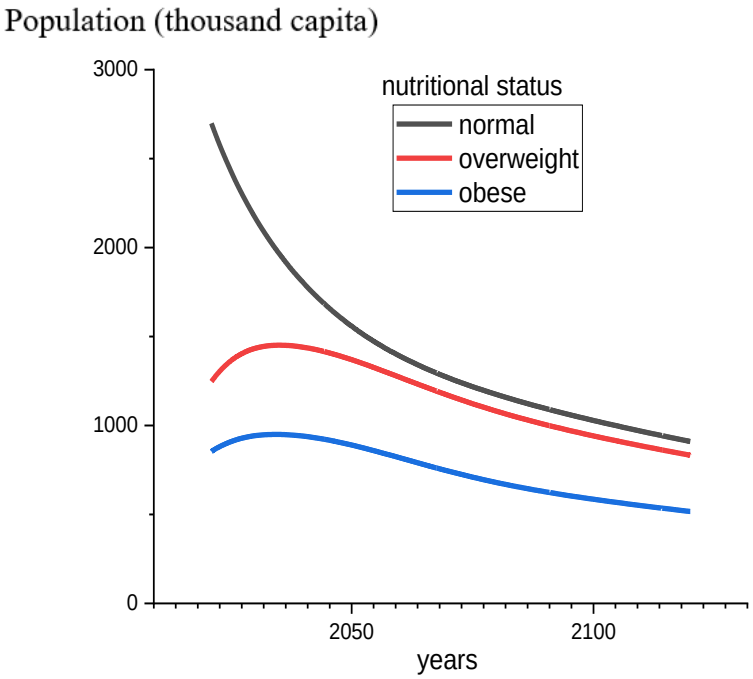


Figure 41. The dynamics of changes of the population according to different nutritional status

Life losses as a consequence of obesity among women

From point of view of years of life lost, the most important tendencies are well demonstrated in Figure 42. The total loss of life years due to obesity is nearly 80 thousand years in our decade, and this value will go up to more than 90 thousand years after fifteen years. Then the total losses in life years will be decreasing to 50 thousand years, but this statement will be valid for a much lesser population. The most important losses in life years are at the later-middle age and early elder age generations. This is extremely important because of considerable losses at the generations, which will be kept on the labor market.

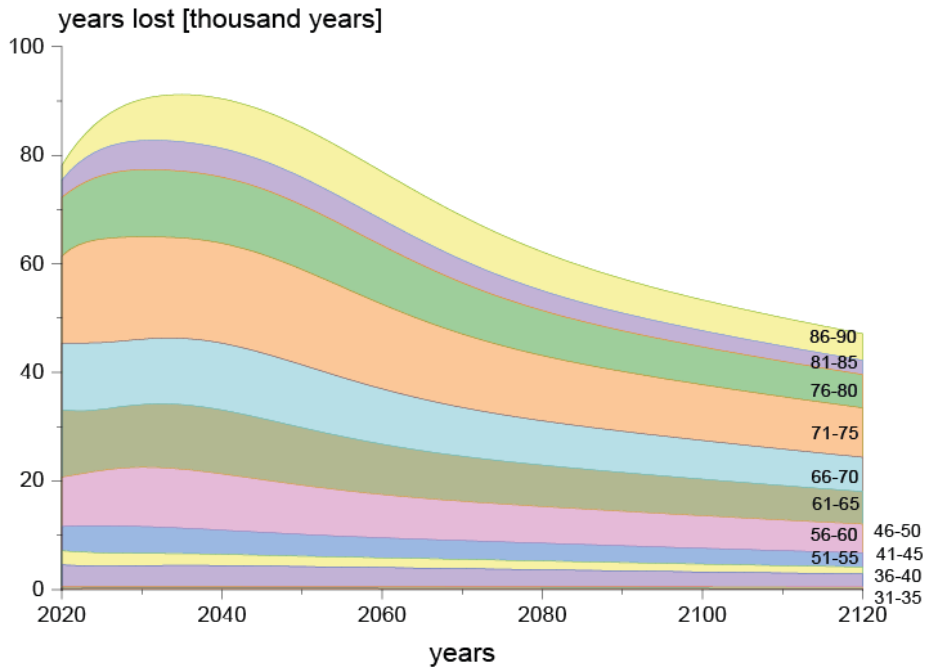


Figure 42. Structure of loss in life years according to different age brackets

Expected prevalence of overweight and obesity in case of men

In the case of young males, a considerable decrease of normal, and rapid increase of overweight population can be expected (Figure 43). This increase in the overweight population can be explained mainly by the transition from the population in normal nutritional status. The number of young males in normal nutritional status is ca. 180 thousand, and this will be decreasing rather rapidly in the next fifteen years to 110 thousand. At the same time, the population in overweight nutritional status will be increasing from 42 to 84 thousand. There will be a decrease in the obese population: their number will be decreasing from 60 thousand to 30 thousand in the next two decades.

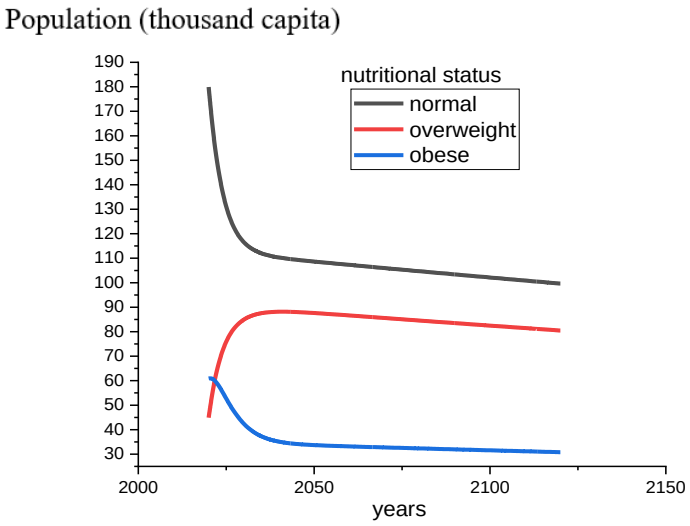


Figure 43. Prognosis of number of boys in different nutritional status at the age-bracket 11-15 years

The dynamics of nutritional status change will be extremely significant at the age-bracket 16-20 years (Figure 44). Here a rapid increase of obese population will be a characteristic feature, parallel with decreasing of overweight and increasing of obese status. The rate of decreasing in normal nutritional status will be extremely rapid in next two decades: because the number of people in normal nutritional status will be decrease from 200 thousand to 105 thousand in next 15 years. This rapid decrease can be explained on one hand by demographic processes, on the other hand by the rapid increase of the overweight population from 40 thousand to nearly 100 thousand people.

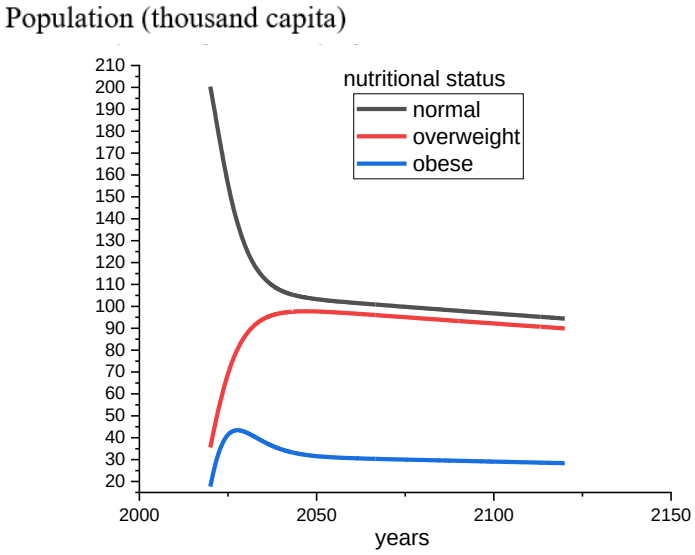


Figure 44. Prognosis of number of adolescent boys in different nutritional status at the age-bracket 16-20 years

In the case of 21-25 years men, a rapid decrease of normal nutritional status is expected (Figure 45), from 180 thousand to 90 thousand in the next twenty years, following a short increase. The dynamics of young males in overweight and obese nutritional status shows considerable similarities: the number of overweight men will be nearly 100 thousand, the number of obese men will be 35 thousand.

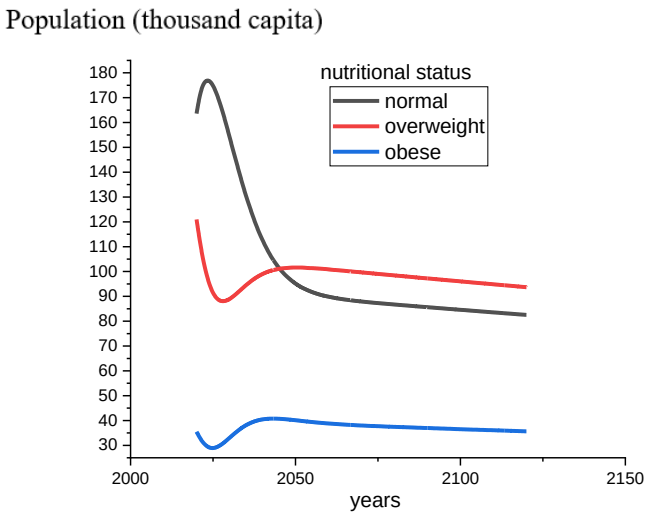


Figure 45. Prognosis of number of men in different nutritional status at the age-bracket 21-25 years

In the case of the 26-30 years population, an extremely rapid decrease can be expected among men in normal nutritional status (Figure 46), from 190 thousand to 80 thousand in the next half-a-century. This fact is supported by the general opinion of experts, that in this age-brackets the considerable changes in socio-economic life (e.g. establishment of families or long-term relationships) will considerably change of lifestyle of this population, and as an adverse consequence of this, a rapid increase of overweight population can be expected.

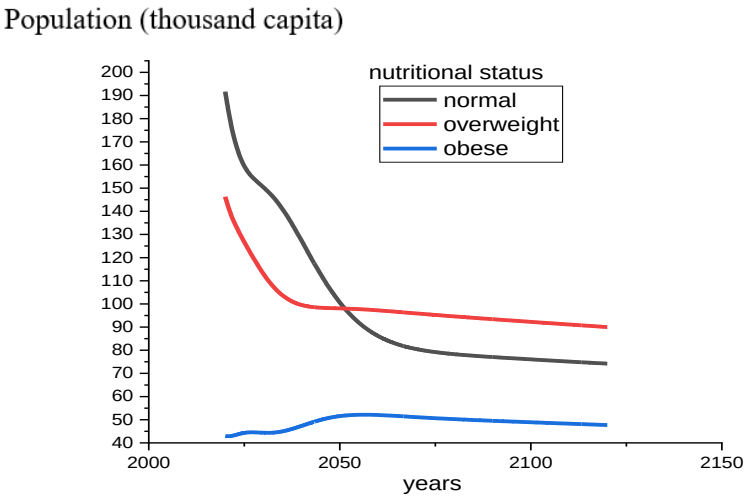


Figure 46. Prognosis of number of men in different nutritional status at the age-bracket 26-30 years

Similar tendencies can be forecasted in members of the 31-35 years age bracket (Figure 47). The population in normal nutritional status will rapidly decrease from 170 thousand to 152 thousand, and after this, there will be a lesser intensive decrease up to 100 thousand in the second half of the forecasting period. The number of obese persons will be relatively stable, between 50 and 45 thousand. As a result of these complex processes the share of overweighted and obese people will be 67%. In this case, the adverse demographic factors will play a considerable role.

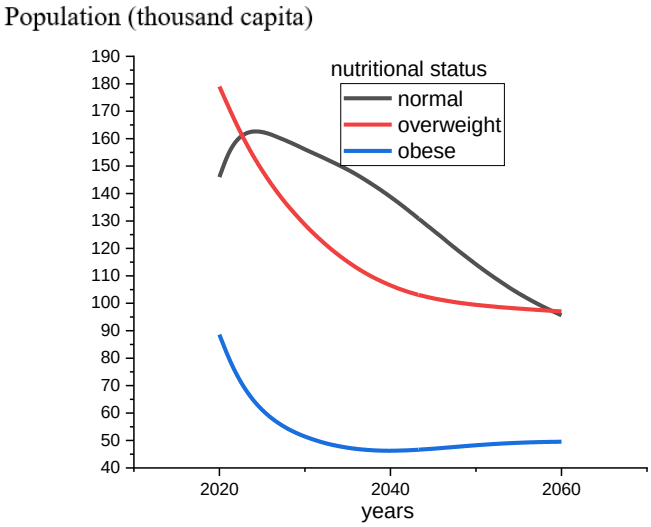


Figure 47. Prognosis of number of men in different nutritional status at the age-bracket 31-35 years

At the 36-40 years bracket (Figure 48) the relative share of the overweight and obese population will be increasing. The number of overweight persons will decrease from 180 thousand to 100 thousand, and the number of obese males will be stabilizing around 50 thousand from 2030. At the same time, it is a positive tendency, that the share of the obese population will be rapidly decreasing in the next two decades. After this period a stagnation can be expected.

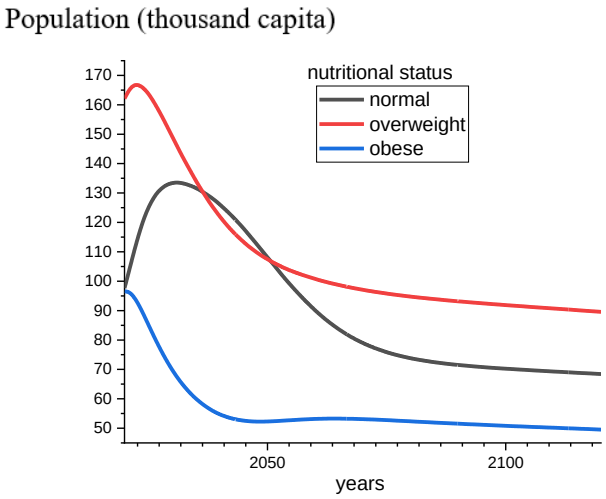


Figure 48. Prognosis of number of men in different nutritional status at the age-bracket 36-40 years

The young-middle age males are dominated by people in overweight nutritional status, but their relative share will be decreasing (Figure 49).

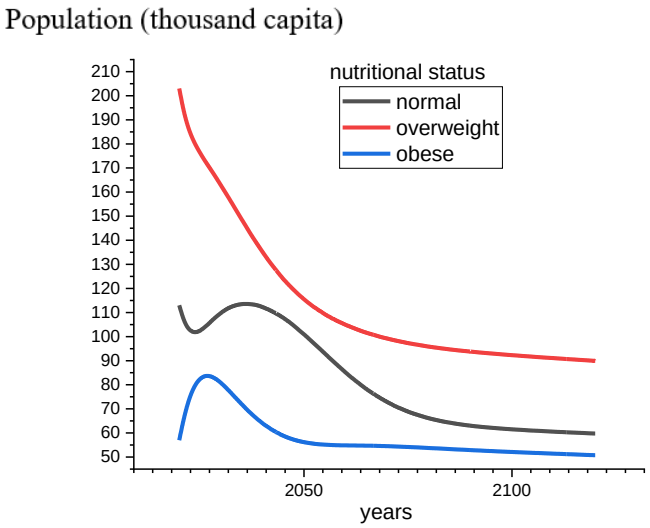


Figure 49. Prognosis of number of men in different nutritional status at the age-bracket 41-45 years

At age bracket, 46-50 years the decreasing number of people in normal nutritional status will be much more intensive (Figure 50), from 200 thousand to 110 thousand up to 2050. The relative share of the obese and overweighed population will be high, more than 2/3 of the total population of the cohorts at the end of the period. The same ratio now can't be considered as a favorable one, too, its value is 37.8%.

