UNIVERSITY OF TARTU
Faculty of Social Sciences
School of Economics and Business Administration

Margit Partei

COST OF OVERWEIGHT AND OBESITY IN ESTONIA

Master's Thesis

Supervisor: Janek Saluse

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Allowed for defence on ……………………………..

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I have written this master's thesis independently. All viewpoints of other authors, literary sources and data from elsewhere used for writing this paper have been referenced.

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Abstract

In this research paper the cost of overweight and obesity in Estonia is studied. Prevalence based top-down cost-of-illness method and Estonian Health Insurance cost data for healthcare services and medications of 11 diseases associated with excess body weight is used. The results show the economic burden of overweight and obesity in 2015 was €45,5 million (0,22% of GDP, 3,7% of healthcare expenditures). While the cost of overweight and obesity is not yet as large as in other European countries or the USA, it is still a serious warning sign from the viewpoint of public health. To alleviate the problem, taxes on unhealthy food and drink products and taxes based on body weight are proposed.

Keywords: obesity, overweight, cost-of-illness, healthcare expenditures, health economics

1. Introduction

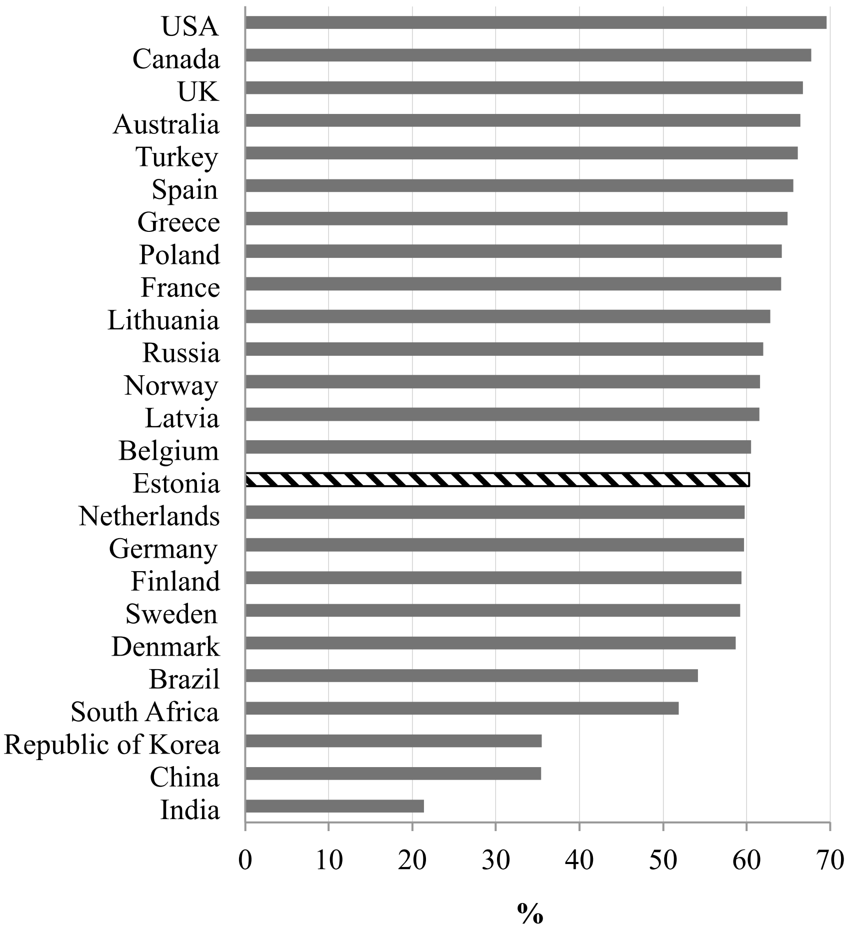
Overweight and obesity have become popular topics in public debate and health policy in the last couple of decades. There can be many definitions of overweight and obesity; of the five anthropometric indices for diagnosing obesity – body mass index (BMI), body fat percentage, waist circumference, waist-to-hip ratio and waist-to-stature ratio – the most commonly used index around the world, including World Health Organisation (WHO), is BMI (Cheng 2004). BMI shows the relationship between weight (in kilograms) and height (in meters) and is calculated as follows:

(1) $$BMI = Weight \cdot (Height)^{-2}$$

A person is considered overweight if BMI ≥ 25 and obese if BMI ≥ 30. Obesity is divided into 3 classes:

- moderate (class I) obesity: 30 ≤ BMI < 35,
- severe (class II) obesity: 35 ≤ BMI < 40,
- morbid (class III) obesity: BMI ≥ 40.

It is an important fact that worldwide obesity has more than doubled since 1980. In 2014, more than 1,9 billion adults (39%) worldwide were overweight, of these over 600 million (13%) were obese. Globally more people live in countries where overweight (including obesity) kills more people than underweight. (Obesity and overweight) It is clear overweight and obesity are spreading fast globally and show no signs of retreat (see graph 1).



Graph 1. Proportion of overweight (BMI ≥ 25) people in selected countries in 2014 (WHO database; compiled by the author)

In the recent years the topic of overweight and obesity has been discussed more and more also in Estonia. In 2014, 60,3% of adults in Estonia was overweight and 24,5% was obese (WHO database). These numbers show obesity is definitely a topical issue in Estonia. The same conclusion can also be drawn from the fact that overweight and obesity have been addressed on a governmental level, for example by Republic of Estonia Ministry of Social Affairs in 'The National Health Plan 2009–2020' [in Estonian: '*Rahvastiku Tervise Arengukava 2009–2020*'] (National Health…) and by official nutritional guidelines, healthy eating and recreational sports campaigns from National Institute of Health Development [NIHD, in Estonian: *Tervise Arengu Instituut*] (National Institute of…). It is clear the government is starting to sense the importance of this health issue and has already taken some measures to alleviate it. However, the author of this research believes more serious actions should be taken, considering how costly overweight and obesity can actually become. Unlike many other medical conditions like cancer, neurodegenerative diseases (for example Parkinson's, Alzheimer's, Huntington's disease) and genetic disorders (for example Down syndrome), overweight and obesity are a great deal more preventable and curable, therefore making it possible to reduce the related costs by a significant amount.

In order to alleviate the problem, it is important to find possible causes. At the most basic level, the cause of increased body weight is well understood: individuals gain weight when calories consumed exceed those expended. (Finkelstein et al 2005) So it comes down to either consuming too much calories or expending too little of consumed calories or both simultaneously. Globally, there has been an increased intake of energy-dense fatty foods and a decrease in physical activity as a result of the increasingly sedentary nature of many forms of work, changing modes of transportation and increasing urbanization. So, in order to reduce overweight and obesity and associated costs, it is important to normalize energy intake, increase fruit and vegetable intake and engage in physical activities regularly (2,5 hours per week) according to WHO. As WHO emphasizes, individual responsibility can only have its full effect if people have access to a healthy lifestyle. Therefore, at the societal level it is important to support individuals through sustained political commitment and the collaboration of many public and private stakeholders and make regular physical activity and healthier dietary choices available, affordable and easily accessible to all, especially the poorest individuals. (Obesity and overweight)

As already mentioned, overweight and obesity do not come without costs. There are both direct and indirect costs. (Hammond and Levine 2010, Lehnert et al 2013) The direct costs come first and foremost from obesity-related medical spending since excessive weight is linked with many diseases, for example type 2 diabetes, hypertension, hypercholesterolemia, coronary heart disease (CHD) and stroke but also with asthma, arthritis, depression, some types of cancer, infertility and pregnancy issues, gout, hyperinsulinaemia, kidney disease, sleep apnoea, depression and many others (Hammond and Levine 2010, Finer 2006, Obesity and overweight, Kortt et al 1998). Diagnosis and treatment of these conditions come with great expenditures. Direct costs come also from non-medical spending, for example costs related to visiting the doctor or a hospital, i.e. transportation, food, lodging (Wolf and Colditz 1998), costs to change diet, car, housing and costs related to taking up sports (Segel 2006). The indirect costs include mostly productivity costs: increased absenteeism, presenteeism, disability and premature mortality (Hammond and Levine 2010, Lehnert et al 2013, Grossel et al 2004, Fontaine et al 2003), and decreased human capital accumulation: decreased years of schooling (Gortmaker et al 1993) and school attendance (Geier et al 2007) and weaker academic performance (Sabia 2007). There can be other indirect costs as well, for example increased disability benefit payments (Burkhauser and Cawley 2010), health insurance market externalities (Bhattacharya and Sood 2010), fuel (Dannenberg et al 2004, Jacobson and King 2009) and environmental costs (Michaelowa and Dransfield 2006).