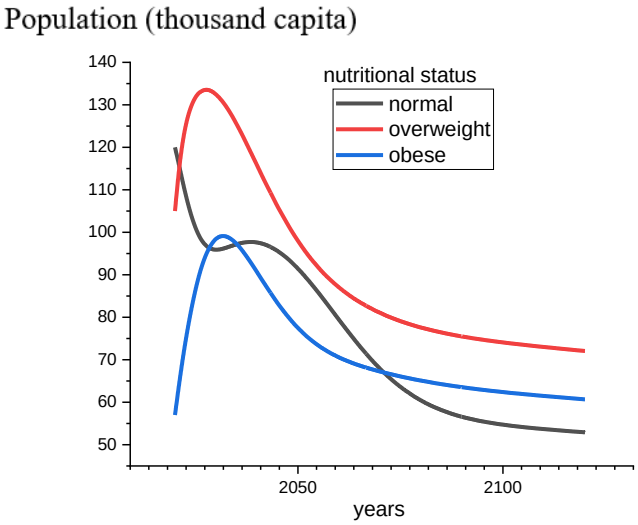


Figure 50. Prognosis of number of men in different nutritional status at the age-bracket 46-50 years

In the case of elder generations, a general dominance of the overweight and obese population will be persistent. The form of curves are highly similar, to save space I present here the change

of numbers in different nutritional statuses in the case of 71-75 years of the population (Figure 51). The number of this population will be increasing rather rapidly in the next three decades, due to the well-known demographic structure of the Hungarian male population.

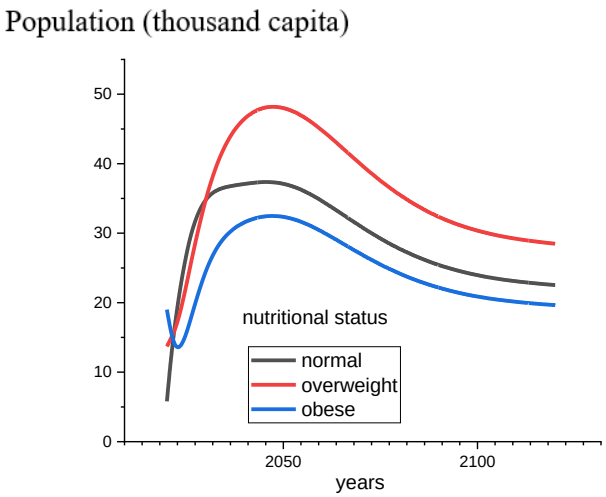


Figure 51. Prognosis of number of men in different nutritional status at the age-bracket 71-75 years

If we summarize the tendencies across different age-groups and transition between different nutritional statuses, a constant decrease can be expected (Figure 52). The relative share of people of different nutritional statuses will remain practically the same.

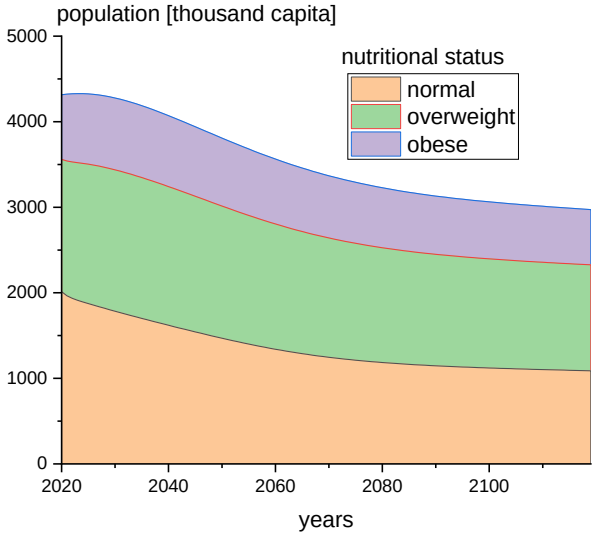


Figure 52. The change of male population in different nutritional status in next one hundred years

The share of the population in normal nutritional status will be decreasing in decades to come from the current 45% up to 36% at the end of the forecast period. The absolute number of overweight and obese citizens won't increase considerably, but the number of people in normal nutritional status will be decreasing from two million to 1.22 million.

In the future the number of death due to obesity will rapidly increase (Figure 53), this fact is easy to explain by the rapidly increasing average age of the population. The highest level of deaths attributable to obesity will be in the forties, at that time this value will reach 3.25 thousand/year.

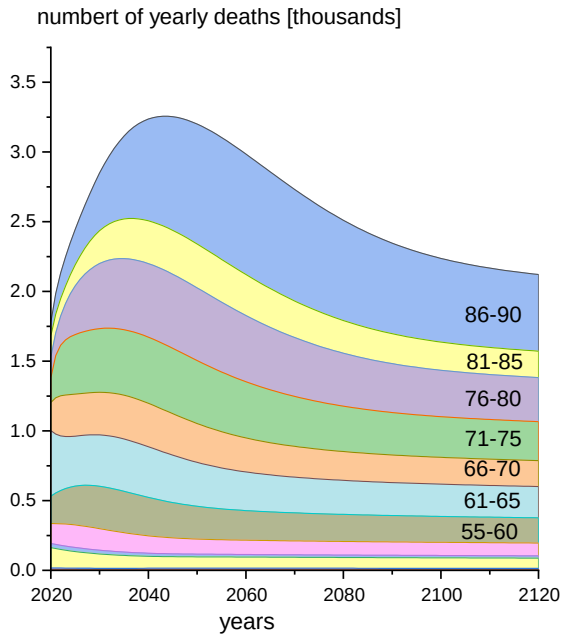


Figure 53. Number of yearly death due to overweight and obesity in the future at Hungarian male population

At the same time, if we take into consideration the number of life-years lost (Figure 54), we see, that currently, the most important cohorts are the 61-65 years old men and the 71-75 years old male citizens. In the short run, the share of relatively younger age brackets will be increasing.

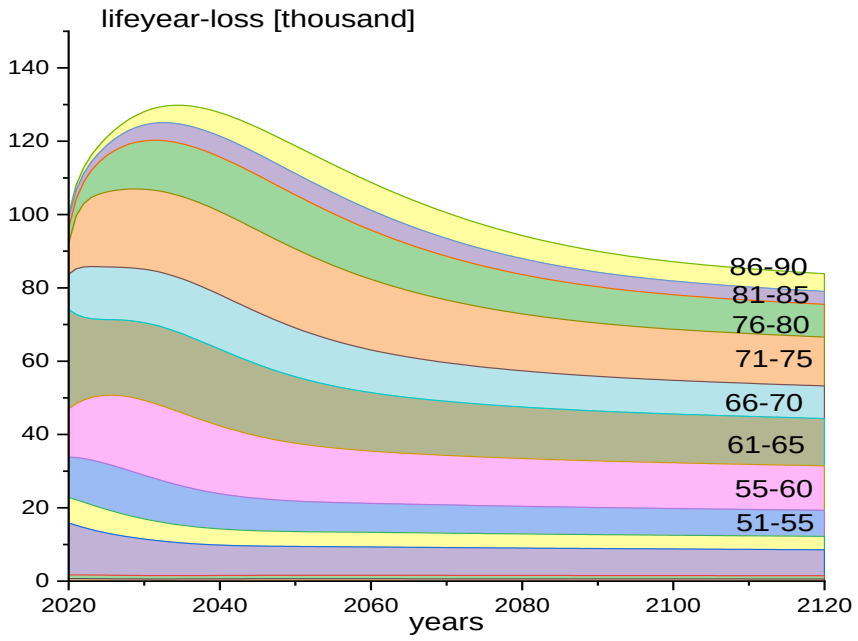


Figure 54. Forecasted life year-loss due to obesity-related death at different age brackets

In the next phase of investigations, I have determined the year of losses, caused by overweight and obesity. If I applied the generally used DALY method, the total number of losses due to overweight and obesity is nearly 50 thousand life-years/year. This is roughly equal to the current population of a medium-size Hungarian town, e.g. Nagykanizsa. Continuing the forecast of a loss of lives, caused by overweight and obesity, short-run, a rapid increase can be expected up to 2040 (Figure 55, 56). In this period the number of lost years will be increasing by more than 50%. After this period a lesser rapid decrease will follow.

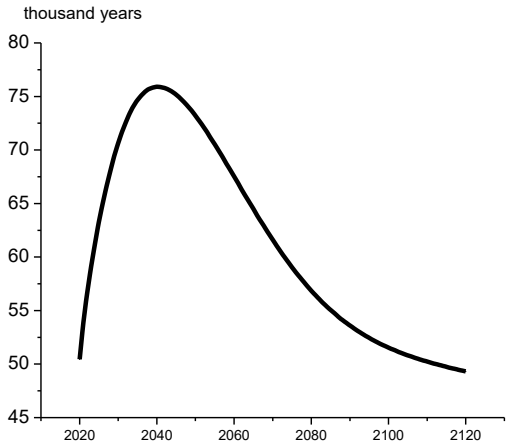


Figure 55. Loss of lives, caused by obesity and overweight in case of men

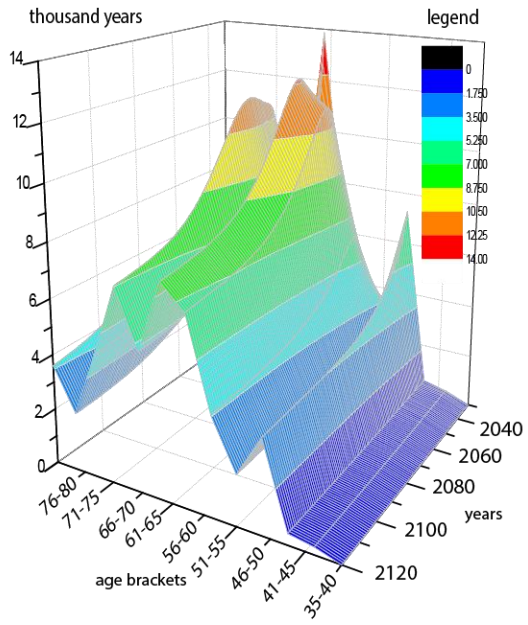


Figure 56. Estimation of life year-losses due to obesity as a function of different age brackets up to the next one hundred years in case of men

For better understanding, I have made a two–dimensional cutting along years and age-brackets of the year-losses. This graph is depicted in Figure 57.

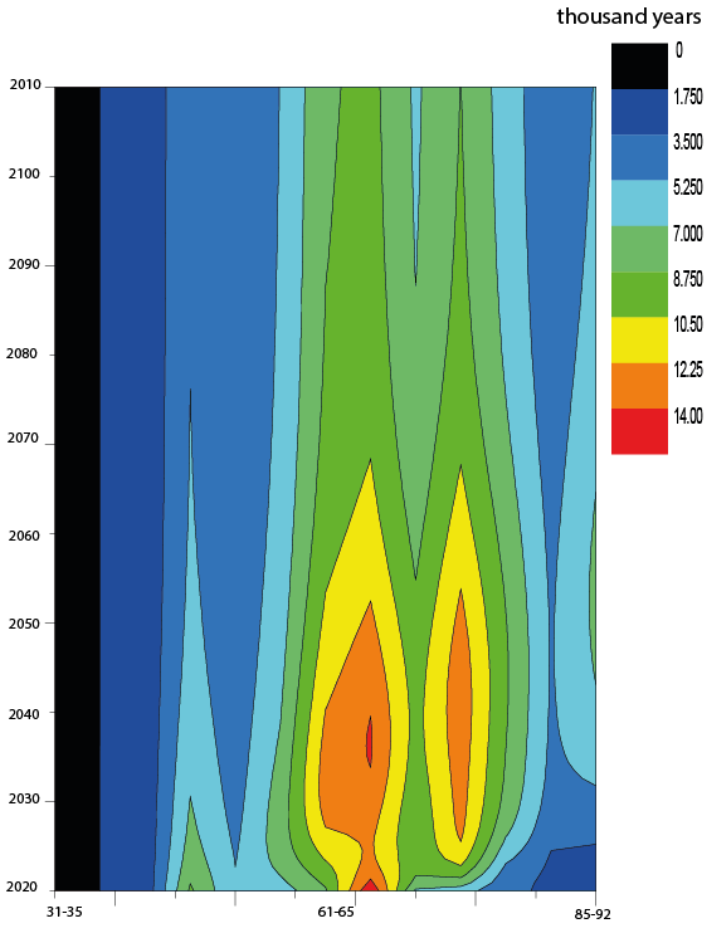


Figure 57. The years lost, depicted on a two-dimensional map as a function of forecast-horizon (y) and cohorts in the case of men

Macroeconomic burden of obesity in Hungary

Some parts of the current chapters contain material, being at the border of methodology, but to enhance the traceability and readability of the current dissertation, I consider it better to summarise these factors in one place.

The burden of obesity by Solow-Swam Model

The Total Factor Productivity is a function of numerous factors, but with a considerable simplification, it can be approximated as a variable, determined by two basic resources of production: capital and living labor. It is evident, that all diseases harm capital accumulation, size, and performance of productivity of the labour force. At the same time, the pharmaceutical costs demand resources, which could be used in other fields of the economy. From this follows, that the health interventions can exercise a positive effect on the production of value-added by increasing the number of material resources, allocated for augmented reproduction. In a summary, it can be stated, that the obesity-related co-diseases exercise a negative effect on economic development: on one hand, by decreasing the labor forces, on another hand by

demanding additional financial resources for medication. From this follows, that prevention and intervention programs could have a positive effect on economic development by decreasing losses in the labor force and increasing the material resources of production. A dynamic model of these processes is depicted in Figure 58.

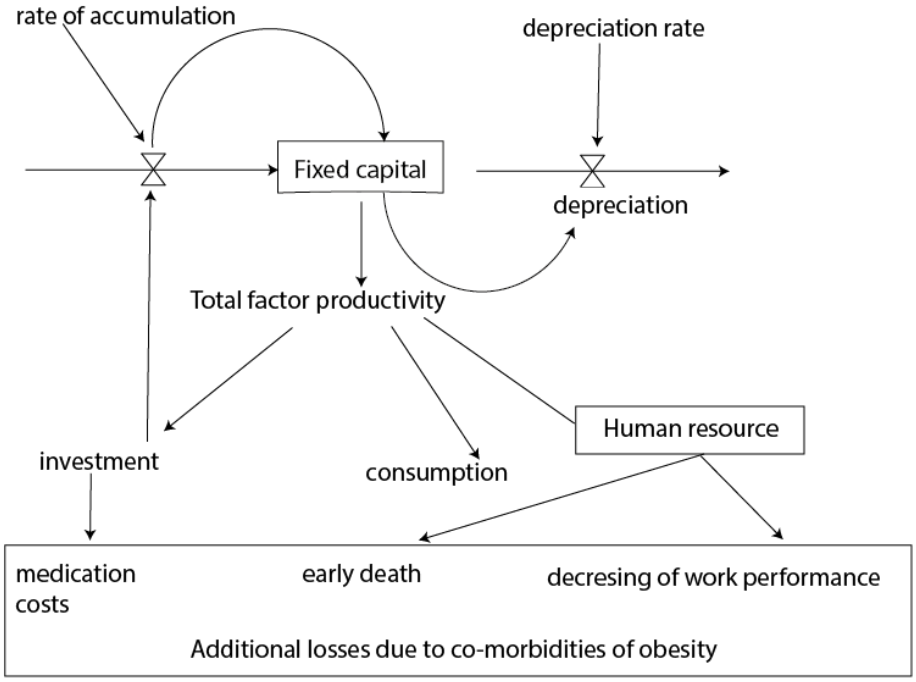


Figure 58. Application of Solow-Swan model to the obesity problem

If we want to quantify the effect of obesity-caused morbidity and mortality of living labor, we have to determine the living labor resources. This can be expressed as follows:

$$L_t = \sum_{k=20}^{k=65} p_k L_{pk}$$

where L_t is the living labor force of at t time in k_{th} age cohort, p_k symbolizes the share of k_{th} cohort in the working-age population.

We have calculated the age of 20 as the lowest threshold of entering the labor force market. The official upper level of retirement is 65 years. We have taken into consideration this age interval.

The losses, as a consequence of obesity-caused morbidity, can be calculated as

$L_{mt}=L_t-L_{tm}$

where L_{mt} indicates the losses due to premature mortality, compared to baseline scenario from point of view of living labor.

The quantity of living labor without mortality due to obesity-related diseases can be expressed as

$$L_{tm} = \sum_{k=20}^{k=65} p_k (L_{kt} + \aleph_{pt})$$

where the $\aleph_{pt}$ indicates the increase in the population due to premature obesity as a consequence of co-diseases at the *t* time period and p_{th} cohorts.

The total losses of living labor can be calculated as a sum of premature mortality and productivity losses, due to obesity-related diseases.

Another factor of productivity loss due to co-morbidities of obesity is the adverse economic consequence of years lived with diseases. The GBD database gives data on YLD values of different diseases, attributable to obesity by different age categories. These values are determined as a difference of statistical life expectancy of different cohorts and the years lived without the disease. Then the 'crude' years, lived with the disease are corrugated with weights, expressing the effect of disease on the life quality of the patient. We have supposed, that (1) the weights, applied for comparison of the severity of different diseases are applicable to express the difference in workability of workers, living with or without the given disease; (2) we have supposed, that these disability weights will be constant from the onset of the disease up to the end of life.

From these data, the working-age years lived with the disease have been calculated on the basis of equation

$$YL_t = \sum_{d=1}^{d=u} \sum_{k=1}^{k=n} YLD_{kdt} \frac{65 - \frac{T_{k\max} - T_{k\min}}{2}}{T_{de} - \frac{T_{k\max} - T_{k\min}}{2}}$$

where YL_d denotes the years, lived with *d* disease in the working-age period, YLD_{kdt} means the years, living with the disease in k_{th} cohorts in *t* year.

T_{kmax} and T_{kmin} indicate the upper and lower levels of *k* cohorts (in years), T_{de} indicates the expected life years with d disease. In the operationalization of the above equation, we have applied expert estimation for the determination of T_{dc}. Where such values had not been available, we had applied the average life expectancy of the population. For simplicity, we have supposed linear processes in disease history.

Based on considerations, outlined above, the total loss of living labor can be calculated as:

$$TLL_t = YL_t + L_t$$

The impact of capital loss can be quantified as

$$C_{it} = \varrho GDP_t - rM_{t-1} + (1-\nu)C_{it-1}$$

where C denotes the fixed capital, ρ the saving rate, M the medication costs, and v the rate of depreciation (amortization). In this way, we had been able to determine both components of the classic Cobb-Douglas production function.

The starting values of our model are summarised below:

Basic starting parameters of the model

Name of the parameter	Value
current working population (head)	6136110
Depreciation	0.04
Present year GDP (2018 international USD)	2.99639E+11
Savings rate	0.27
Aggregate fixed capital (2018 international USD)	1.02151E+12

In the first phase of investigations, we have determined the future development of Hungarian GPD, based on presuppositions, outlined in previous chapters. Results of calculations show a continuous decrease in GDP, highlighting the importance of decreasing living labor and the relatively low performance of fixed capital (Figure 59).

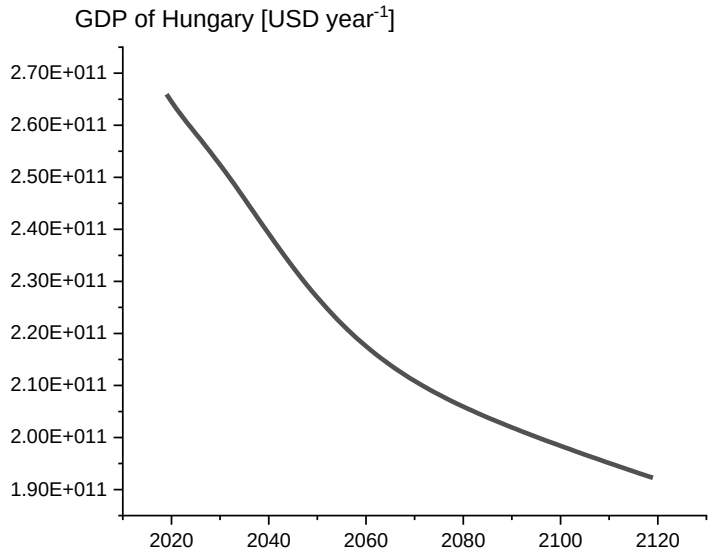


Figure 59. Forecasted values of Hungarian GDP for next one hundred years

If we determine the number of deaths in the working-age population, due to co-morbidities of obesity it can be stated, (Figure 60) that the maximal death will be ca. two thousand persons. The share of men and women will be approximately the same. From the forties of our century, the number of deaths will be decreasing, as a consequence of the general decreasing of the working-age population.

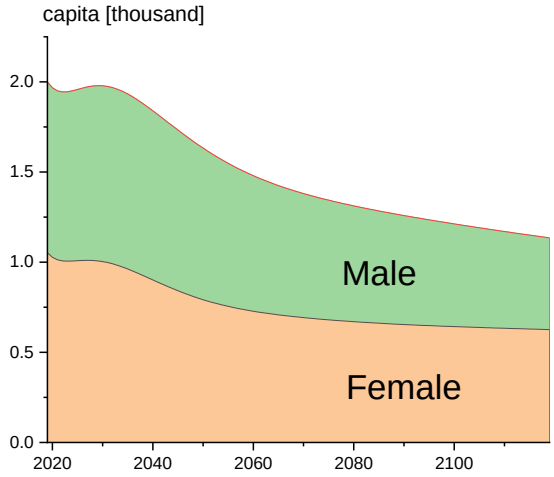


Figure 60. Number of additional deaths in case of active age population due to co-morbidities of obesity

Analysis of morbidity is a question of extremely high importance because this will decrease the productivity of living labor, and increase the cost of medication. The pharmaceutical cost of obesity will be exponentially rising by increasing the age of different cohorts (Figure 61).

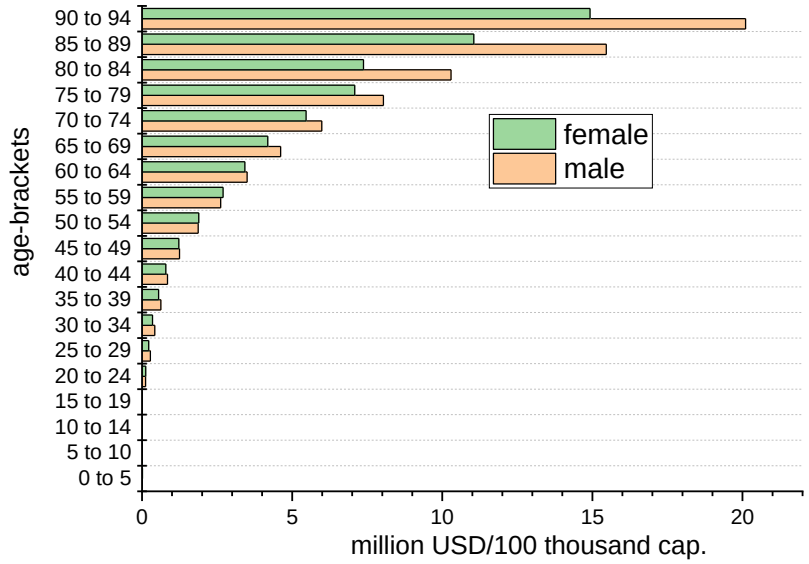


Figure 61. Estimated costs of medication of co-morbidities of obesity according to different age-brackets

This is an especially important problem because in the case of the Hungarian population an extremely rapid increase in the elder population can be expected. In the next fifty years, the number of 90+ generation people will increase from 50 thousand to a quarter of a million, the number of people in the 100+ age bracket will increase from one to nineteen thousand (Figure 62). From this follows, that the importance of obesity will be rapidly increasing.

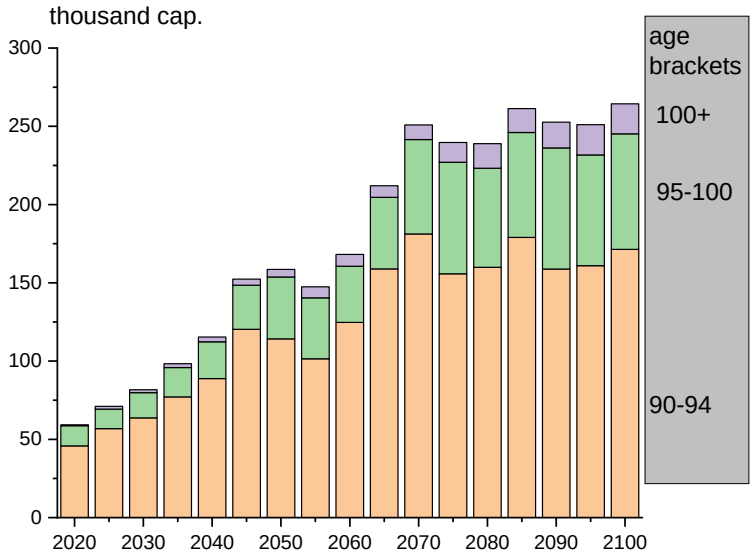


Figure 62. Expected share of 90+ generation according to UN population forecasting tables

There are not significant differences in medication costs of male and female patients in first half of life, but later the cost of medication in case of male population will be significantly higher than in case of female population. At this point we have to highlight, that currently the mortality of male population is much higher than that of female population. From this follows, that if we will be able to decrease the gap between the two genders from point of view of mortality, the elder-age extra costs of obesity related diseases will be considerably higher.

Analysing the burden of obesity from point of view of economic development potential it is important to mention, that the losses in working age population due to premature death will be relatively low. This can be explained by the low share of death of obese population compared to the total working age population, as well as by constant decreasing of population.
At the same time the productivity losses, due to co-morbidities of obesity will gain in importance. The highest increasing in absolute as well as relative terms can be expected in case of medication costs. Figure 63 shows the difference between the obesity-free situation and the baseline scenario. It is important, that the difference form point of view of value-added production of the national economy currently is by 0.25% lower, then the obesity could be eliminated. This gab will increase rapidly up to the sixties of our century. Later on, the rate of increasing of this difference will be lower, but continuous. After one hundred years the difference between the obesity-free scenario, and the scenario, calculated on base of my system-dynamics model will be 0.8 % of the GDP in each year. If we would like to determine the relative importance of different factors, contributing to the burden of obesity (decreasing of living labour due to early death and obesity-related co-morbidities at the working age population as well as medication cost) we have to calculate their relative share in this gap (Figure 64). The main component in this gap is the additional loss due to diseases. Share of this

component will decrease from 0.9 % to 0.6% after one century, but this will remain the most important factor of the gap. Parallel with increasing of share of obesity as well as the aging of population, the share of medication costs will be increasing. At this point we have to highlight, that in preparation of the model we purposefully neglected the 90+ generation, however the important of members of this age bracket will be continuously increasing.

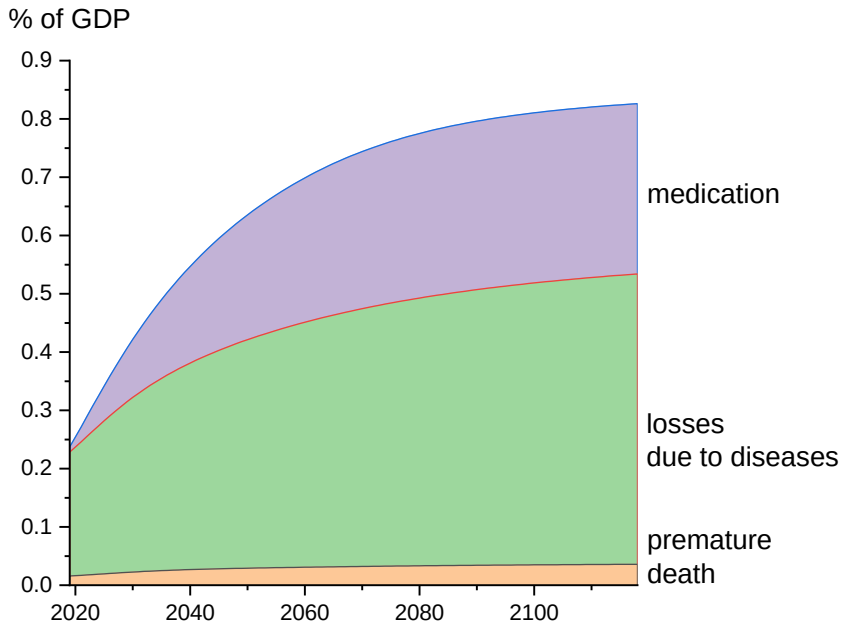


Figure 63. The burden of obesity to Hungarian economy as a % of GDP

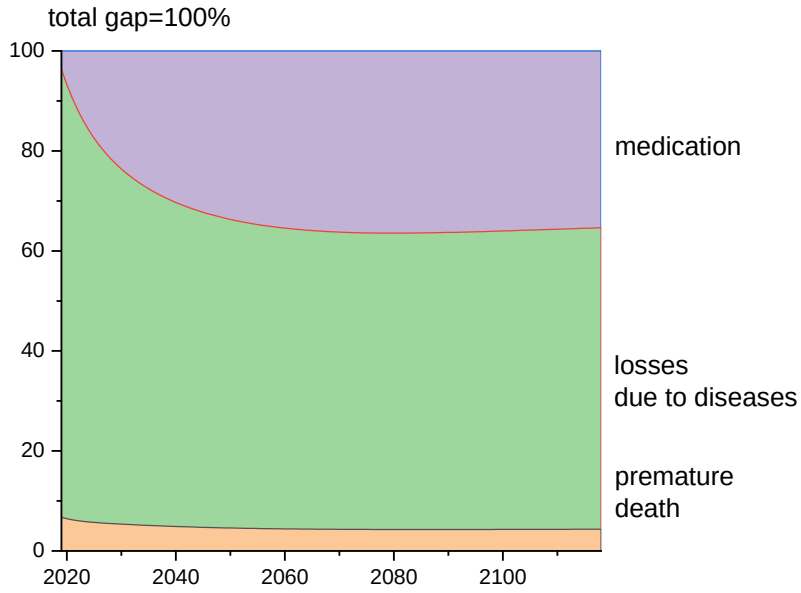


Figure 64. Components of burden of obesity to Hungarian economy as a % of total burden

4.2. Obesity in Hungarian Roma population: present and future

To estimate the burden of obesity-related diseases, it is essential to determine the current nutritional status. For this purpose, I have applied my data, which I have obtained in the framework of my research, described in detail in Chapter 3.2. If we project the data on nutritional status, obtained as a result of my survey to the totality of the Roma population, we got the number of normal, overweight, and obese individuals according to gender and age. These data are presented in Figure 65. 50.8% of men and 40,6% of women can be considered as overweight or obese in the age bracket 18-35 years, based on BMI values. In the case of the Roma population, every second man (56.4%) and every third woman (37.3%) can be categorized as overweight, nearly one-third of the man and women population is obese.