Many authors have tried to estimate the cost of (overweight and) obesity. Most of the studies include only direct medical costs; there are only a few also incorporating indirect productivity costs. Not much has been published about the cost of obesity on a global level. Dobbs et al (2014) have been among the very few to do so. They found the global economic impact from obesity is roughly $2 trillion or 2,8% of global GDP, roughly equivalent to the global impact from smoking or armed violence, war and terrorism. The healthcare toll of obesity can reach up to 20% of health expenditures in developed countries. As can be assumed, the greatest share of research focuses on the USA. Wolf and Colditz (1998) found total cost of obesity in 1995 was $99 billion (10,9% of total health expenditures, 1,44% of GDP). Finkelstein et al (2003) estimated direct cost of obesity to $78 billion (9,1% of health expenditures, 1,26% of GDP) in 1998. According to the same authors, the cost had almost doubled in 10 years in absolute terms: it was 147 billion (10% of health expenditures or 1,13% of GDP)

(Finkelstein et al 2009). However, Cawley and Meyerhoefer (2012) found direct medical cost of obesity in 2008 was even larger: $210 billion (20,6% of health expenditures, 1,61% of GDP). This discrepancy comes first and foremost from the use of different methods.

The aim of this paper is to evaluate cost of overweight and obesity in Estonia in monetary terms. The author will also provide some suggestions and policy proposals to reduce the estimated costs, for example via tax policy that typically has not been included in cost of obesity studies. There is a clear research gap: cost of obesity research has been conducted and published for many other countries (USA, UK, Australia, Canada, New Zealand, the Netherlands, France, Sweden, Germany, China, Thailand, Mexico etc) by many authors using various methods but never before for Estonia, a small post-Soviet eastern European country with relatively poor health indicators and relatively low healthcare expenditures: 6,2% of GDP in 2014 (NIHD database, for comparison with other countries see appendix 3). This sort of cost evaluation provides valuable information for public health practitioners to argue for more prevention resources, for policy makers to allocate resources inside the healthcare system, give insight to how much could be saved through successful prevention and provide important information for cost-effectiveness and cost-benefit analyses.

To study the cost of overweight and obesity in Estonia, prevalence based top-down cost-of-illness (COI) method and Estonian Health Insurance cost data for healthcare services and medications of 11 diseases associated with excess body weight is used. The diseases were divided into five categories: cancers, endocrine diseases, cardiovascular diseases, digestive diseases and musculoskeletal disorders. The economic burden of overweight and obesity in 2015 was €45,5 million (0,22% of GDP, 3,7% of healthcare expenditures). The most costly disease categories were cardiovascular (50% of total direct costs) and endocrine diseases (38%). From the results it appears overweight and obesity is not yet as large of a problem as in other European countries or the USA but it is still a serious warning sign from the viewpoint of public health. To alleviate the problem, taxes on unhealthy food and drink products and taxes based on body weight are proposed.

The paper is structured as follows. Section 2 gives a literature review on the topic. Section 3 introduces cost-of-illness method and data, followed by section 4 in which analysis and main results are presented. Section 5 provides a rather extensive discussion and section 6 concludes and summarizes the main findings of the study.

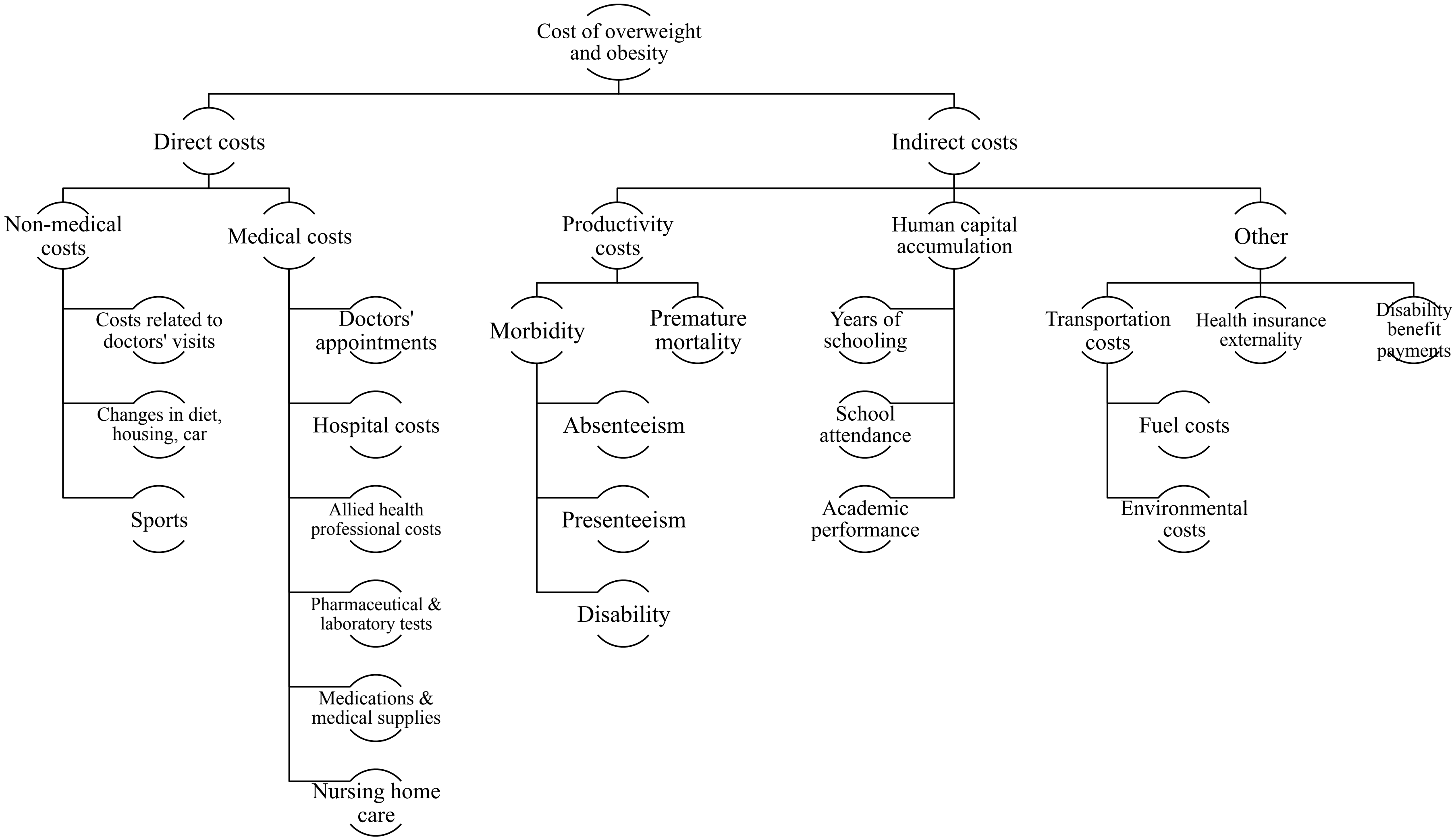
2. Literature Review

Overweight and obesity have direct and indirect costs. The most important theoretical links are presented in graph 2.

Direct costs

First of all, the most apparent and researched cost of overweight and obesity is direct cost, first and foremost direct medical spending. Excessive weight is linked with higher risk of numerous diseases, most importantly and widely known with type 2 diabetes, hypertension, hypercholesterolemia, coronary heart disease (CHD) and stroke but also with asthma, arthritis, depression, some types of cancer (for example breast cancer, cancer of pancreas, colon and uterus), infertility and pregnancy issues, gout, hyper-insulinaemia, kidney disease, sleep apnoea, depression and many others (Hammond and Levine 2010, Finer 2006, Obesity and overweight, Kortt et al 1998, see illustration 1).

For example, Thompson et al (1999) have estimated the relationship of obesity and five most frequently associated diseases (diabetes, hypertension, hypercholesterolemia, CHD and stroke). As expected, they found risks of all diseases higher for the obese and overweight for both men and women. For example, the risk of hypertension was twice as high and risk of diabetes was almost three times as high for the obese compared to the healthy weight group. Risks of CHD and stroke did not increase as much with BMI but were still roughly 15–20% higher for the obese group. Similar results for diabetes and hypertension but also statistically significant increase in risk of hyper-cholesterolemia, asthma and arthritis have been found in Rimm et al (1995), Gorsky et al (1996), Van Itallie (1985) and Mokdad et al (2001). It is clear overweight and obesity are serious risk factors to many diseases.