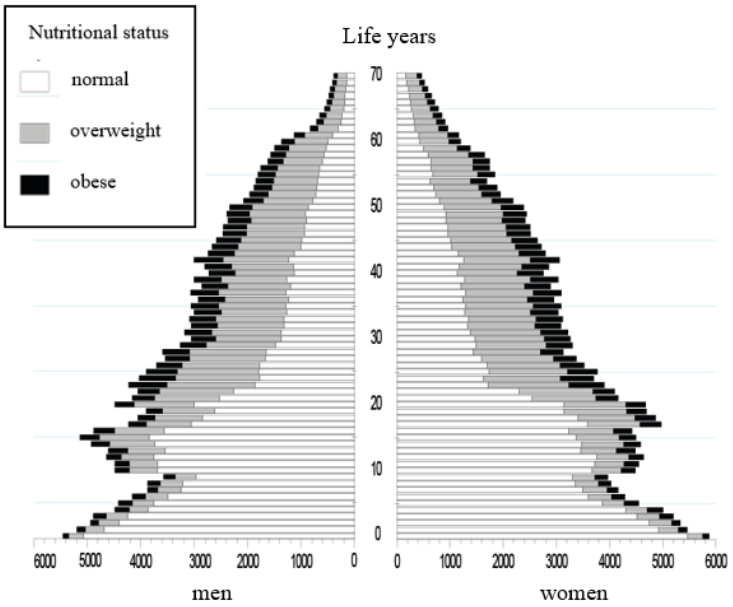


Figure 65. Nutritional status of Roma population

There is a raid decreasing number and share of overweight and obese people in the case of both genders, as the age is increasing. The expected prevalence of overweight and obesity in 2070 will be 21.000 in the case of women and 17.000 in the case of men. The prevalence of overweight or obesity was generally higher among women than among men in all age brackets. In the next half, a century the prevalence of co-morbidities of obesity will be increasing from six thousand up to 22 thousand in the case of women, in the case of men for nearly six thousand up to 16 thousand (Figure 66).

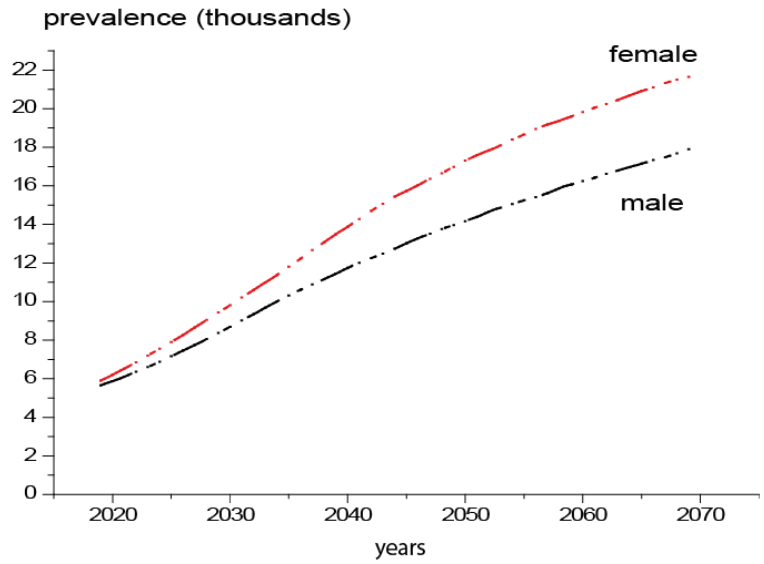


Figure 66. Expected prevalence of comorbidities of overweight and obesity in Roma population in the next 50 years

We could register the co-morbidities of obesity in more than 300 cases in 2019. Two-third of these cases are diabetes mellitus followed by ischaemic heart disease and stroke (Table 8).

Table 8. The additional disease burden, caused by obesity in the case of the Hungarian Roma population, in 2019

Disease	Men	Women	Total
Ischaemic heart disease	44	31	75
Stroke	14	11	25
Diabetes mellitus	101	94	195
Lung cancer	7	3	10
Bowel and rectal cancer	3	1	4
COPD	5	1	6
Breast cancer		4	4
Total	**174**	**145**	**319**

I have prognosticated the prevalence of obesity-related diseases to the next half-century. The prevalence of obesity-related diseases between the first five years (2019-2023) and the last five year period (2065-2069) considerable increasing can be observed (Table 9). In the next half a century, the prevalence of co-morbidities of obesity will be increasing from 6 thousand up to 26 thousand in the case of women, while in the case of men from nearly 6 thousand up to 16 thousand. Based on my prognosis it can be forecasted, that the prevalence of co-morbidities of obesity will be monotonically increasing. Within this general tendency, the prevalence of

ischemic heart disease will be six times higher in the case of obese men and three times higher in obese women. The prevalence of cerebrocardiac diseases will be three times, in the case of diabetes two times higher than currently. The frequency of other co-diseases of obesity will be at least doubled in decades to come. On the population level, the burden of diseases, caused by obesity will decrease the life expectancy by 0.2 years in the case of men and 0.66 years in the case of women.

Table 9. The ratio of prevalence of obesity-related diseases between the first five years (2019-2023) and the last five-year period (2065-2069) of the forecast period, according to gender and nutritional status

	Man			**Woman**		
	Normal	Overweight	Obese	Normal	Overweight	Obese
Ischemic heart disease	2,81	3,87	5.87	2.89	3.84	3.12
Stroke	3.25	4.10	3.53	3,19	3.55	4.05
Diabetes	2.16	2.28	2.44	1.71	2.62	3.24
Lung cancer	2.75	4.14	3.38	1.77	2.37	4.82
Cancer of the oral cavity	2.83	3.07	3.70	2.11	2.89	4.78
Oesophageal cancer	2.89	3.06	3.38	2.34	3.19	5.37
Colorectal cancer	3.13	3.36	3.89	2.81	3.62	5.48
Breast cancer				1.87	2.72	4.96
COPD	2.47	2.54	2.92	2.21	3.10	5.44

As it has been documented in previous parts of my thesis, obesity and obesity-related diseases are in the focus of international and Hungarian public attention (Waddeen és Bray, 2018, Ábrahám et al., 2017; Fekete et al., 2019, Nádasdy et al., 2019), thus, it is not enough to determine the cost and burden of obesity, but the possible effects of prevention and intervention programs must be quantified as well.

Prevalence of obesity in case of a hypothetical intervention program, focusing just on one factor

Changes in prevalence of obesity, caused by a hypothetical prevention program, focusing just on one factor of obesity – in our case, this is the prohibition of advertising of food products high in salt, sugar, and fat – are summarized in Table 10. Analyzing the results of modeling the effect of this intervention by different age groups, it can be seen, that the effect of intervention at age-brackets 4-5 years and 11-12 years can be considered as moderate, because the additional number of the population, categorized as normal from point of view of nutritional status will increase just by two percent point both in case of boys and girls. The most important change can be proven in the case of the 60+ population, here the share of obese women will be decreasing by eight percent point.

As we have seen, there are more than one hundred transition probabilities in the system. From this follows, that the testing of the effect of each probability-change on every other state seems to be an impossible experiment. That's why we have chosen five different, important age-brackets, where the changing of transition probabilities could be supposed, that these changes influence considerably the change in years gained and economic losses minimized. These models are presented in Table 10.

Table 10. Preliminary conditions in modeling the effects of relatively moderate interventions at the different age bracket

Nutritional status	**Age of intervention: childhood (5 years old)**			
	Male		Female	
	Baseline version	Post intervention	Baseline version	Post intervention
Normal	84	86	91	92
Overweight	9	8	7	6
Obese	6	5	2	2
	Age of intervention: prepuberty (10 years old)			
	Male		Female	
	Baseline version	Post intervention	Baseline version	Post intervention
Normal	84	86	90	91
Overweight	10	9	8	7
Obese	6	5	2	2
	Age of intervention: middle-aged (42 years old)			
	Male		Female	
	Baseline version	Post intervention	Baseline version	Post intervention
Normal	38	40	43	46
Overweight	44	43	38	37
Obese	18	17	19	13
	Age of intervention: elderly (63 years old)			
	Male		Female	
	Baseline version	Post intervention	Baseline version	Post intervention
Normal	36	40	40	44
Overweight	45	42	36	34
Obese	19	18	24	16

The relatively highest efficiency can be achieved by interventions in the later stage of life. In a summary, it can be stated, that obesity prevention cannot be considered as short-run campaign activity. Such programs are no more than burning of money. On the contrary: obesity-related prevention and intervention should be a long-range process. Another important lesson of

simulations is that in the case of the female population, the number of death, caused by COPD can be decreased relatively moderately, but the difference is not higher than some per mille.

The results of the analysis, based on a simple intervention have prevented, that this does not capable to achieve a measurable improvement in the health condition of the target population. The prevalence of obesity and obesity-related diseases had remained practically the same. Taking into consideration the biases of taking the sample, obtaining relevant information one can state, that the forecasted results of moderate, 'conservative' interventions remain within the error of measurement and estimation. Some effects of prevention programs in the case of children cannot be proven in the case of the male population. The same is true for the efficiency of prevention programs in youth and childhood.

Results of modeling of effects of a complex prevention program, aiming at a radical change of nutritional behavior

We have analyzed the effects of complex interventions. In this case, we have calculated the supposed effects of concentrated efforts, integrating all the material and intellectual resources for decreasing the transitional probability of overweight status into obese nutritional status in the next age bracket. Prevention programs, focusing on first childhood or prepuberty age can decrease the prevalence of obesity by 1500-2000 persons in the second half of the forecasting period. As a result of the intervention, the number of overweight persons will decrease by 0.12% in the case of boys and 0.04% in girls by 2070. In the case of middle-aged citizens, the prevalence of overweight will be decreasing by 0.31% in the case of males and by 0.22% in the case of the female population. The most efficient period of intervention is the elder age. At this age, the number of overweight people will decrease by 0.37% in the case of men and 0.42% in the case of women. Considering the number of obese persons, it can be stated, that the prevention programs, focusing on middle age and elder generations are more efficient than the preventions and interventions in early childhood or prepuberty. Prevention programs, focusing on the middle-aged population offer moderate results: the prevalence of obesity will decrease by 0.42% in the case of men and 0.35% in the case of women. Intervention programs in the early childhood age offer low results: the rate of decreasing in the case of boys will be 0.10%, at girls 0.13% (Table 11).

Table 11. Effect of complex intervention programs in different age groups in 2070

Nutritional status	**Intervention in different age groups**	
	Childhood (5 years old)	
	Men (%)	Women (%)
Normal	+0.15	+0.12
Overweight	+0.12	+0.04
Obese	-0.10	-0.13
	Prepuberty (11 years old)	
	Men (%)	Women (%)

Normal	+0.32	+0.73
Overweight	+0.07	+0.05
Obese	-0.31	-0.37
	Middle-aged (42 years old)	
	Men (%)	Women (%)
Normal	+0.41	+0.543
Overweight	-0.31	-0.22
Obese	-0.42	-0.35
	Elderly (63 years old)	
	Men (%)	Women (%)
Normal	+0.661	+0.503
Overweight	-0.37	-0.42
Obese	-0.42	-0.27

There are considerable differences from point of view of decreasing the number of population in overweight and obese nutritional status (Figure 67 and 68). The intervention programs in the first childhood and puberty period offer a decrease by one thousand and five hundred-two thousand in the second half of the period under investigation. If the prevention/intervention program focuses on the population in the middle age or the elderly, the number in this nutritional status will increase.

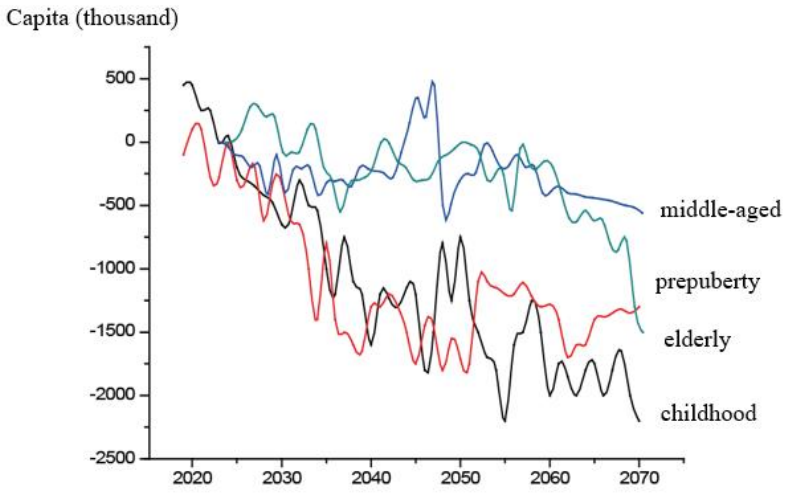


Figure 67. Development of overweight nutritional status in different age groups, compared to the baseline model

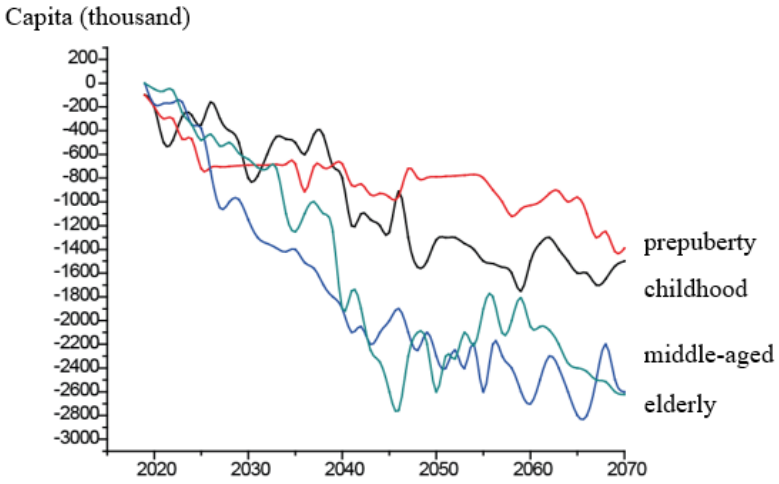


Figure 68. Development of obese nutritional status in different age groups, compared to the baseline model

The prevalence of obesity and the comorbidities of obesity will increase considerably in the Roma population, parallel with the augmentation of the frequency of obesity. Our results have proven, that obesity is and will be an extremely important problem for the Roma population because the multiply disadvantaged groups are especially prone to this epidemiologic phenomenon. This is true for the Hungarian Roma population, even if the Hungarian population can be considered as rather obese in comparison with other member states of the European Union. This statement is supported by our result, which highlighted, that the prevalence of obesity in the Roma population is by 3-7% higher, than in the case of the general population. This fact underlines, that the rate of obesity in the Roma population is a considerable burden for the social security system, the importance of which will be rapidly increasing in the next decades. Obesity causes ca. 80% of prevalence of type-2 diabetes mellitus, 55% of hypertonia, and 35% of ischaemic heart disease (Weiss, Japie, Balahura, Bartos, & Badila, 2018). Llanaj et al (2020) conducted the first quantified dietary data collection and completed comprehensive anthropometric measurements among the Hungarian Roma (HR) population. According to their result, the Roma population has a higher average body mass index (BMI, 27.7 kg/m^2), compared to Hungarian general adults. These data are supported by our results. However it is hard to compare our results with similar studies in Hungary or abroad because of the heterogeneity in methodological approaches in studies, but it is obvious, that the obesity problem in the case of the Roma population will mean a long-range challenge for Hungarian social security and health care system.

Not even when the most efficient proceedings of the scientific literature are applied do prevention-intervention programs of moderate intensity offer a perceptible result about the incidence and prevalence of diseases linked to obesity. In the case of application of these programs not more than a ten-person order of magnitude, a decrease can be achieved. This is not enough to prove statistical detectability on the level of the population. Whereas, complex intervention programs, based on a comprehensive transformation of lifestyle and food

consumption patterns can present perceptible outcomes primarily among the middle-aged and the elderly. The survey results in direct attention to the fact that reducing the burden of obesity in the Roma population caused by obesity is only to be achieved as a complex, all-councils act that requires resources much greater than what is available now.

4.3. Uphill fight: the reform of Hungarian school catering system

The individual comprehensive interviews offered a favorable opportunity for understanding the views of different expert actors and their key goals. It was very interesting to see the convergence in the opinions of the respondents concerning the estimation of the goal structures of different actors.

Governments

All respondents agreed that the role of government was essential in the SCS and that neither the e it is much less spectacular (i.e. it offers much less possibility to increase the number of votes) than the delivery of a new sports complex or Christmas gift for older voters. This phenomenon can serve as an explanation of the fact that up to 2010 no significant efforts were made to change the rather negative trends of obesity among children and adolescents.

At the same time, the efforts of the government to change the traditional SCS in Hungary were weakened by the differences of approaches of various ministries and public administration institutions. The attention of governmental organs was divided among different goals and dispersed projects aiming at changing the SCS in Hungary. A possible explanation for this is the scattered structure of the Hungarian public administration and governmental system: the SCS – as a catering service – is supervised by the state secretariat of Health Care at the Ministry of Human Capacities, while as a service operated in schools it is subordinated to the state secretariat of Public Education of the same ministry, while as a part of the food chain it is controlled by the Ministry of Agriculture. Under these conditions, a wide range of actions was taken by different actors and lobbies. In the opinion of our interview partners, the SCS is regarded as an important market for local products by the Hungarian Ministry of Agriculture. It's not a coincidence that the ministry intensively supported the Canteen-Pattern (in Hungarian: Minta Menza®) project, which aims to sell local products in the SCS, often involving specific ingredients (e.g. game-meat, local–grown mushrooms, quail eggs). The project mainly focused on increasing the diversity of dishes and marketing (Varga et al, 2018). Children were considered in this framework as consumers, and not as real partners in development. Another state-supported program was the Canteen Reform (in Hungarian: Mensareform®) project developed by some Hungarian celebrity chefs. The goal of this project was the diversification of dish portfolios in the SCS, streamlining the traditional dishes by the introduction of such dish names as 'bang-bang crazy chicken' as well upgrading the knowledge of local chefs by a sophisticated qualification system. Both of these programs lost their impetus in the absence of government support.

The question arises of what the reason was for launching different programs in parallel. In the opinion of our interview partners, the reason is not just the activity of different lobbies and governmental organs: each public servant tries to highlight his/her importance with the management of one or more programs. For that reason, numerous small-scale projects were

initiated, often without any real chance of accomplishment (e.g. ‘Start with breakfast!’, or ‘Happy week’ to increase tap water consumption).

Under these conditions, the initiative of the Healthcare secretariat was not able to mobilize the agricultural lobby, nor the catering system providers.

Local authorities

Local authorities have played an important role in the development of the SCS because the operative running of schools is their responsibility. All of the respondents agreed that (1) the decisions, taken by local authorities concerning the SCS are considerably influenced by policy, namely by the central government and local lobbies, (2) local authorities have a relatively high level of influence on business enterprises because they can allocate additional financial resources to increase the per-capita financial subsidy for school catering by agreements with SCS firms, (3) the SCM plays an important role in the welfare system as under these conditions the relative availability of food and school services can be considered a political question par excellence.

The catering service providers

There is an increasing number of municipalities that buy the catering service for schools from specific enterprises, which run the kitchen at schools or run the finishing kitchens, where they heat and serve the meals prepared in the central kitchens of the enterprises. The catering service provision has been considered a flourishing business. One anonymous source with a considerable level of experience in the private detective sphere has informed us, in the framework of another research, the different catering sector providers are his regular business partners because his firm is asked to uncover hidden microphones and voice transmitters in the offices and cars of the decision-makers of these enterprises. The purpose of spying activity has been to get information on the price offer of the entrepreneur before a public procuration bid.

Catering service managers

The catering service managers are the bosses of kitchens or finishing kitchens. In general, their work consists of the procuration of raw materials, food preparation, and management of the serving process. All respondents agreed that local managers are extremely important in the SCS but their scope of the decision is rather limited due to budget limits and the difficult systems of regulations. A surprising phenomenon has occurred, namely the Burn-out of the catering managers.

A catering manager said: ‘*I am sick and tired of from early morning to late night each day the sniveling spoiled children. They encourage each other to refuse to eat our food, and they complain about the bad meals we prepare*.’

The catering managers are frontline soldiers of the system; however, they felt abandoned. They complained in the following way: ‘*From these limited material resources (i.e. a lack of money) we are not able to buy the raw materials for the kind of food which could satisfy the requirements of Decree… I do not know enough recipes to prepare a diverse menu to satisfy the requirements – we did not receive any help to do this.*’

The parents

Our interviews highlighted that in numerous cases parents do not have enough time to cook, and often even go to fast-food restaurants. This phenomenon decreases families' influence on the healthy nutrition of children and adolescents. All of the respondents agreed that due to the considerable differences within the socio-economic structure in Hungary, it is hard to speak about parents as a homogenous group, because (1) there are parents who simply do not have energy/time to care about the food consumption of their children. There are those (2) who worry about the low quality/quantity of food served to their children in school canteens, which is why they pack them sandwiches or give them money to buy additional food, while (3) in the case of poor families the school canteen plays an important role in relieving families (and their budgets) from the burden of daily food provision. One school canteen manager said: "The most important days for us are Mondays and Fridays: on Monday we have to prepare energy-rich food because the children want nutrient-rich food after the unsatisfactory food consumption on the weekend, and on Friday we have to 'fill-up the children with copious food'.

The children

Our interviews highlighted that the current world of the SCS is quite distant from the demands of children. There is old, adolescent-sized furniture and sometimes rude and un-motivated kitchen staff (mainly older, often burned-out female employees), who acquired their experiences in years of relative food shortage and are not able to communicate appropriately with children. Catering reform will only be successful if pupils like and choose to eat these meals, but this aspect has been neglected in Hungary. The majority of specialists agreed that time has passed the old-style catering infrastructure by, and it has not been renovated for decades. This contrasts noticeably with the vivid colors and modern interiors of the majority of fast-food restaurants which target the younger generation. Under these conditions, there is just a relatively low chance of attracting young consumers, who often consider traditional food as old-style. We have not included children in our evaluation/interview, because we have been focussing on the socio-economic arena of SCS, and the primary aim of our investigation has not been the determination of optimal (qualitative and quantitative) parameters of school meals.

Teachers

Our interview partners agreed that, theoretically, teachers play a very important role in the formation of the eating behaviors and eating habits of children. The teachers eat mainly the same food as the children if they are eating in the same canteen.

Under these conditions, there is an increasing tendency towards overburdened, burnt-out teachers. As one teacher formulated it: '*I have a lot of problems in school and in my private life, I am simply too tired to deal with such problems as the nutrition of the children*'. As another teacher formulated it: '*I am fed up with the fact that society tries to push all its problems onto the schools and teachers. I do not feel it to be my responsibility to care about what children eat under such conditions when I have to teach them the most elementary rules of social behavior, just because their parents are playing with their smartphones or lingering on social websites.*'

Analysis of actors' positions and strategies using the MACTOR method

By using the results of extensive interviews we determined the set of key actors, and the set of strategic goals, which were determined for one or more actors.

The matrix of the direct influences of actors is shown in Table 12. The goals in the table have been derived from preliminary interviews. This is a rectangular matrix. The main diagonal of the matrix (the influence of a given actor on itself) is by definition zero. The actor considered as the influencer is placed in the row, and the influenced party is situated in the column. The values in the cells of the matrix are the simple averages of responses obtained as a result of the discussion, rounded to the nearest integer values. To be on the safe side we have calculated the averages by a group of actors (e.g. teachers, parents, catering managers, etc.) but we have not been able to prove significant differences between the two methods. The in-depth analysis of standard deviations according to interviewees could go beyond the limits of the current research.

Table 12. The matrix of direct influences on actors measured on a 0-4 scale (0 – no direct influence, 4 – very strong influence)

	GOV	MUNICIP	PARENTS	CHILDREN	MANAGERS	BUSINESS	TEACHERS
Government (GOV)	0	3	1	0	1	4	2
Local authorities (MUNICIP)	1	0	1	0	1	4	0
Parents	1	3	0	3	0	0	2
Children	0	0	2	0	0	0	1
Catering service managers (MANAGERS)	0	0	0	2	0	0	1
Catering service providers (BUSINESS)	1	1	0	0	3	0	0
Teachers	1	2	2	3	1	1	0

Some remarks about the results of the matrix of direct influences based on in-depth interviews are indicated as follows:

- The matrix highlights the considerable influence of the government on the behavior of catering service providers and the SCS in general because the government has a considerable influence on the monetary resources for school catering.

- Local authorities can exercise an important influence on catering service providers because they can select the SCS provider for different schools in the framework of the public procurement procedure.
- In the opinion of interview partners, a positive tendency has occurred over the last years – the increasing influence of parents' organizations on the life of schools. At the same time, due to the lack of democratic roots and traditions, it is quite difficult to achieve a situation in which parents' influence is based on an absolute majority of the parents and not just on a small group with active and noisy members.

The interest relation of the different actors is summarized in Table 13. This is not a rectangular matrix. The actors are placed in rows and the different goals are located in columns. The values in the cells of the matrix are the simple averages of responses obtained as a result of the discussion. The actors' interest relations were measured on a -4…+4 scale.

Table 13. Interpretation: -4 the objective is against the vital interest/jeopardizes the existence of the actor, +4 the objective is a vital interest of the actor

	good taste of the meal (TASTE)	the healthiness of the food (HEALTH)	Healthy children (HEALTHYCHI)	Vote maximisation (VOTE)	the feeling of being sated (SATED)	minimization of expenditure on health promotion (CPOSTMIN)	the simplicity of food preparation (SIMPLE)
GOV	1	3	4	4	3	3	0
MUNIICIP	2	1	4	4	3	4	0
PARENT	4	3	4	0	2	3	0
CHILD	4	1	4	0	2	0	0
CATERING	3	0	0	0	2	4	4
BUSINESS	3	0	0	0	2	2	4
TEACHERS	3	1	3	0	3	1	0

The health of children is a generally accepted goal for all participants, but this goal is relatively more distant in time, which means it is difficult to translate into operative actions. Local authorities are in direct connection with the population so the taste of food is especially important for them. The children's acceptance of food is important for the parents, too, because in this way they can reduce their household expenditure on feeding their children. A well-fed child can be managed easily so the taste and acceptance of food are important for teachers, as well. It should be highlighted that the goal of minimization of expenditure on health promotion is quite an important question for the majority of actors.

We have found that school feeding was important for parents. It can be assessed as a positive point, that – at least on the verbal level – the healthiness of school feeding was evaluated as a question of great importance. This can be considered as a favorable tendency. The bargaining

position of different actors has been depicted on a two-dimensional coordinate system. On one ordinate of the system, we have indicated the level of influence of the given actor. This value has been calculated based on Table 12 by the summation and normalization of direct influences for each given actor in relation to another actor. The dependence of actors has been calculated similarly.

Analyzing the map of influences and dependences between actors (Figure 69) it is obvious that the government has a relatively favorable bargaining position because it has a relatively high level of influence and a low level of dependence. The direct socio-economic environment of children's food consumption is the following: the triangle of teachers, local authorities and parents have roughly the same position, namely a relatively high level of influence and a low level of dependence. The owners of the SCS firms have approximately the same level of dependence as the former three actors, with a much lower influence. The two key actors of the SCS system, the children and the catering service managers, have an extremely low level of influence, which – especially in the case of the children – is accompanied by high dependence. In other words, the two critical actors of the systems, namely the actual service providers and the children have the least possibility to influence the operation of the system.

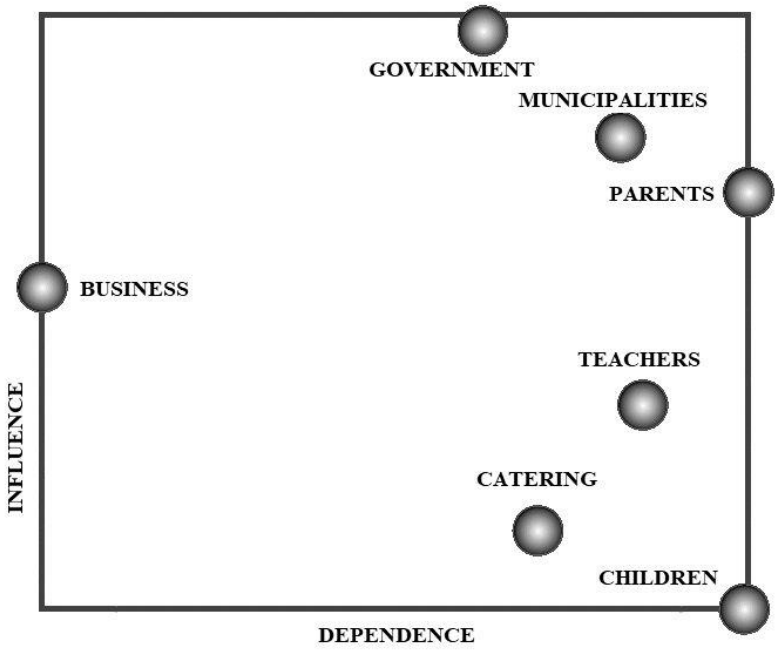


Figure 69. The influence-dependence relations of actors

The analysis of the influence dependence matrix offers information on estimated power relationships between actors and also on the way of thinking of respondents. It can be considered as a rather negative tendency that interviewees evaluated the catering system as a set of different, relatively separated actors instead of a coherent system with numerous relations. This fact is expressed in a high number of zeroes indicating no influence.

The indicator ‘mobilizing force’ of different goals has been calculated based on the acceptance of differing goals weighted by bargaining power (influence) on actors. Analyzing the mobilizing force of the different interests, good taste and children’s health have the highest value (Table 14). Notwithstanding, it is important to stress that the mobilizing force of the cost minimization of health expenditure promotion and simplicity is much higher than the healthiness of food criteria.