Graph 2. Possible costs of overweight and obesity (based on Lehnert et al (2013), amended by the author)

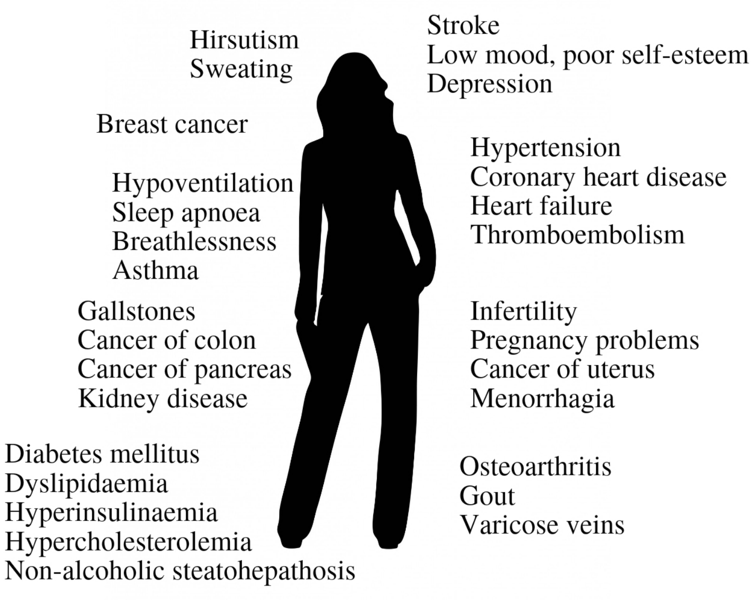
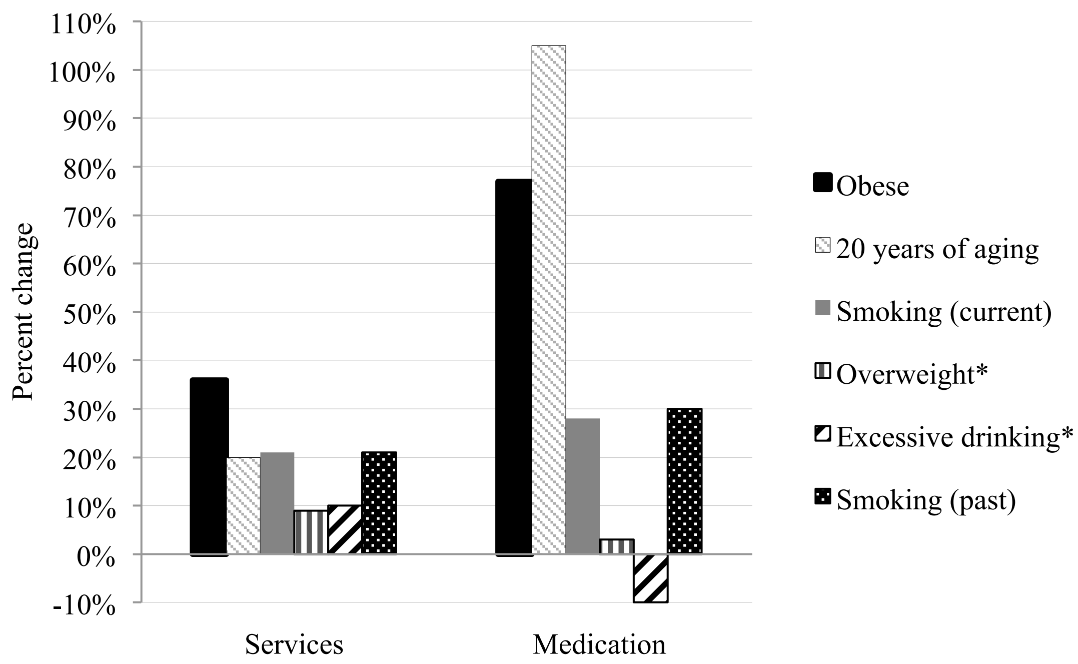


Illustration 1. Diseases associated with excessive weight (based on Finer (2006), amended by the author)

The diagnosis and treatment of these health problems come with great costs, consisting of allied health professional (profession distinct from nursing, medicine and pharmacy, for example psychologist, therapist, nutritionist etc) costs, pharmaceutical and laboratory test costs, hospital (including emergency department) costs (inpatient and outpatient procedures and rehabilitation), general practitioner (medical / family doctor) visit costs, medications' and medical supplies' costs, nursing home care costs etc (Lal et al 2012, Segel 2006). Since the rise of overweight and obesity will increase incidence of these diseases, medical costs will grow with obesity rates. Many studies have tried to estimate these costs with variety of methods: cost-of-illness studies, regression analyses, simulation forecasting, instrumental variable (IV) approach etc. (Hammond and Levine 2010) Authors seem to agree obesity-related medical costs are indeed substantial.

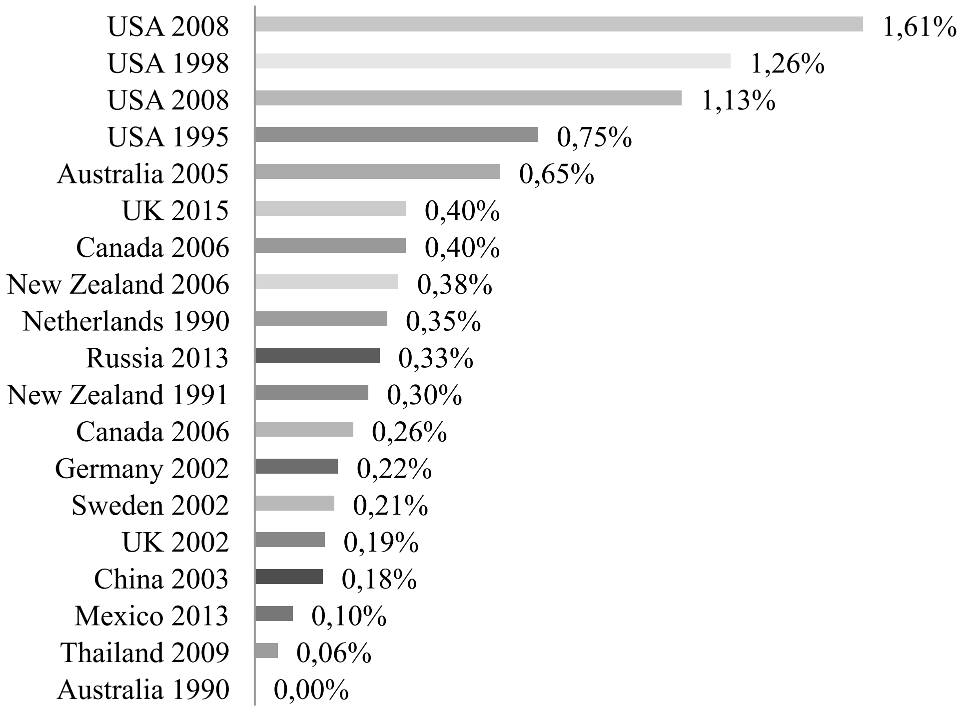
Many authors have studied how excessive weight affects healthcare costs. Thompson et al (2001) used a retrospective study with 1286 respondents who were sorted into three groups: healthy, overweight and obese according to their initial BMI. Respondents were followed for nine years. They found that compared to the healthy weight group, the obese had on average 36% and the overweight 10% higher annual medical costs. Thorpe et al (2004) carried out a two-part regression controlling for key individual variables like demography, insurance status and smoking. In 1987 the medical costs of the obese were 15,2% higher than the costs of the healthy weight but by 2001 the difference had already increased to 37%. Finkelstein et al (2003) found the average increase in annual medical expenditures associated with obesity was 37,4% in 1998, the same result found by Thompson et al (2001) and Thorpe et al (2004). Sturm (2002) did a rather interesting comparison study and contrasted healthcare cost of obesity, overweight, smoking and excessive drinking. Obesity had roughly the same effect on chronic health problems as twenty years' aging that exceeds the effects of smoking or drinking by a great amount. Obesity increased health service costs by 36% and medication costs by 77%, compared with being in a normal weight range; twenty years' aging increased service costs 20% and medications costs 105%; current or past smoking increased service costs 21% and medications costs 28–30% (see graph 3). The effects of excessive drinking and being overweight were not statistically significant. Smoking and excessive drinking has received quite a lot of attention in public health policy in the last decades, although as appeared from Sturm (2002) study, obesity is associated with a larger impact on expenses.



Graph 3. Cost increases associated with obesity, aging, smoking, and drinking in 1998 (Sturm 2002)

Many studies have estimated direct medical costs of obesity (usually defined as BMI ≥ 30) or overweight and obesity (BMI ≥ 25). Wolf and Colditz (1998) presented results for the United States in 1995. They used NHIS (National Health Interview Survey) data, cost-of-illness method (including population-attributable risk percents) and generalized to whole US population. Since obesity is related with many diseases, they included the most important ones in their study: type 2 diabetes, cardiovascular disease, gallbladder disease, breast, endometrial and colon cancer and musculoskeletal disease. The direct cost attributable to obesity was $52 billion (5,7% of health expenditures, 0,75% of GDP). 63% of direct costs were associated with diabetes, 14% with CHD, 8% with musculoskeletal disease, 6% with hypertension, 5% with gallbladder disease and 4% with mentioned types of cancer. Impact of obesity was similar to complete impact of diabetes, 1,25 times larger than impact of CHD, 2,7 times larger than impact of hypertension. Excess body weight put a burden of significant size on the healthcare system. Also, the authors bring out the cost of excess weight might be underestimated. They defined obesity as BMI ≥ 29 but most health risks appear in most diseases already at BMI ≥ 25, so the economic toll of overweight could be much larger. Other authors have also estimated the cost (overweight and) obesity in the USA (Finkelstein et al 2013, Finkelstein et al 2009, Cawley and Meyerhoefer 2012). The cost in absolute values varied from $78 billion to $210 billion (9,1% to 20,6% of healthcare expenditures or 1,13% to 1,61% of GDP) (for a more comprehensive overview see appendix 1) As already concluded by Wolf and Colditz (1998), obesity represents a major avoidable contribution to the overall cost of illness in the United States.

But the cost of overweight and obesity has also been studied in other countries. Direct medical cost in different countries in various years as a percentage of GDP is summarized in graph 4 and later on also in table 1 (based on information from appendix 1). In European countries, the cost of (overweight and) obesity reached from 0,2% to 0,4% of GDP. In Australia and New Zealand it was typically slightly higher and varied from 0,3% to 0,65% of GDP (excluding Australia 1990 from Segal et al 1994). In Canada the corresponding figures reached from 0,26% to 0,4%, being very similar to European countries. In less developed countries the cost of overweight and obesity was noticeably smaller: 0,06%–0,18% of GDP. This outcome is probably partly due to the fact obesity is not yet as prevail in these countries (see again graph 1) and partly because they simply do not expend as much on healthcare.



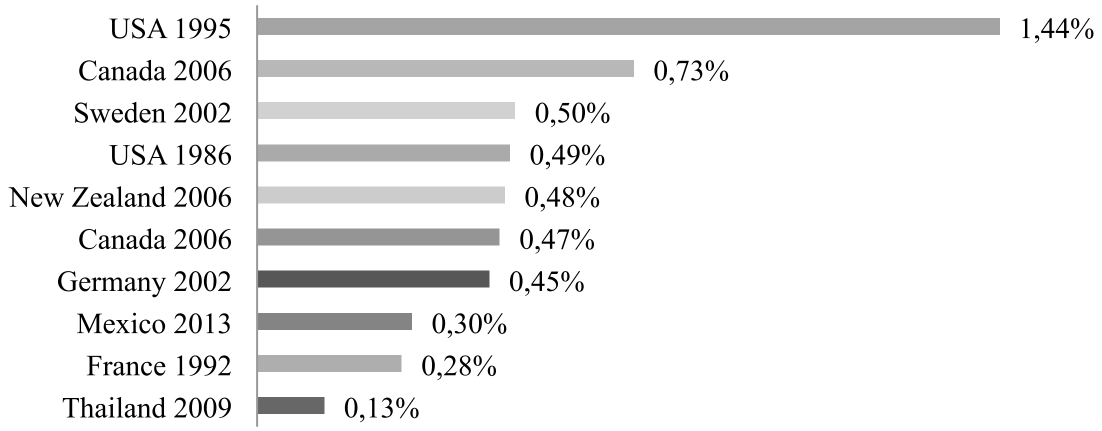
Graph 4. Direct medical cost of (overweight and) obesity as a percentage of GDP (compiled by the author from appendix 1)

Indirect costs

However, direct medical costs are not the only costs of obesity. In addition to non-medical direct costs, for example costs related to visiting the doctor or a hospital, i.e. transportation, food, lodging (Wolf and Colditz 1998), costs to change diet, house, car, housing and costs related to taking up sports, usually not measured due to lack of data and/or difficulties with measurement (Segel 2006), there are also indirect costs related to obesity. Indirect costs usually focus on effects on productivity. Productivity losses are the costs associated with lost or impaired ability to work due to health status (Russell et al 1996). Productivity loss is related to absenteeism (being absent from work because of obesity-related health issues) and presenteeism (being less productive at workplace because of obesity-related physical and mental health conditions) but also to premature mortality and loss of quality-adjusted life years. (Hammond and Levine 2010, Lehnert et al 2013, Grossel et al 2004, Fontaine et al 2003) There have been very few published studies that include productivity losses (in monetary terms) in the cost of obesity (Lal et al 2012).

Studies find strong correlation between higher rates of absenteeism and obesity. For example, 3,73 days of work per each obese employee were annually lost in the Northern American division of Shell Oil Company compared to normal weight workers. Productivity losses due to absenteeism from obesity-related reasons reached 11,2 million US dollars per year. (Tsai et al 2008) Wolf and Colditz (1998) estimated obesity resulted in 239 million restricted activity days and 89,5 million bed days in 1995. Tucker and Friedman (1998) reported obese employees (percent body fat ≥ 25% and 30% for men and women, respectively) are 1,74 and 1,61 times more likely to experience high (7 or more absences due to illness per 6 months) and moderate (3–6 more absences due to illness per 6 months) levels of absenteeism, respectively, than their lean counterparts (percent body fat ≤ 15% and 20% for men and women, respectively). Trogdon et al (2008) estimated obesity-related productivity losses from absenteeism in the United States to range from \$3,38 billion to \$6,38 billion per year. Thompson et al. (1998) estimated obesity-attributable absenteeism cost employers \$2,4 billion in 1998. Ricci and Chee (2005) tried to estimate total lost productivity time (LPT), i.e. add cost of presenteeism to cost of absenteeism. They found LPT among obese workers in the US reached \$11,7 billion per year. Surprisingly, absenteeism attributed to only one third and presenteeism to two thirds, so the latter may actually be a bigger problem in economic terms. These numbers show a relevant economic cost.

Most of the studies dealing with costs of (overweight and) obesity have not estimated indirect costs but there are a few available (see all empirical cost of overweight and obesity studies summarized in appendix 1). In addition to direct medical spending, Wolf and Colditz (1998) also estimated productivity costs related with obesity-associated diseases, total cost of obesity reached \$99 billion in 1995 (10,9% of health expenditures or 1,44% of GDP). Colditz (1992) did a very similar study with older data for 1986 (excluding musculoskeletal disease); the economic cost of obesity then was \$39 billion (5,5% of health expenditures or 0,49% of GDP). Total cost (direct medical + productivity cost) of (overweight and) obesity in different countries in various years as a percentage of GDP is summarized in graph 5 and table 1. In European countries, the total cost varied from 0,28% to 0,5% of GDP. In Canada, it was higher: 0,47%–0,73% of GDP. In less developed countries, the total cost of (overweight and) obesity was again significantly smaller: 0,13%–0,3% of GDP. As already mentioned, due to both less prevalence of overweight and smaller overall medical expenditures.



Graph 5. Total cost (direct medical spending + productivity cost) of (overweight and) obesity as a percentage of GDP (compiled by the author from appendix 1)

Table 1. Comparison of cost of (overweight and) obesity as a percentage of GDP by country groups (compiled by the author from appendix 1)

Country / Country group	Cost of (overweight) and obesity as % of GDP	
	Only direct cost	Direct + Indirect cost
USA	0,75–1,6%	0,5–1,4%
Australia & New Zealand	0,3–0,65%	0,5%
Canada	0,3–0,4%	0,5–0,7%
Europe	0,2–0,4%	0,3–0,5%
Less developed countries	0,06–0,18%	0,13–0,3%

Another important indirect effect in addition to productivity costs comes from human capital accumulation. Obesity and overweight are linked with reduced quality and quantity of schooling. This problem will probably become more significant during time as rates of childhood obesity are increasing. Gortmaker et al (1993) have shown that women who were obese had significantly less school years completed. Also, a significant positive link between body mass index and dropping out of school for teen males was found by Kaestner et al (2009). School attendance and obesity were studied by Geier et al (2007) who identified days missed from school were higher for obese children. Moreover, Sabia (2007) has shown that adolescent obesity has a negative effect on grade point average (GPA). These results provide evidence that obesity has a negative impact on school attendance, educational attainment, grades and knowledge and a positive impact on dropping out of school. Clearly, human capital accumulation seems to be negatively affected by obesity, especially childhood and adolescence obesity. However, these costs have usually not been estimated due to lack of data and/or difficulties with measurement.

In addition to indirect effects from productivity costs and human capital accumulation, there could be other, less significant obesity-related factors affecting the overall costs, for example increased disability payments (Burkhauser and Cawley 2010) and welfare loss from health insurance market externality (Bhattacharya and Sood 2010). One interesting, yet not so widely studied cost is the effect overweight and obesity might have on transportation costs, both directly, as more fuel and larger vehicles are needed for the same number of commuters (Dannenberg et al 2004, Jacobson and King 2009), and indirectly, in the form of greater greenhouse gas emission (Michaelowa and Dransfield 2006). Other possible (and perhaps weakly related) factors remain unidentified at the moment and need further research.