Table 14. The mobilizing force of different goals

Goal	Mobilizing force
good taste of the meal	12.8
healthy food	17.1
healthy children	17.8
vote maximization	8.6
the feeling of being sated	10.2
minimization of expenditure on health promotion	17.4
the simplicity of food preparation	2.4

The results of this survey highlight that government support has been rather weak so far because the majority of parents accept the importance of healthy eating, but they avoid conflicts with their children. The overburdened teachers have done little to change the eating habits of the students. The caterers and the catering service managers support the best solution for themselves. At the same time, the direct influence of catering managers is relatively low; however, their behavior and attitude are of great interest in any reform. It is a contradiction that they have not been prepared to make use of these reforms. Neither the government nor the local municipalities have been determined enough to mobilize additional financial and intellectual sources to change the situation and consequently follow the policy. In general, it can be stated that the MACTOR method has been an efficient tool to uncover the direct and indirect force relations and motivations of different actors.

Our results are consistent with conclusions drawn by other actors. For example, in the opinion of Gaál, Szigeti, Csere, Gaskins, & Panteli (2011), the central government of Hungary has almost exclusive power to formulate and realize strategic decisions and shape the regulatory framework of the health care system, as well as make public-health-related interventions. The majority of schools (except for schools owned by foundations and churches) are in state ownership.

Due to a wide agreement on the long-term instability of the Hungarian healthcare system (Docteur & Oxley, 2003; Boncz, Nagy, Sebestyén, & Kőrösi, 2014), preventive measures should be given priority.

It is a contradiction that while all Hungarian governmental programs have highlighted the importance of prevention in the healthcare system, obesity among the young population groups has been increasing in the last few decades (Tóth, Molnár, & Suskovics, 2014). It should be

highlighted that neither schools, teachers, nor parents can be considered homogenous groups (van Zanten, 2009). There are significant differences in parents' attitudes and behavior in relation to the school catering system. The results of van Zanten (2003) and Raveaud and van Zanten (2007) highlight that upper- or middle-class parents have a much higher level of aspiration to participate in the decision-making process in the framework of the school than working-class parents, who are more 'loyal' to local schools. The importance of school feeding for parents was a surprising result. It can be regarded as positive that the healthiness of school feeding has been evaluated as a question of great interest. This can be considered a favorable tendency.

4.4. New scientific results

1. I have proven, that – based on system dynamics modeling – it is possible to construct a more transparent, traceable, simpler, more robust, and reliable risk analysis system than the current methods, based on Markov chains and micro simulations. Hence the hypothesis H1 is accepted.

2. I have been the first to quantify the long-range burned of obesity in Hungary, based on a complex system dynamic and econometric model. My results have proven, that the burden of obesity will be increasing rather rapidly in the next decades. Parallel with the aging of society, obesity in elder age will be an increasing problem. Obesity, as a socio-economic problem decreases the economic development by 0.2 % currently, and this will increase to 0.7 % at the beginning of next century. Hence the hypothesis H2 is accepted.

3. I have carried out an in-depth analysis to uncover the current and future situation in the case of the Roma minority in Hungary. Combining the methods of modern demographic prognostics, my anthropometric measures, and health impact assessment modeling methods I have proven, that the Roma population, as multiple disadvantageous groups, belonging to the most vulnerable ethnic minority in Europe is extremely prone to obesity problem as well as co-morbidity of obesity. Currently, nearly 20% of the Roma population can be characterized as obese. The co-morbidities of obesity will be increasing from 6 thousand to 26 thousand, in the case of a man from 6 to 17 thousand. These diseases will decrease the life expectancy of men by 0.2 years, by women by 0.66 years. My calculations highlight, that the short-range interventions, focussing just one factor of obesity won't be able to decrease the obesity problem in a significant way. On the contrary, the targeted projects, focussing on different factors of obesity, and concentration the middle-aged and elder generations will be able to significantly decrease the burden of obesity. A complex obesity prevention program can offer a 0.42 % reduction of obesity in the case of men and a 0.35% decrease in the case of women. Hence the hypothesis H3 is accepted.

4. I have carried over an in-depth analysis of attempts, aiming at the improvement of the public catering system. My results have proven the importance of a complex, holistic approach, and application of system theory. Analyzing the bargaining position of different actors my results highlight the importance of children, because they play a central role, and are capable to influence their parents and the pedagogic staff. From this follows, that there is a need to mobilize considerable resources to better understand the food consumption behavior of children. The school should better integrate the parents as well as their organizations into the school food policy and catering system. This could contribute to the better acceptance of reform steps with the vision of education of new generations of consumers. Hence the hypothesis H4 is accepted.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Obesity in Hungarian adults

Based on system dynamic analysis it can prove, that the importance of obesity will be increasing. This is valid for the different age brackets as well as for the population in general. The culmination of this process will be in the middle of our century's absolute numbers. As I have proven, the average age of the population will be rapidly increasing and the total population will decrease considerably. By on econometric models, it can be proven, that obesity will cause considerable economic losses, due to decreasing working-age population as a consequence of premature death and losses by co-morbidities of overweight and obesity. On another hand, the medication of the obese population will demand further material resources, which could be used for increasing the material base of augmented reproduction. As I had proven, the gap between obesity–free development trajectory and the current development path (baseline scenario) will be continuously increasing. Currently, this difference is ca. 0.2%, but this value will increase up to 0.6% at the beginning of the middle of the century. This will be circa 10% of the current share of health-related costs within the Hungarian GDP. Demonstrating the effect of obesity burden by another example: the GDP in Hungary according to the official data of World Bank in 2019 has been 160.97 milliard USD. This means a 1.975 % increasing, compared to the value of the year 2018. Without the burden of obesity and additional, 1.995% increasing could have been achieved. This 0.2% increase means 0.31579 milliard USD increasing. This difference equals 94.7281 milliards HUF. This value is one and a half times more than the total sum of state support to sport; and reconstruction and development of sport-related facilities of the Hungarian state budget for 2019. Expressing in another way: This could cover nearly two times the total budget of the Hungarian Academy of Sciences (at that time this system included the research institutes of the Academy, too.). It is rather hard to overestimate the importance of obesity, as a considerable hindrance factor of economic development.

As a summary of this analysis, it can be stated, that obesity should be considered as a factor of the considerable importance of the performance of the national economy. The effect of decreasing health treatment costs is much more important than the change in the workforce. At the same time, it should be taken into consideration, that the analysis has been focusing just on the working-age population. This is a rather over-simplification, because (1) the upper age-limit of working age will be increasing in next decades, due to imbalances between different generations, (2) the elder generations play an active role in running of households and creating such an environment, which supports the active age population in the achievement of considerable work performance. That’s why the elimination of elder generations from point of GDP generation can be considered a rather dangerous phenomenon.

It is an important question; how realistic our prediction is. Practically: is there a reality of a relatively stable, positive economic development for Hungary? Is the hypothesis on continuous economic development well-founded or not? To respond to this question I have collected the economic prognoses of some research centers and think thanks concerning Hungary and Euro

zone, first of all, Germany and Poland, which are key partners and indicators of development from point of view of Hungary. There seem to be good possibilities of development, that's why the macro-economic environment cannot be considered as a hindrance factor. I have limited my work to the pre-Covid-19 period. This pandemic causes a considerable drop in economic performance, that's why factors, contributing the economic development will gain importance in a short-and medium-term perspective.

In a summary, it can be concluded, that the importance of obesity-related prevention and intervention programs will be gaining in importance. Methods, intensity, and focal groups of these prevention and intervention programs should be determined on careful analysis of international and Hungarian experiences and in-depth mathematical optimization. These calculations are beyond the scope of the current research but it is obvious, that obesity will be an important hindrance factor of economic development. In light of these results the question of debates on obesity prevention and intervention should not be the 'if', but the 'who' and 'when'.

5.2. Obesity in the Hungarian Roma population

There will be an increasing burden both on the micro- and macro-level among the Roma population due to obesity. Based on BMI, 56.4% of Roma men and 37.2% of Roma women are overweight, and nearly 20% of Roma men and women are obese. In the next half, a century the prevalence of co-morbidities of obesity will be increasing from 6 thousand up to 22 thousand in the case of women, in case of men for nearly 6 thousand up to 16 thousand. From this follows, the obesity prevention and intervention programs, based on in-depth analysis of the actual, complex situation will gain in importance. Working out and running such programs demand an extremely high level of commitment and persistence from decision-makers. The allocation of material resources to such type of program will generate considerable political discussions. We have to take into consideration, that this is an extremely sensitive question, that's why the political will be is essential. All of these factors highlight the importance of scientifically well-founded preparation, and the complex optimization of ways and means, because these projects offer results only in the long run, that's why the targeting and the continuous controlling of efficiency are necessary preconditions of success.

Effect of obesity intervention and prevention program

My results, presented in the above paragraphs have proven, that obesity prevention programs, focusing on just one aspect of obesity won't be able to offer long-range success, which could be quantified on the macroeconomic level. As I have demonstrated, if we focus just on one factor (e.g. restricting TV, radio and newspaper advertise of foods high in sugar, salt-, or fat) there is no possibility to achieve significant results, which could be considered as an important disburden of the social security system. However, this approach is widely analyzed in international literature and considered as a 'best practice' we can't accept it as an efficient way of decreasing the rate of obesity in general and in the case of the Hungarian Roma population in particular. The results of my calculations, which are presented in Table 10 and Table 11 are

similar to the results, demonstrated in the literature. These sources are not able to demonstrate better results. In the optimal case, the prevalence of obesity can be decreased by two percent point, in the nutritional status of a given cohort. This fact highlights the problems of the application of this intervention approach. Relatively the most favorable results could be achieved in the case of middle-aged and elder populations, but even at these cohorts the differences hardly achieve the level of statistical detectability. These results are in line with the results of Lhachimi et al (2013). Decreasing obesity could be an important step in decreasing the considerable differences in health status among different segments of Hungarian society (Schwarte et al, 2014) because the odds of obesity is six times higher in case of people in lower socio-economic status than in case of the upper classes of the society. Results of Sándor et al (2017) highlight, that the socio-economic as the ethnic status (Roma vs. non-Roma) are important predictors of frequency of use of prevention services. These results induce the question: which level of investment can be considered as the minimum necessary level to achieve measurable results? The answer to this question is especially difficult because even the cutting-edge international literature shows a high level of divergence. That's why we have to determine, that the improvement of the nutritional status of the Roma population is a highly complex question, which could not be solved just by focusing on one or another aspect of the problem. From this follows, that the prevention programs must be built on a complex, system-based approach.

In the opinion of Economos (2001) there are nine necessary preconditions to be satisfied, to achieve changes in health behavior:

1. recognition of the crisis situation
2. scientific evidence and data for crisis-handling
3. awareness of economic consequences of the crisis and the positive aspects of crisis handling
4. charismatic leaders
5. coalition of stakeholders
6. support of government
7. support from the side of media
8. changing of the socio-economic environment
9. comprehensive strategic plan, taking into consideration all of the above factors.

The complex action plan, aiming at a radical improvement of the nutritional status of the Roma population, should consist of elements as follows:

1. Obtaining a holistic and at the same time detailed picture of food consumption patterns and nutrition of the Roma population, including the motivational factors behind the actual health behavior. Currently, we do not have such pieces of information, however, in lack of these, there seems to be no possibility to formulate an adequate strategy. For methodically well-founded data collection, processing, and evaluation we need to apply an integrated approach, widely applying the latest results of cultural as well as medical anthropology, sociology, and postmodern research methodologies.

2. Identification of the potential stakeholders. It is very important to understand, that the health of the Roma population is a highly complex issue, that's why it is extremely important to forge a coalition of all potential partners, from schools to churches, to sports clubs, municipalities as well as Roma and non-Roma civil organizations.
3. Reformation of lifestyle (first of all: modification of financial behavior), health literacy, and health-related behavior necessitates targeted education programs under continuous quality control, monitoring, and development.
4. The firm political will of the Hungarian political elite, overarching different governments, and election cycles.

5.3. The reform of the Hungarian school catering system

The results of investigations have demonstrated clearly that children are key players in the Hungarian SCS but have little influence on the system. In Hungary, there does not exist any mechanism to survey the opinion and test the preference system of children. The most reliable indicators are the cleaners, who can furnish some information on the quantity of food and the amount leftover. There are neither experiences nor resources or mechanisms to uncover the drivers behind children's behavior (DeCosta, Møller, Frøst, & Olsen, 2017). The average uptake level is low, varying from 40% to 95%; the highest take-up rate in Europe is in Finland (over 90%), probably because school lunch plays a central role in education (Harper, Wood, & Mitchell, 2008).
Based on our analyses, the failure of the new regulation of the SCS was predictable because children have not accepted dishes with low salt content and milk with low-fat content. The uptake level of the reform was extremely low as children were not involved in the new and rapidly introduced changes. The reluctance of children induced a chain reaction: neither the parents nor the teachers were motivated, nor did they have any background knowledge to argue for the positive aspects of the reform. The catering service providers and the local managers experienced a high level of food waste. These negative views were reinforced by the media, which over-emphasized the negative aspects of the new regulations. Under these conditions, it was relatively easy to forge a coalition between parents, catering service providers and managers, teachers, and local authorities to choose the easier option: i.e., to force the government to substantially modify the original legislation. The fate of this regulation, based on sound professional arguments, lends itself to an analysis of the failures leading to the collapse of the regulation. The most important failures can be summarized as follows:

1. There was no general, well-designed study and testing of the effects of the regulation in the framework of a pilot study.
2. There was no multilateral communication between the government and the stakeholders, mainly with catering service providers and catering managers.
3. The teachers did not have the necessary background to discuss the issue with children due to their total illiteracy in the field of nutrition.
4. Children do not have to learn practically any nutrition or food skills during their studies in primary and secondary school, so they could not understand the reason for the changes.

5. The energy and resources of different governmental organs were scattered among different, partially competing, goals.

The school lunch provides an excellent opportunity to learn healthy eating habits, promote nutrient-rich foods, involve children in foodservice planning, and improve the nutritional intake of school children. There is an urgent need to improve the situation, taking into account the WHO tool for the development of school nutrition programs in the European Region (WHO, 2006). The policy paper emphasizes that healthy food and nutrition should be given a high priority on every school agenda and school meals are an indispensable part of a whole-school approach to health promotion.

As a conclusion of this study, it can be determined that the position and the system of interests of different actors must be taken into consideration before setting up SCS-related regulations. Children play a central role because they will be able to indirectly influence parents and teachers. From this, it follows that considerable resources should be mobilized to understand the driving forces of children's behavior and their taste. On the other hand, from a retrospective perspective, it is obvious that the government wanted to improve the SCS 'by force', following top-down logic, with minimal mobilization of material and human resources on education and widening the possibilities of raw material procuration.

Cooperation among all the different stakeholders is crucial when working out a school food and nutrition policy. Moreover, one can even state that cooperation between different players, including coopetition, is a fundamental issue in today's world.

Representatives of teachers, parents, pupils, caterers and representatives from a school's governing body should develop an action plan and introduce a comprehensive education program. The study of the policy itself can be an educational tool. Teaching about food and nutrition policies in schools would make students active participants throughout the policy process (McKenna, 2016). The SCS should be better integrated into the general education program. For example, the participation of children in food preparation and servicing could promote family-life education and a more harmonious division of work between the genders, too. To establish a successful and effective strategy, continuous dialogue is needed between parents, health promotion experts, teachers, and their organizations. It should be emphasized that there is no universal solution: the specific needs of children should be taken into consideration because a good school meal is an investment in the future.

6. SUMMARY

Introduction

The prevalence of obesity and its co-morbidities is increasing monotonically all over the world. Obesity, and its adverse consequences, like morbidity, mortality, and obesity-related diseases, cause a considerable burden to society in general and the social security system, in particular, e.g. in form of enhancing costs of the health care system. Results of the National Nutrition Status Survey in 2014 have proven, that nearly two-thirds of the Hungarian population is overweight or obese. 28.2% of the male and 31.5% of the female population is suffering from obesity. The social costs of obesity and overweight are well characterized by calculations of Iski and Rurik (2014) who have proven, that 11.6% of the National Health Insurance Found (207 billion HUF) had been spent on medical treatment of obesity-related diseases. This was 0.73% of the Hungarian GDP. Obesity is a general problem in Hungary, which has deep consequences in the case of minorities, especially in the Hungarian Roma population, too.
It is well known, that in the case of socio-economic groups in multiple adverse social statuses the prevalence of obesity and its co-morbidities is extremely high. The health condition of Roma minority members all over Europe is less favorable than the health of members of the majority part of the national states. However considerable efforts and resources had been allocated in development and research of efficiency of interventions, aiming at prevention and decreasing of obesity, there are relatively few pieces of evidence-based information of efficiency of prevention and intervention programs.
An important, vulnerable group in society is the children. Overweight and obesity in the case of children in first childhood (kindergarten) age and school-age is a global problem too, being in the focus of public attention and international research. The prevalence of overweight is 13.4 % and obesity is 6.6% in the case of children and young people in the age bracket 3-18 years (Jakab et al, 2018). It is evident, that there is a positive correlation between childhood obesity and adulthood, obesity-related morbidity and mortality. School feeding systems have a key role in the formation of nutritional behavior and habits. An important goal of high-level regulation (37/2014. (IV. 30.) MHC) of catering systems in children-related institutions (kindergartens, schools) has been the modification of the activity of these nutritional systems, aiming at the enhancement of quality and nutritional value of foods, served to the children, laying down the foundations of the healthy nutritional behavior in adulthood. The difficulty of modification of these systems is well demonstrated by the fact, that as a consequence of the considerable social pressure the Ministry had had to modify this regulation considerably.

Goals

My thesis is based on the realization of three research goals:

1. Determination of current and prognostic burden of obesity in case of Hungarian adult population, quantification of macro-economic consequences of obesity and their prognosis for the next one hundred years (three-generation period).
2. Determination of prevalence of obesity, current and prognostic burden of disease in case of Hungarian Roma population. Guided by this goal, preparation of a forecast for the prevalence of obesity and its burden in case of Roma population, and estimation of

efficiency of intervention programs, different in intensity, preparation of quantitative models to a comparative analysis of different type intervention programs, based on changes in nutritional status and prevalence of co-morbidities of obesity.

3. An in-depth analysis of an actual government-level project aiming at the prevention of childhood obesity: the investigation of socio-economic causes, leading to introduction and modification of 37/2014. (IV. 30.) Ministerial Decree on the nutritional standards of public catering.

Methodology

1. Estimation of socio-economic burden of obesity-related diseases and their prognosis has been based on demographic and health statistical data, applying an own-developed system dynamics model. These data had been applied to the quantification and forecasting, by combined application of health statistical and econometric models.
2. The burden of obesity has been determined and forecasted by the application of the Dynamic Modelling for Health Impact Assessment (DYNAMO-HIA) software. The main goal of this simulation software, built on the Markov-chain approach is the determination and forecasting of the effect of some well-defined risk factors (e.g. obesity) on health condition, morbidity and according to different age-cohorts and gender. This software can be widely applied for the analysis of different interventions, aiming at the improvement of the health condition of a given population.
3. The causes and consequences of modification of school-nutrition regulation have been analyzed by strategic position analysis, based on institutional analysis as well as game theory. This part of the analysis has been based on 72 interviews with different stakeholders (33 experts, 26 parents, 13 teachers). I have applied the MACTOR algorithm of identification and analysis of different actors, their mutual influence relations, as well as the convergence and divergence between their strategic goals.

Results

1. I have proven, that the most important changes in nutritional status in the case of women are in the age categories 46-50 years and 71-75 years. In the 71-75 age cohort, the number of overweight women will be 120 thousand and the number of obese will be 100 thousand. In the second part of the forecasting period, more than two-thirds of women will be in the overweight and obese category. I have proven, that currently the number of years, lost due to obesity is nearly 80 thousand years, and in the middle of thirties of our century will be more than 90 thousand. The highest level of life years loss will be in middle age and the elderly in the case of women.

   In the male population, the most important changes in nutritional status will be in 31-35-year cohorts, and 71-75 years cohorts. At 31-35 years cohorts, the number of obese citizens will be 45-50 thousand, but the share of the obese population will be significantly higher in the case of all cohorts. E.g. share of overweight and obese men in this cohort will be 67%. In the case of the male population, the number of years due to the co-morbidity of obesity will be 50 thousand years.

   Analyzing the burden of obesity from point of view of economic development it can be stated, that the losses in the working-age population due to premature death will be

relatively low. At the same time the productivity losses, due to co-morbidities of obesity will gain in importance. The highest increase in absolute as well as relative terms can be expected in the case of medication costs. After one hundred years the difference between the obesity-free scenario, and the scenario, calculated based on my system-dynamics model will be 0.8 % of the GDP in each year

2. Currently, nearly 20% of the Roma population can be characterized as obese. Without prevention and intervention, the share of the obese or overweight male population will be 40% by 2070. The prevalence of co-morbidities of obesity will be increasing monotonically, too. The co-morbidities of obesity will be increasing from 6 to 26 thousand, in the case of men from 6 to 17 thousand. These diseases will decrease the life expectancy of men by 0.2 years, by women by 0.66 years. All of these factors highlight the importance of interventions. I have proven, that if we apply prevention programs, which focus just on one aspect of factors, causing obesity, this won't be able to contribute to a considerable decreasing in obesity. On the contrary, complex, intensive intervention programs are capable to decrease obesity considerably. The most suitable age period for practical realization of these programs is the middle life period: in this case, the complex programs can offer a 0.42 % reduction of obesity in the case of the man and 0.35% decreasing in the case of women.
3. Analyzing the bargaining position of different actors involved in public catering, the government has the strongest influence, as the government has a significant influence on the monetary resources of the school catering system. According to the interviewee's parents and parent-teacher associations have a growing influence on the school environment. In terms of influences and dependencies between actors, the government has a relatively favorable bargaining position as it has a high level of influence and a low level of dependence. My results have highlighted the importance of children, because they play a central role, and are capable to influence their parents and teachers. It should be mention that the influence of the two key players in the school catering system, children and catering providers, is extremely low. In other words, the two critical actors in the systems, namely the actual providers and the children, have minimum opportunity to influence the operation of the system. The results point to a lack of preparations prior to the introduction of the new regulation and inadequate communication between the various stakeholders. To ensure effective implementation, stakeholders should review the available information on nutritional status and eating patterns before developing school lunch standards and issuing any regulation on nutrition requirements in school food services and catering systems.

Conclusion

1. Obesity will cause considerable economic losses at the macroeconomic level, due to decreasing working-age population as a consequence of premature death and losses by co-morbidities of overweight and obesity. On another hand, the pharmaceutical cost of obesity will demand further material resources. Obesity should be considered as a factor of the considerable importance of the performance of the national economy in Hungary. The gap between obesity–free development trajectory and the current development path

will be continuously increasing, currently, this difference is ca. 0.2%. This value is one and a half times more than the total sum of state support to sport and reconstruction and development of sport-related facilities of the Hungarian state budget for 2019. Thus, the importance of obesity prevention and intervention programs in Hungary will be gaining to prevent the development of obesity. Methods, intensity, and focal groups of these prevention and intervention programs should be determined on careful analysis of international and Hungarian experiences and in-depth mathematical optimization.

2. The results of our research proved that the prevalence of overweight and obesity in the Roma population (minority ethnic group) is equal to the prevalence of overweight and obesity in the Hungarian population. The rapidly increasing number of Roma population and the prevalence of obesity is an increasing challenge of Hungarian health care systems, which highlight the importance of evidence-based prevention and intervention programs. Regarding intervention programs, only the complex obesity intervention programs, based on a comprehensive transformation of lifestyle and food consumption patterns can present perceptible outcomes primarily among the middle-aged and the elderly. The results of the research draw attention to the fact that the normalization of the nutritional status and the reduction of co-morbidities of obesity among the Roma population requires complex, race-specific intervention.
3. My results have proven the importance of a complex, holistic approach, and application of system theory. It can be stated that before drawing up the regulations related to school catering, the situation of the various actors involved in the catering and their system of interests must be taken into account. Children play a central role in school catering because they can indirectly influence parents and teachers. It follows that significant resources need to be mobilized to understand children's eating behaviors and to develop interventions to change behaviors. Initiators and implementers of changes in school meals may benefit from collaborations with parents to increase acceptance of school meals and food consumption. Developing and adopting healthy child nutrition requires a complex nutrition education program and ongoing dialogue between teachers, parents, and school nutrition professionals, and the government. The requirements of school catering standards carrying important messages to students about healthy eating and are an effective way to change the eating behavior of new generations.

7. ÖSSZEFOGLALÁS

Bevezetés

Az elhízás, valamint az elhízással összefüggő krónikus, nem fertőző betegségek prevalenciája világszerte növekszik. Az elhízás előfordulása és az azzal összefüggő morbiditás, mortalitás, valamint az elhízáshoz kapcsolódó társbetegségek következményei (pl. az egészségügyi ellátás igénybevétele és költségei) hazánkban is egyre nagyobb terhet rónak a társadalomra és az egészségügyi ellátó rendszerre. A 2014-es Országos Tápláltsági Állapot Vizsgálat eredményei alapján a magyar felnőtt lakosság csaknem kétharmada túlsúlyos vagy elhízott. A férfiak 28,2%-a, a nők 31,5%-a szenved elhízásban (Erdei et al, 2017). A túlsúly és az elhízás magyarországi társadalmi terheit jól jelzi, hogy a kezelésére fordított közkiadások Iski és Rurik 2014-es számítása alapján a teljes Egészségbiztosítási Alap 11,6%-át tették ki, ami a bruttó hazai termék 0,73%-a, legalább 207 milliárd forint volt. Az elhízás azonban nem csupán a magyar lakosságot érinti.

A magyarországi lakosság növekvő arányú részét képezi a roma populáció. Többszörösen hátrányos helyzetük egyik következménye a helytelen táplálkozás, mely számos esetben vezet elhízáshoz és az elhízás társbetegségeinek magas prevalenciájához. Európában a roma lakosság egészségi állapota rosszabb, összehasonlítva a nem roma lakossággal. A roma népesség egészségi állapotára és annak javítási lehetőségeire hazákban nagy hangsúlyt fektetnek. Az elhízás megelőzését és csökkentését célzó beavatkozások fejlesztésére és tesztelésére fordított hatalmas erőforrások ellenére kevés információ áll rendelkezésre az evidencián alapuló intervenciós programok hatékonyságáról.

A roma lakosság mellett az elhízás szempontjából a másik veszélyeztetett csoportot a gyermekek alkotják. Az óvodás és iskolás korú gyermekek körében kialakuló túlsúly és elhízás globális méretű probléma. A magyar, 3-18 év közötti gyermekek 13,4%-a túlsúlyos és 6,6%-uk elhízott (Jakab et al, 2018). A gyermekkori elhízás és a felnőttkori morbiditás és mortalitás között pozitív összefüggés mutatható ki. Az iskolai közétkeztetésnek meghatározó szerepe van a gyermekek táplálkozási magatartásának kialakításában, az elhízás prevenciójának támogatása céljából és a gyermekek étrendi minőségének növelése érdekében a közétkeztetésre vonatkozó előírásokat jogszabályba foglalták. Az iskolai közétkeztetésre vonatkozó táplálkozás-egészségügyi előírásokról szóló 37/2014. (IV. 30.) EMMI rendelet bevezetésének az óvodai és iskolai étkeztetés szabályozása volt a célja. E szabályozás a gyermekek egészséges táplálkozását igyekszik előmozdítani az iskolai közétkeztetés minőségibbé tétele révén, azonban a növekvő társadalmi nyomás hatására a rendelet módosításra került.

Célkitűzések

Doktori munkámnak három alapvető célja volt:

1. Az elhízás jelenlegi és prognosztizált betegségterhének meghatározása a magyar felnőtt lakosság körében. Az elhízás okozta makrogazdasági terhek számszerűsítése és prognózisa a következő 100 évre.
2. Az elhízás előfordulása, jelenlegi és prognosztizált betegségterhének meghatározása a magyarországi romák körében. A roma populációban előrejelzés készítése az elhízás

okozta betegségteher alakulására, továbbá annak meghatározása, hogy a különböző életkori kategóriákban megvalósuló, egymástól eltérő intenzitású intervenciós programok milyen mértékben hozhatnak változást a roma lakosság tápláltsági állapotában és az elhízás okozta társbetegségek előfordulásában.
3. Egy konkrét, a gyermekkori elhízás megelőzésére irányuló intervenció elemzése: A közétkeztetésre vonatkozó táplálkozás-egészségügyi előírásokról szóló 37/2014. (IV. 30.) EMMI rendelet bevezetése és módosítása mögött álló okok feltárása.

Módszerek

1. A magyar lakosság körében az elhízás okozta betegségterhek elemzése és előrejelzése demográfiai és egészségstatisztikai adatok alapján, rendszerdinamika vizsgálat segítségével történt. Ennek eredményei alapján az elhízás makrogazdasági terheink számszerűsítése és prognózisa egészségstatisztikai és ökonometriai modellek kombinált alkalmazásával. Munkám elméleti alapját a termelőerők hatásának Cobb-Douglas függvénnyel történő közelítése és a gazdasági növekedés Solow-Swan modellje képezte.
2. A cigányság körében az elhízás okozta betegségterhek előrejelzésére a Dynamic Modeling for Health Impact Assessment (DYNAMO-HIA) szoftvert alkalmaztam. A Markov-láncra épülő szimulációval működő szoftver fő célja, hogy egy adott populáció alapvető jellemzőinek (életkor és nemek szerinti megoszlás) ismeretében meghatározható legyen az egyes kockázati tényezők (pl. elhízás) hatása a lakosság egészségi állapotára, mortalitására és morbiditására nemek és korcsoportok szerinti bontásban. A szoftver segítségével mérhető a különböző népegészségügyi beavatkozások hatása a lakosság egészségi állapotára.
3. A közétkeztetési rendelet módosításának okait az intézményi gazdaságtan fogalmi keretében és stratégiai modellezésén keresztül elemeztem. Munkám során 72 interjút (33 szakértő, 26 szülő és 13 tanár) készítettem a különböző, közétkeztetésben érdekelt felekkel. Az érintett gazdasági-társadalmi érdekcsoportok (stakeholder) azonosítása, viszonyrendszerük feltárása, a céljaik között lévő azonosságok és különbségek elemzése a MACTOR algoritmus alkalmazásával.