Although annual healthcare costs among the obese are higher, it has been occasionally mentioned that lifetime costs may be lower because obese individuals live shorter lives (Stevens et al 1998, Fontaine et al 2003). However, it has not been confirmed by studies conducted (Thompson et al 1999, Allison et al 1999, Gorsky et al 1996), especially if indirect costs of overweight and obesity are included. Authors agree obesity-related costs comprise a significant proportion of total healthcare expenditures and add to the burden of the whole society.

The case of Estonia

Overweight and obesity in Estonia are yet to be studied from a monetary perspective. There have only been a few authors who have tried to research this topic in Estonia from a more economic viewpoint. Vals et al (2013) studied how alcohol consumption, smoking and overweight affect utilization of healthcare services, using binary logistic regression and data from Health Behaviour Survey of the Estonian Adult Population. They found the odds of visiting a GP (general practitioner / medical / family doctor) were almost 80% higher for obese women and 32% higher for obese men and both obese men and women had 28% higher odds of visiting a specialist compared to respondents whose weight was normal. Obese women also had 54% higher odds for hospitalizations and 45% higher risk for ambulance calls. Overall, overweight and smoking had the largest impact on healthcare utilization in Estonia. They also emphasize that considering the high prevalence of these behavioral risk factors, health policies should prioritize preventive programs promoting healthy lifestyles in order to decrease the disease burden and to reduce healthcare costs. A study by Tekkel et al (2010) also confirms the previous result: obese men and women tend to use outpatient services more than normal weight individuals.

Republic of Estonia Ministry of Social Affairs and University of Tartu Department of Public Health (2004) estimated burden of disease in Estonia, measured in years of life lost, and connections with risk factors, including overweight. They found 5% of burden of disease (approximately 17 000 years of life lost) in Estonia is caused by overweight or obesity, respective numbers for alcohol abuse, smoking and drug abuse were 6,7%, 8,3% and 1%. In comparison to more prioritized problems like smoking and alcohol abuse, the damage by obesity is actually not far off. Coronary heart disease caused 53% of overweight related mortality, followed by stroke and hypertension. In total these three diseases caused 86% of years of life lost associated with overweight.

From these studies we get some insight that overweight and obesity are topical issues in Estonia and create excessive burden on the society. The severity of this issue and the size of the burden, however, need further investigation.

3. Method and Data

Health economics deals with allocation of scarce resources to improve health, both within the economy to healthcare system and within the healthcare system to different activities and individuals. One important field of applied research in health economics is cost-of-illness research (COI). COI studies first appeared in 1950s and since then, at least 1700 have been published in USA alone (U.S. Health Policy…). Cost-of-illness (or burden-of-illness) studies are not concerned with a particular healthcare intervention but instead attempt to estimate the economic burden a specific disease places on society. (Kobelt 2013) As stated by Rice (2000), cost-of-illness studies translate the adverse effects of diseases or injuries into monetary terms, the universal language of decision makers and the policy arena. These estimates are used to:

- define the magnitude of the disease or injury in monetary terms;
- justify intervention programs;
- assist in the allocation of research finances on specific diseases;
- provide a basis for policy and planning relative to prevention and control initiatives;
- provide an economic framework for program evaluation.

The aim of COI studies is descriptive: it aims to itemize, value and sum the costs of a particular problem to give an idea of its economic burden (Jefferson et al 2000). It gives insight about the amount of scarce resources consumed because of the illness (Tarricone 2006). COI studies try to estimate the maximum amount that could potentially be saved or gained if a disease were to be eradicated. Also, cost-of-illness studies provide important information for cost-effectiveness and cost-benefit analyses. (Segel 2006) COI studies give valuable insight for the healthcare system: usually there is no surplus in the healthcare budget and more effective use of available resources would benefit everyone via the increase of quantity of other healthcare services offered. It is not a question of reducing healthcare costs in total or creating surpluses in the healthcare budget; it is the question of opportunity cost(s) of treating a particular health problem and effective allocation of resources within the healthcare system.

Costs

A comprehensive cost-of-illness study includes both direct and indirect costs, although the specific focus of a study may make one or the other unnecessary. Some studies also include intangible costs of pain and suffering but this category of costs is often omitted because of the difficulty in accurately quantifying it in monetary terms. In COI studies, direct costs include direct medical costs and direct non-medical costs, indirect costs include mortality costs, morbidity costs due to absenteeism and presenteeism, informal care costs (in terms of the opportunity cost of hiring outside care) and, for the few relevant cases such as substance use or violence, losses due to crime (incarceration, policing, legal, and costs to victims of crime). (*Ibid.*) Summary of direct and indirect costs in COI studies are presented in table 2.

Table 2. Typical items of resource use in COI studies

Cost type	Examples of resources
Direct medical costs	Hospitalisation • Days of hospitalisation • Discharges Outpatient visits • Outpatient clinic attendance • Visit to private practitioner • Visit to paramedic Procedures and tests • Tests (blood analysis, x-ray, scans, gastroscopies, etc) • Surgical interventions Devices: medical devices (wheelchairs, hearing aid etc) Services • Home care (hours or days) • Nursing care (hours or days)
Direct non-medical costs	Transportation • For outpatient visits (ambulance, taxi, etc) • For daily activities Services • Home help (hours or days) • Meals on wheels • Social assistance (hours or days) Devices and investments • Adaptation to house or car • Special kitchen and bathroom utensils Informal care: care by relatives
Indirect costs	Sick leave (days or weeks) Reduced productivity while at work (percentage or hours) Early retirement due to illness (years to normal retirement) Premature death (years to normal retirement)

Source: Kobelt (2013)

As can be seen, there are a lot of cost sources to be considered in COI studies. The specific selection of costs included depends on the perspective of the study and often also on data availability.

Perspective. Scope. Approach

A cost-of-illness study may be conducted from several different perspectives (see table 3). Each perspective contains slightly different costs. These perspectives measure costs to society, the healthcare system, third-party payers, businesses, the government and participants and their families (Luce et al 1996). In COI studies regarding overweight and obesity, societal perspective (including direct and indirect costs) and healthcare system perspective (including direct medical costs) are most common. The societal approach is often favoured because it is the most comprehensive but as a downside, it also requires the most data, making it difficult to use in certain cases (especially with less common diseases). (Segel 2006)

Table 3. Costs included in COI studies by perspective

Perspective	Medical costs	Morbidity costs	Mortality costs	Non-medical costs	Transfer payments
Societal	All costs	All costs	All costs	All costs	–
Healthcare system	All costs	–	–	–	–
Third-party payer	Covered costs	–	Covered costs	–	–
Businesses	Covered costs (self-insured)	Lost productivity (presenteeism/ absenteeism)	Lost productivity	–	–
Government	Covered (Medicare, Medicaid)	–	–	Criminal justice costs	Attributable to illness
Participants and families	Out-of-pocket costs	Lost wages/ Household production	Lost wages/ Household production	Out-of-pocket costs	Amount received

Source: Luce et al (1996)

The scope of COI studies might be broader (incidence based studies) or narrower (prevalence based studies). Incidence based studies involve calculating the lifetime costs of cases first diagnosed in a particular year, providing a baseline against which new interventions can be evaluated (Byford et al 2000). Incidence costs include the discounted medical, morbidity and mortality costs during a person's lifetime for the incident cohort. Prevalence based studies on the other hand estimate annual costs and measure the costs of an illness in one period (usually a year). Prevalence based studies include all medical care costs and morbidity costs for a disease within the study year. However, the mortality and permanent disability costs are calculated differently from the other costs: they are discounted and calculated for all patients who die or become permanently disabled in the study year for that year and each year until the expected age of death. (Segel 2006, Hodgson 1988)

Direct costs in COI studies can be estimated using one of three approaches (Segel 2006):

- bottom-up,
- top-down,
- the econometric approach.

Bottom-up studies are based on patient level cost data. They often report excess costs: the difference between individual who are affected by a disease and those who are not affected. (Lehnert et al 2013) Average cost of treating an illness is multiplied with the prevalence of the illness (Segel 2006).

The top-down approach, also known as the epidemiological or attributable risk approach, measures the proportion of a disease that is due to exposure to the disease or risk factor (Bloom et al 2001). The approach uses aggregated data along with a population attributable fraction (PAF) to calculate the attributable costs (Segel 2006). For example: in the case of cost of obesity, top-down COI studies estimate the shares in disease-specific costs attributable to overweight/obesity (i.e. population attributable fractions or PAFs) by combining data on the prevalence of excess-weight with relative risks of developing the specific diseases (Lehnert et al 2013). The formula to calculate population attributable fractions is the following:

(2)
$$PAF = \frac{p(RR-1)}{1+p(RR-1)}$$

where:
PAF – proportion of medical care for disease B attributable to disease A,
p – prevalence rate of disease A,
RR – unadjusted relative risk of disease B for people with disease A, compared with those without disease A.

The last possible approach is econometric approach. The econometric or incremental approach estimates the difference in costs between a cohort of the population with the disease and a cohort of the population without the disease. The two cohorts are matched, usually via regression analysis, by various demographic characteristics (e.g., sex, age, race, geographic location) and the presence of other chronic conditions. (Segel 2006)

It is important to emphasize the costs of risk factors, such as smoking and obesity, are estimated slightly differently than costs of most illnesses. Risk factors have few costs themselves but rather cause other illnesses that may have high costs. Thus, the risk factor is rarely listed as a diagnosis, meaning many of the surveys of medical care utilization for more common illnesses are not appropriate. On the other hand, certain risk factors are common, such as smoking and obesity, meaning national databases capture the appropriate data. Therefore, a method of attributing the medical costs to the risk factor is necessary. Either an econometric or a top-down approach including PAFs is used. Thus, the top-down or econometric approaches are more appropriate than the bottom-up approach for measuring the costs of a risk factor. (*Ibid.*) The most common COI method for estimating the economic burden of obesity is prevalence based top-down cost-of-illness method, either from the perspective of the healthcare system or the society. In this research paper, the direct medical costs of overweight and obesity are also estimated with a prevalence based top-down COI method. In summary, the direct medical costs attributable to overweight and obesity will be calculated as follows:

(3) $$\sum_{i=1}^{n} CAO_i = \sum_{i=1}^{n} (C_i \cdot p_i \cdot PAF_i)$$

where:
COA_i – cost of disease i attributable to overweight and obesity,

C_i – direct medical cost of disease i,

p_i – prevalence rate of overweight and obesity among people with disease i,

PAF_i – proportion of cost of disease i attributable to overweight and obesity,

n – number of overweight and obesity related diseases.

In addition to direct medical costs, indirect productivity costs will also be included, giving the analysis a societal perspective.

Indirect Costs

Indirect costs include the loss of resources as a result of morbidity and mortality. This means valuing life in monetary terms. It often comes with ethical controversy on how to accurately calculate the value of life (Cooper and Rice 1976, Hodgson 1983) but also creates disagreement on the correct method of estimation (Rice and Hodgson 1982, Mrozek and Taylor 2002). To estimate indirect costs, there are three most common approaches (Segel 2006):

- human capital approach (HCA),
- friction cost approach (FCA),
- willingness to pay method (WTP).

The HCA estimates the value of potential lost production from death until retirement age, assuming full employment. Alternatively, the FCA assumes someone currently unemployed can replace individuals on long-term sick leave after a 'friction' period. (Liljas 1998) The willingness to pay approach measures the amount an individual would pay to reduce the probability of illness or mortality. For practicality reasons, the HCA is the most widespread approach used to calculate the indirect costs of an illness. (Segel 2006)

In this research paper, morbidity and mortality costs will be estimated in a more approximate manner due to lack of available data. In many previous papers (see appendix 1), the magnitude of indirect productivity costs of overweight and obesity that include both mortality and morbidity are roughly the same as total direct medical costs. To get an approximate estimation of indirect costs in this research paper, the author will also make an assumption that indirect costs are equal to direct medical costs.

Data

For the empirical part of the study, data for 11 overweight and obesity related diseases was used. The selection included diseases most often incorporated in previous cost of obesity studies that are most strongly associated with obesity. Data availability also set some constraints on choice of diseases. The chosen diseases were divided into 5 categories:

- Cancers:
    - cancer of colon,
    - breast cancer,
    - endometrial cancer;
- Endocrine diseases:
    - type 2 diabetes,
    - hypercholesterolemia;
- Cardiovascular diseases:
    - hypertension,
    - myocardial infarction,
    - coronary heart disease,
    - stroke;
- Digestive diseases: gallstones;
- Musculoskeletal disorders: osteoarthritis.

Estonian Health Insurance (EHI, in Estonian: *Eesti Haigekassa*) provided direct medical cost data for sum of healthcare services and sum of medication cost (paid by both EHI and patients) for these diseases in 2015. The data also includes information about the number of patients but it cannot be summarized as one patient might have more than one diagnosis. The direct medical cost data is summarized in appendix 2.

In order to estimate the economic burden of overweight and obesity in Estonia, it was first of all necessary to calculate direct medical cost attributable to overweight and obesity. For this task population attributable fractions (PAFs) were also needed. To calculate PAFs (see again formula 2) relative risk and prevalence data were obtained. Relative risk data for chosen 11 diseases was drawn from numerous medical literature sources (see notes of table 4) and – if possible – relative risks were given with lower and upper bounds. The necessary data for prevalence of overweight and obesity among patients of a certain disease was unfortunately not available for Estonia, so corresponding data was obtained from other studies. For the most part prevalence data from European studies was used; there were 2 diseases (colon and endometrial cancer) for which such data was unavailable, so in these cases the author used data from US studies. After calculating PAFs direct medical cost attributable to overweight and obesity for all diseases could be calculated and summarized to obtain total direct cost of overweight and obesity in Estonia in 2015.

Unfortunately there is no appropriate data available to calculate indirect costs of overweight and obesity in Estonia. The indirect cost was therefore estimated approximately: in relation to direct costs. From previous studies (see appendix 1) it has appeared that for the most part indirect costs are roughly of the same size or slightly larger than direct medical costs. In this study, the author makes the assumption that indirect costs are equal to direct medical costs (i.e. half of total burden of overweight and obesity are comprised by indirect costs).

4. Analysis and Results

As can be seen from table 4, the cost of overweight and obesity in Estonia in 2015 was €45,5 million (3,7% of all healthcare expenditures, 0,22% of GDP, €35 per capita). Total direct medical cost was €22,8 million, indirect costs were considered to be approximately equal to direct medical costs. While 0,22% of GDP might seem a fairly modest cost, €45 million would be enough to cover all medical costs of type 2 diabetes for 2 years, myocardial infarction for 2,5 years, hypertension for 4 years and breast cancer for 4,4 years. Also, €33,9 million – 0,22% of GDP, exactly the cost of over-weight and obesity in 2015 – was spent on pregnancy and birth benefits in Estonia in 2008 (Võrk and Karu 2009). Next the direct medical cost of overweight and obesity by disease categories is presented.

Table 4. Relative risks of chosen obesity related diseases, prevalence of overweight and obesity among patients of these diseases, PAFs, total medical cost of diseases and cost of overweight and obesity in Estonia in 2015

Illness	Code (ICD-10)	Overweight and obesity Relative risk (RR)			Prevalence (%)	Population attributable fraction (PAF)			Total medical cost of disease (€)	Total medical cost attributable to overweight and obesity (€)		
		Value	Lower bound	Upper bound		Value	Lower bound	Upper bound		Value	Lower bound	Upper bound
Cancers												
Cancer of colon[ad]	C18	1,30	*n.s*	*n.s*	74,0%	18,2%	18,2%	18,2%	5 750 961	774 037	774 037	774 037
Breast cancer[ae]	C50	1,15	*n.s*	*n.s*	52,0%	7,2%	7,2%	7,2%	10 342 242	389 129	389 129	389 129
Endometrial cancer[af]	C55	1,38	*n.s*	*n.s*	86,5%	24,5%	24,5%	24,5%	5 496	1 164	1 164	1 164
								Total	*16 098 698*	*1 164 331*	*1 164 331*	*1 164 331*
Endocrine diseases												
Type 2 diabetes[bg]	E11	2,13	1,30	3,55	79,4%	47,2%	19,2%	66,9%	22 121 949	8 288 817	3 379 821	11 759 668
Hypercholestero-lemia (and other lipidaemias)[bg]	E78	1,35	1,05	1,73	71,3%	20,0%	3,4%	34,1%	2 932 915	417 167	71 897	711 881
								Total	*25 054 865*	*8 705 984*	*3 451 718*	*12 471 549*
Cardiovascular diseases												
Hypertension[bg]	I10	2,10	1,68	2,63	76,6%	45,7%	34,1%	55,5%	11 207 258	3 928 876	2 928 444	4 763 981
Myocardial infarction (acute + subsequent)[cg]	I21, I22	3,15	1,58	6,63	65,9%	58,6%	27,7%	78,8%	18 482 347	7 140 673	3 376 776	9 591 375
Coronary heart disease[bh]	I25	1,05	0,60	1,83	79,0%	3,8%	−46,2%	39,5%	7 941 831	238 408	-2 898 536	2 475 623
Stroke[ag]	I64	1,45	*n.s*	*n.s*	67,6%	23,3%	23,3%	23,3%	14 789	2 330	2 330	2 330
								Total	*37 646 225*	*11 310 286*	*3 409 014*	*16 833 308*