Eredmények

1. A tápláltsági állapotban bekövetkezett változás a nők esetében a 46-50 és a 71-75 éves korcsoportokban a legnagyobb mértékű. A 71-75 éves korcsoportban 120 ezer túlsúlyos és 100 ezer elhízott nő lesz. A nők több mint kétharmada túlsúlyos és elhízott kategóriába fog tartozni a vizsgált időszak második felében. Az elhízás miatt elveszített életévek száma évtizedünkben közel 80 ezer év, és ez az érték meghaladja a 90 ezret a következő tizenöt év után. Az életévekben a legjelentősebb veszteségek a nők körében a középkorúak és a korai időskorúaknál fordulnak elő. A férfiak esetében a tápláltsági állapotban a legnagyobb változás 31-35, valamint a 71-75 éves korcsoportban következik be várhatóan. A 31-35 éves korcsoportban az elhízottak száma 45 ezer lesz, az elhízott férfiak száma elemzett időszak alatt szignifikánsan nem változik. A túlsúlyos és elhízott férfiak aránya ebben a korcsoportban 67% lesz. A férfiaknál a túlsúlyból és az elhízásból adódó elveszített életévek száma 45-50 ezer életév/évre tehető.

Az elhízásból adódódó betegségteher mintegy 0,24%-kal fékezi a gazdaság bruttó hazai termékben kifejezett növekedését. Az elhízás prevalenciájának prognosztizált növekedéséből adódóan ez az arány húsz év múlva 0,5 % lesz, az évszázad végére pedig eléri a 0,7%-ot. A legfőbb terhet az elhízás társ-betegségeiből adódódó munkaerő-kiesés jelenti, napjainkban ezek adják az összes veszteség mintegy 15%-át, a korai halálozásból adódó veszteségek aránya nem éri el a 10%-ot. Jelenleg a gyógykezelési költségek okozta tőke-lekötésből adódó veszteségek mértéke alacsony.

2. A roma férfiak és nők közel 20%-a szenved elhízásban jelenleg, népegészségügyi beavatkozás (intervenciós és prevenciós programok) nélkül 2070-re a romák közel egyharmada túlsúlyos és elhízott, a férfiak közül mintegy 30% túlsúlyos és 10%-uk az elhízott kategóriába fog tartozik. Az elhízáshoz kapcsolódó betegségek prevalenciája folyamatosan emelkedik: a nők esetében a következő fél évszázadban 6 ezerről 26 ezerre, a férfiaknál közel 6 ezerről több mint 17 ezerre nő az elhízás okozta egyéb megbetegedések száma. A roma populációban az elhízás társbetegségei a roma férfiaknál 0,2 évvel, a roma nőknél 0,66 évvel csökkentik a várható élettartamot.
   Az elhízás egy tényezőjére fókuszáló intervenciós programok nem hoznak érdemi eredményt a roma lakosság tápláltsági állapotában. A komplex beavatkozás elvére épülő intervenció azonban érdemben járulhat hozzá az elhízás előfordulásának csökkenéséhez. A legnagyobb mértékű változás a középkorúak körében tapasztalható, a férfiaknál 0,42%-kal, a nőknél pedig 0,35%-kal csökken az elhízásban szenvedők aránya.
3. A közétkeztetésben érintett gazdasági-társadalmi érdekcsoportok közül általánosságban a kormánynak van a legerőteljesebb befolyása, mivel a kormány jelentős hatással bír az iskolai étkeztetés monetáris forrásaira. Az önkormányzat fontos befolyást gyakorolhatnak az étkeztetési szolgáltatókra, mert lehetőségük van arra, hogy a közbeszerzési eljárás keretében kiválasszák a közétkeztetési szolgáltatót a különböző iskolák számára. Az interjúpartnerek véleménye szerint alapvetően pozitív tendencia az elmúlt években, hogy a szülői szervezetek növekvő befolyása van az iskolák életére. A szereplők közötti befolyások és függőségeket tekintve a kormány viszonylag kedvező alkupozícióval rendelkezik, mivel magas szintű befolyással és alacsony szintű függőséggel bír. A gyermekek élelmiszer-fogyasztásának közvetlen társadalmi-gazdasági környezete a következő: a tanárok, az önkormányzat és a szülők háromszögének nagyjából ugyanaz az álláspontja, nevezetesen a magas szintű befolyás és az alacsony függőség. A közétkeztetési rendszer két kulcsszereplőjének, a gyermekeknek és az közétkeztetési szolgáltatók vezetőinek rendkívül alacsony a befolyása, ami - különösen a gyermekek esetében - nagy függőséggel jár. Más szavakkal, a rendszerek két kritikus szereplőjének, nevezetesen a tényleges szolgáltatóknak és a gyerekeknek van a legkevesebb lehetőségük arra, hogy befolyásolják a rendszer működését. Az eredmények rámutatnak az új szabályozás bevezetését megelőző előkészületek hiányára és a nem megfelelő kommunikációra a különböző érdekelt felek között. A vizsgálatok eredményei egyértelműen kimutatták, hogy a gyermekek a magyar iskolai közétkeztetés kulcsszereplői, de csekély befolyásuk van a rendszer működésére.

Következtetések

1. Az elhízás és az elhízás betegségterheinek hosszú távú makroökonómiai hatásainak vizsgálata nem szorítkozhat a munkaerő-veszteségek és a kezelések okoztat többlet-költségek meghatározására, hanem azt is meg kell vizsgálni, hogy a kieső munkaerő és a társadalmi bővített újratermelésre is használható tőke csökkenése milyen mértékben fékezi a gazdasági teljesítmény növekedését. Az elhízás társbetegségeiből adódódó munkaerő–kiesés jelenti a legnagyobb gazdasági terhet, azonban a következő évtizedekben arra kell felkészülni, hogy a kezelési költségekből adódó tőke-lekötés abszolút és relatív aránya tovább emelkedik. A konzervatív becslés szerint is gazdaságstratégiai jelentőségű az elhízás elleni küzdelem: az elhízás kis előfordulási aránya esetén annyival több értéket lehetett volna előállítani hazánkban 2019-ben, mint az ez évben sportra és sportlétesítmények fejlesztésére előirányzott állami források másfélszerese, vagy a Magyar Tudományos Akadémia és (az akkor még meglevő) kutatóhálózatának fenntartására szánt források duplája.
2. Kutatásunk eredményei igazolták, hogy az elhízás közel azonos mértékben érinti a roma populációt (mint halmozottan hátrányos helyzetű kisebbség), mint a teljes magyar lakosságot. Az egészségügyi ellátórendszernek fel kell készülnie az elhízás társbetegségeinek gyorsan növekvő arányú kezelésére a hazai romák körében. Az intervenciós programok közül a komplex beavatkozás elvére épülő intervenció járulhat hozzá érdemben az elhízás előfordulásának csökkenéséhez. Az életkort tekintve nem igazolható az óvodai intervenciós programok hatása az elhízás társbetegségeinek incidenciájára és prevalenciájára, a legkedvezőbb eredmények a közép-és időskorúaknál végzett intervencióval érhetők el, ezért a jövőbeli prevenciós programoknak erre a korcsoportra kiemelt figyelmet érdemes fordítani. A kutatás eredményei arra hívják fel a figyelmet, hogy a roma lakosság körében a tápláltsági állapot normalizálása és az elhízás kísérő betegségeinek csökkentése komplex, rasszspecifikus beavatkozást igényel.
3. Megállapítható, hogy a közétkeztetési rendelettel kapcsolatos előírások kidolgozása előtt figyelembe kell venni a közétkeztetésben szerepet játszó, különböző szereplők helyzetét és azok érdekrendszerét. A gyermekek központi szerepet játszanak az iskolai közétkeztetésben, mert közvetett módon képesek befolyásolni a szülőket és a tanárokat. Ebből az következik, hogy jelentős forrásokat kell mozgósítani a gyermekek táplálkozási magatartásának megértésére és a magatartás megváltoztatására irányuló intervenciók kidolgozására. Az iskolai közétkeztetés megváltoztatását kezdeményezők és megvalósítók számára előnyös lehet a szülőkkel való együttműködés, hogy növeljék a megváltozott iskolai étkeztetés elfogadását és az ételek elfogyasztását. Az egészséges gyermekétkeztetés kialakítása és elfogadása érdekében komplex táplálkozási oktatóprogramra és folyamatos párbeszédre van szükség a tanárok, a szülők, valamint az iskolai közétkeztetésben dolgozó szakemberek és a kormány között. Az iskolai közétkeztetési sztenderdek előírásai üzenetet hordoznak magukban a diákok számára az egészséges táplálkozásról és hatékony módját képezik az új generációk táplálkozási magatartásának megváltoztatásában.

8. Appendices

Appendix 1. References

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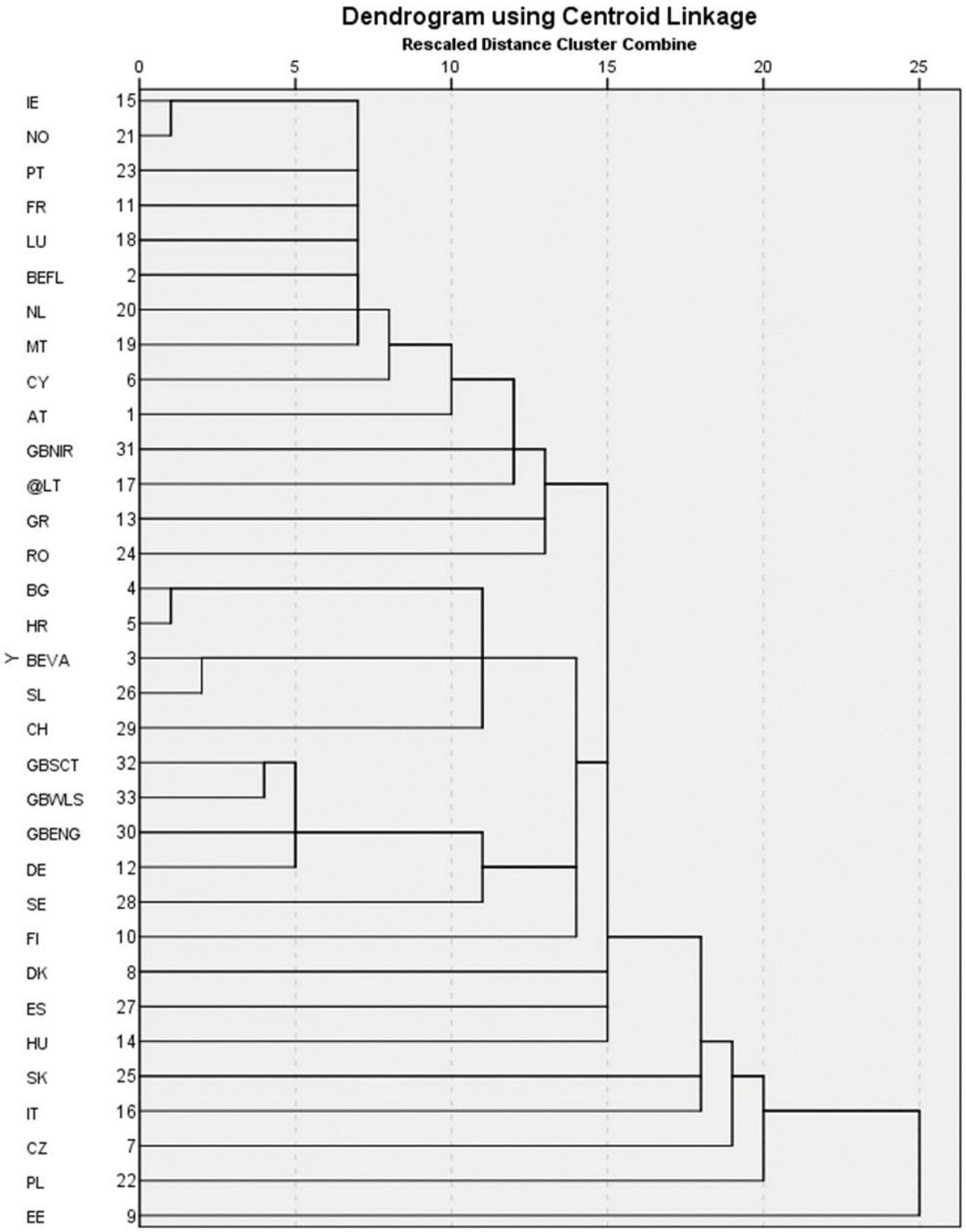
Appendix 2. Results of cluster analysis of different states, based on their school nutrition policy



Appendix 3. Costs of treatment of different diseases, based on literature resources

Disease	**Source**	**Year**	**Country**	**Cost estimation**	**Yearly cost estimation to Hungary, current international dollar**
alzheimer	Maresova et al.	2018	Europe	3896/month	*18700.8*
arterial fibrillation	Rahman et al.	2016	European states	1010-3225 EUR	*1200*
asthma	Puig/Junoy, Pacrula/Aregent;	2017	review	416-5317 USD	*2500*
breast cancer	Sun	2018	review	29724-62108 USD/year	*8000*
chronic kidney disease	Coresh et al.	2003	US	60 milliard USD/19.2 million	*3125*
chronic kidney disease	Kerr et al	2012	UK	1.44-1.45 million GBP /year/2814230 head	*100*
colorectal cancer	Wong et al.	2015	China, Hong kong	16552-71751 USD/year	*4000*
column cancer	Orango	2018	USD	26539 USD	*9554.04*
diabetes	Iski és Rurik	2014	HU	133 thousand HUF	*443.3333*
oesophageal cancer	Tramontano	2019	US	8953-18150 USD/year	*6000*
gallbladder	Sutton	2017	UK	4570-5664 GBP/year	*2500*
hypertension	Iski és Rurik	2015	HU	115 thousand HUF	*383.3333*
intracerebral haemorrhage	Porsdal and Boysen	2003	DK	22000 DK	*5852*
intracerebral haemorrhage	Shannon et al.	2018	US	52417 USD	*16773.44*

ischaemic heart disease	Menzin et al.	2008	US	2800 USD	*1120*
ischaemic stroke	Jennum	2015	DK	10750+989 DK	*3051.62*
lower back pain	Crow and Willis	2009	US	251USD/3 month	*321.28*
multiple myeloma	Kaur	2018	IN	6085-666 USD	*2000*
myeloid	Velde et al.	2016	NL	134000 euro/year	*40200*
non-Hodgkin lymphoma	Beveridge et al.	2011	US	19797 USD	*6335.04*
ovarian cancer	Bercow et al.	2017	US	93000 USD/year	*29760*
pancreas cancer	Bardou, Marc Le Ray, Isabelle	2013	Systematic review	35000 Euro/QUALY	*14000*
renal cancer	Wallen	2007	US	12155 USD/year	*3889.6*
stroke	Jennum	2015	KD	9022	*2345.72*
stroke	Dewiled et al.	2017	US	33147USD/first year	*10607.04*
stroke	Wang	2014	US	20396-23256 USD/year	*4000*
subarachnoid haemorrhage	Ridwan	2016	DE	16030 EUR	*6412*
tiroid cancer	Lubitz	2014	US	20,8 thousand USD	*6656*
uterine fibroid tumor	Soliman	2015	survey	USD/year	*5000*

Appendix 4. The socio-economic characteristic features of participants (n = 72)

	Highest level of qualification			**Gender**		**Age**			**Place of residence**			
	High school	BSC	MSc	male	female	<35	36–50	>50	Budapest (capital)	Big town	Small town	Village
Catering service entrepreneur (n = 6)	1	3	2	3	3	1	4	1	2	1	1	2
Catering service manager (n = 12)	2	8	2	1	11	2	8	2	6	1	3	2
Independent nutritional specialists (n = 6)			6		6	3	2	1	6			
Government (n = 5)			5	2	3	1	2	2	5			
Local authority (n = 4)		1	3	2	2			3	1	1	1	1
Parents (n = 26)	13	9	4	5	21	13	12	1	12	4	5	5
Teachers (n = 13)	9	4	1	1	2	2	7	4	3	4	3	3