Table 4 continues

Illness	Code (ICD-10)	Overweight and obesity Relative risk (RR)			Prevalence (%)	Population attributable fraction (PAF)			Total medical cost of disease (€)	Total medical cost attributable to overweight and obesity (€)		
		Value	Lower bound	Upper bound		Value	Lower bound	Upper bound		Value	Lower bound	Upper bound
Digestive diseases												
Gallstones[ai]	K80	1,88	*n.s*	*n.s*	72,1%	38,7%	38,7%	38,7%	*4 568 241*	*1 274 338*	*1 274 338*	*1 274 338*
Musculoskeletal disorders												
Osteoarthritis[bj]	M15	1,35	1,05	1,75	75,0%	20,8%	3,8%	39,6%	*2 004 148*	*312 528*	*56 367*	*595 572*
									Total medical costs (€)	22 767 466	9 355 767	32 339 098
									Indirect productivity costs (appr.) (€)	22 767 466	9 355 767	32 339 098
									TOTAL (€)	**45 534 933**	**18 711 534**	**64 678 196**

Source: author's calculations

Notes:

- Relative risk: [a] – Mathers et al (1999), [b] – Kearns et al (2014), [c] – Oliviera et al (2009)
- Prevalence: [d] – Nock et al (2008), [e] – Rosenberg et al (2009), [f] – Beavis et al (2015), [g] – Akin et al (2015), [h] – De Bacquer et al (2004), [i] – Boland et al (2002), [j] – Spector et al (1994)
- Medical cost data from Estonian Health Insurance (*Eesti Haigekassa*)
- PAFs calculated according to formula 2
- Total attributable costs calculated according to formula 3
- Indirect costs are considered approximately equal to direct costs (based on previous studies)
- *n.s* – not specified

Cancers

Total medical cost of cancers was €16,1 million, of which €1,16 million (7,2%) was attributable to overweight and obesity. Healthcare services comprised a major part of total cost (88%) while medications were only 12% (see appendix 2). This result is logical considering the nature of the disease: cancer treatment needs more healthcare services (for example chemotherapy) than pharmacy-bought medications. Total medical cost of cancers attributable to obesity and overweight comprised 5% of total direct medical cost of overweight and obesity, a relatively small proportion.

Endocrine Diseases

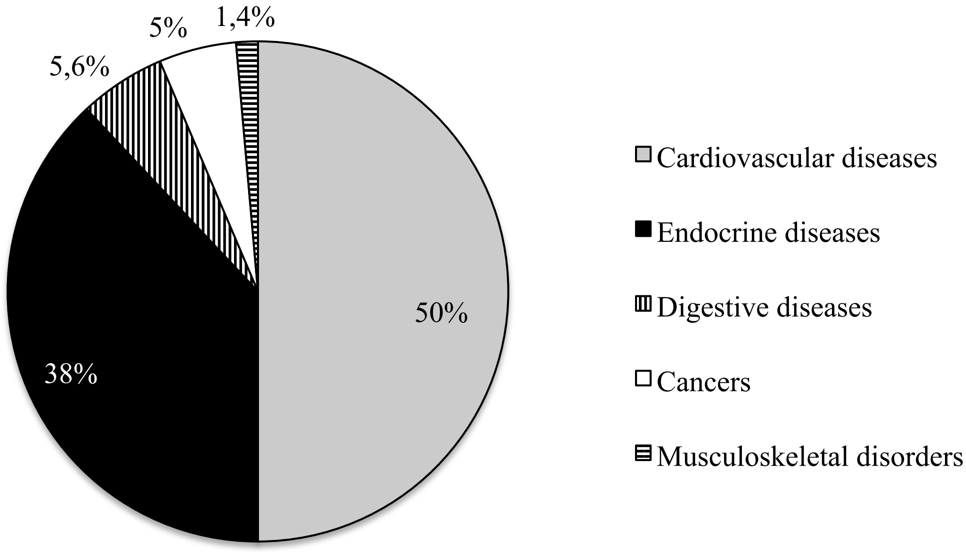
Total medical cost of endocrine diseases was €25 million, of which €8,7 million (35%) was attributable to overweight and obesity. Cost of endocrine diseases (for example type 2 diabetes) came mostly from cost of medications (82%), services played a more modest role (18%). Total medical cost of endocrine diseases attributable to obesity and overweight comprised 38% of total direct medical cost of overweight and obesity, a relatively large proportion of total cost. The most costly disease in the whole study was type 2 diabetes: €8,3 million.

Cardiovascular Diseases

Cardiovascular diseases were the most costly category with €37,6 million, of which €11,3 million (30%) was attributable to overweight and obesity. Healthcare services comprised ¾ and medications ¼ of total cost. Total medical cost of cardiovascular diseases attributable to obesity and overweight comprised the largest proportion – 50% – of total direct medical cost of overweight and obesity (see graph 6 for distribution of direct medical cost among disease categories).

Digestive Diseases

Total medical cost of digestive diseases (gallstones) was €4,6 million, of which €1,3 million (28%) was attributable to overweight and obesity. As treatment of gallstones is surgical, healthcare services comprised 99% and medications only a minor 1% of the cost. Total medical cost of digestive diseases attributable to obesity and overweight comprised a modest 5,6% of total direct medical cost of overweight and obesity.



Graph 6. Distribution of direct medical cost of obesity and overweight by disease category (author's calculations)

Musculoskeletal Diseases

Total medical cost of musculoskeletal disorders (osteoarthritis) was €2 million, of which €0,3 million (16%) was attributable to overweight and obesity. Distribution of cost among services and medications was almost even (52% and 48%). Total medical cost of musculoskeletal disorders attributable to obesity and overweight comprised a very small proportion of total direct medical cost of overweight and obesity: only 1,4%.

Scenario Analysis

As already mentioned, relative risks of diseases were given with upper and lower bounds if possible. Hence, PAFs and total medical cost attributable to overweight and obesity were also calculated and given with three values which in the context of this study can be named conservative, optimistic (lowest cost possible) and pessimistic (highest cost possible) scenario (see table 5).

According to the conservative scenario, the cost of overweight and obesity in Estonia in 2015 was €45,5 million (3,7% of all healthcare expenditures, 0,22% of GDP, €35 per capita). The pessimistic scenario estimates 42% larger cost: €64,7 million (5,2% of all healthcare expenditures, 0,32% of GDP, €49 per capita). The optimistic scenario gives 59% smaller estimate than the conservative scenario: €18,7 million (1,5% of all healthcare expenditures, 0,09% of GDP, €14 per capita). It is also worth mentioning that according to optimistic scenario, the relative risk of coronary heart disease of overweight persons is smaller than risk of normal weight persons (relative risk less than 1). In medical literature this peculiar phenomenon is known as obesity paradox in coronary heart disease (Banack and Kaufman 2014, Lavie et al 2009, Clark et al 2014, De Schutter et al 2014). However, it is usually still concluded that weight reduction is beneficial for overweight patients with cardiovascular diseases (Lavie et al 2009). The obesity paradox is not enough to discourage weight control measures. Obesity paradox in CHD still needs further deeper research.

Table 5. Total cost of overweight and obesity according to conservative, pessimistic and optimistic scenario

Scenario	Cost	% HE	% GDP	per capita	Change
Conservative	€45,5 million	3,7%	0,22%	€35	*(baseline)*
Pessimistic	€64,7 million	5,2%	0,32%	€49	↑ 42%
Optimistic	€18,7 million	1,5%	0,09%	€14	↓ 59%

Source: author's calculations

To test the sensitivity of the results, it was assumed prevalence of overweight and obesity among diseases associated with obesity is reduced by 10% (not percentage points) for each disease. After this change the total cost of overweight and obesity becomes:

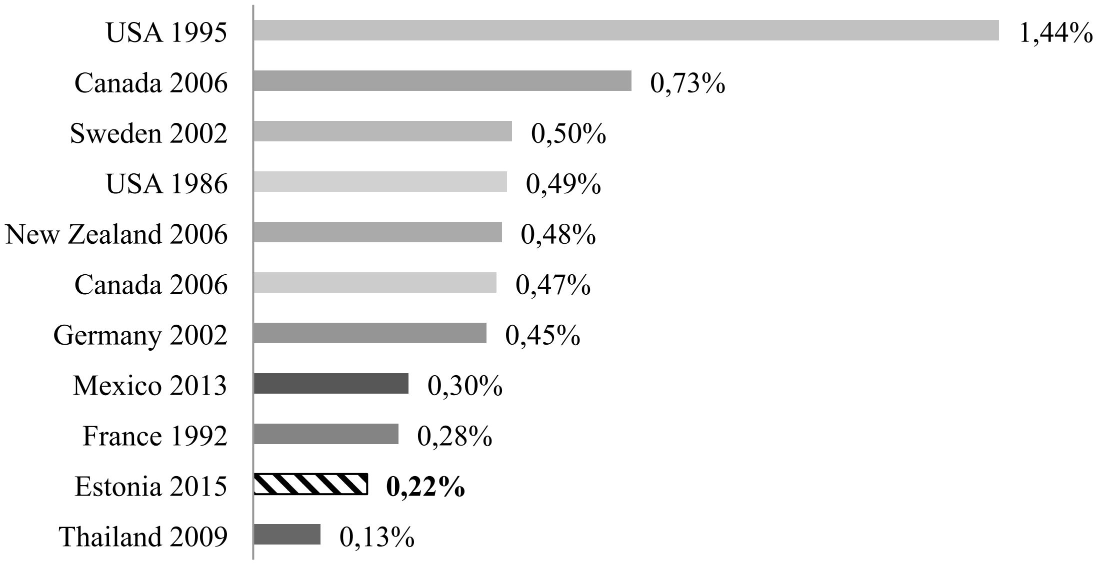
- €38,7 million (−6,8 million, −15%) according to conservative scenario,
- €55,9 million (−8,8 million, −13,6%) according to pessimistic scenario,
- €15,9 million (−2,8 million, −14,9%) according to optimistic scenario.

It appears the results are sensitive to changes in prevalence for all scenarios: a 10% decrease in prevalence of overweight reduces cost of overweight and obesity more than 10% (15%, 13,6% and 14,9% respectively).

5. Discussion

Results

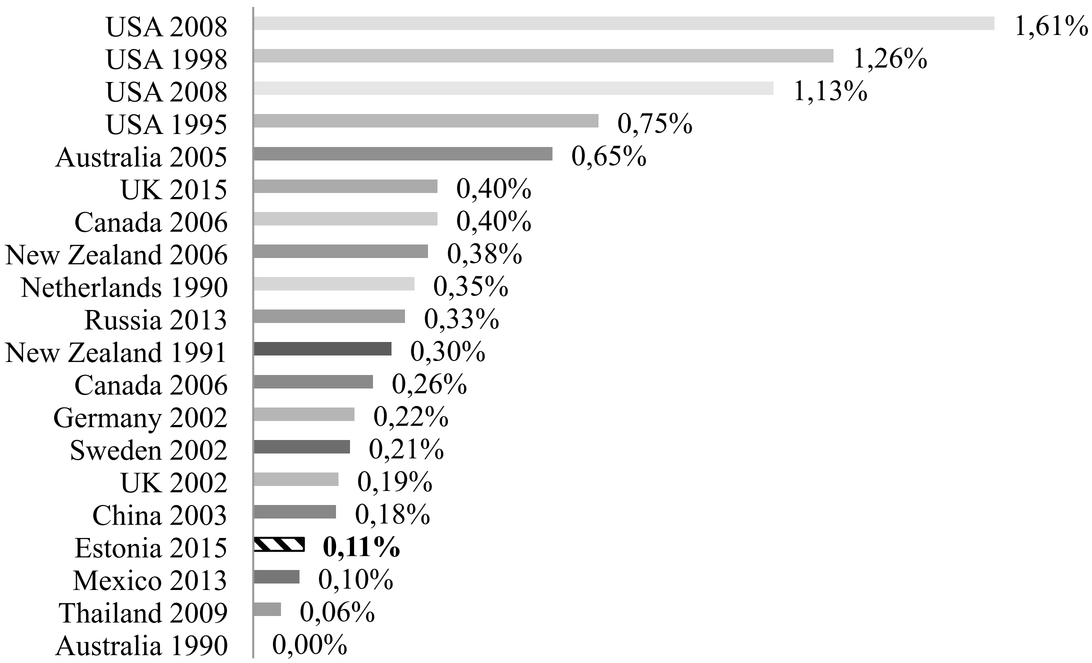
The cost of overweight and obesity in Estonia in 2015 was €45,5 million (0,22% of GDP, 3,7% of healthcare expenditures). The cost is much smaller than in the USA: well over 1% of GDP (Wolf and Colditz 1998). As already mentioned, in European countries the total cost usually was around 0,5% of GDP. Actually, the cost of overweight and obesity in Estonia is more similar to less developed countries like Mexico and Thailand than European countries (see graph 7). While the cost of overweight and obesity is not yet as large as in other European countries or the USA, it is still a serious warning sign from the viewpoint of public health as prevalence of overweight in Estonia has been increasing: 58,3% in 2010, 60,3% in 2014 (WHO database).



Graph 7. Total cost (direct medical spending + productivity cost) of (overweight and) obesity as a percentage of GDP including Estonia (compiled by the author from appendix 1)

If we look at only direct medical cost of overweight and obesity (€22,8 million, 0,11% of GDP, 1,8% of healthcare expenditures), we can observe a similar situation as with total cost: 0,11% of GDP puts Estonia among less developed countries (see again graph

4). In European countries the direct medical cost was typically 2–4 times larger than in Estonia, in Australia up to 6,5 times larger and in USA 7–15 times larger (see graph 8). Disease categories with highest direct medical costs were cardiovascular diseases (50% of total medical cost of overweight and obesity) and endocrine diseases (38%). The most costly diseases were type 2 diabetes (€8,3 million) and myocardial infarction (€7,1 million).



Graph 8. Direct medical cost of (overweight and) obesity as a percentage of GDP including Estonia (compiled by the author from appendix 1)

Policy Implications

In addition to well-known health solutions to reduce the burden of overweight: healthy eating and recreational sports, promoted for example by WHO (Obesity and overweight), in this paper two economic solutions are proposed.

The first set of solutions is Pigouvian taxes on unhealthy food and drink products, for example junk food and refined sugar products like sweets and soft drinks. Such taxes are used in some countries around the world. For example, there is a 5,2% sales tax on soft drinks in 33 states in the USA (Brownell et al 2009), taxes on refined sugar products of almost 20 NOK (approximately €2) per kilogram in Norway (*Sjokolade- og sukkervarer*) and a tax of 1 peso (€0,05) per litre on soft drinks in Mexico (*Procuraduria de la Defensa del Contribuyente* 2013 via Grogger 2015). Grogger (2015) found the soft drink tax in Mexico was relatively powerful: a 9 percent tax increased prices of soft drinks by 12 percent. Arantxa Colchero et al (2016) have found consumption of soft drinks in Mexico decreased by 6,1% in 2014. However, as Grogger (2015) brings out, it is complicated to estimate how the tax affected the body weight of Mexicans since the nationwide tax means there are no unaffected consumers to serve as controls. We can assume decreased consumption of unhealthy products also decreases the body weight but the effect is difficult to quantify.

Taxation of unhealthy food and drink products has some issues. One problem is taxes based on volume only do not direct companies to reduce sugar (or fat) content of their products, it only makes them increase the prices. Taxing sugar (or fat) content would probably be more effective and encourage businesses to introduce new healthier alternatives. (Marron et al 2015) Another issue is that the direct body weight effect of such taxes is difficult to estimate (Grogger 2015), making it hard to justify such taxes to people, the public, policy makers etc. What is more, the tax of unhealthy food and drink products is also regressive, affecting lower income population relatively more (Marron et al 2015). A Pigouvian tax on unhealthy foods and drinks should be implemented alongside health education to direct people towards healthier dietary choices.

The second set of solutions is taxes based on body weight. These taxes have not yet been implemented or evaluated anywhere. One option would be to tax all excessive units of weight (for example kilograms) of an overweight person. This option has been previously very briefly mentioned by Võrk (2012). The second option would be a tax reduction (for example social tax) for all normal weight people. The third option would be an increase in cost-sharing of healthcare services for overweight people. A tax should create incentives for overweight population to lose their excessive weight and also extra revenue for government budget. However, there are numerous issues with solutions including a tax of such nature.

Firstly, it would be problematic to identify the people who should be taxed in case of an excessive weight tax. Self-reporting would fail because most overweight people would simply report false data in order to avoid the tax. Compulsory weight and height measuring by family doctors would create a huge extra workload for the doctors. In case of a tax reduction for normal weight people, issues related to weight reporting would be less prevalent because people themselves would be interested in the tax reduction. Therefore they would be more eager to report their weight and height (for example in special facilities) to avoid the tax in legal ways.

Secondly, defining overweight via BMI might be unfair in some cases. For example, some athletes who have higher than normal lean muscle mass and therefore more body weight (bodybuilders, weight-lifters, discus throwers, shot-putters etc) and most pregnant women would be considered overweight when in reality they are perfectly healthy and should not be subject to tax. The list of exceptions would have to be thorough and all-encompassing.

Thirdly, the size of the tax would have to be very carefully calculated. In case of an excessive weight tax, it should be considered whether the tax needs to be progressive, i.e. should all excessive weight units be taxed equally or differently in different overweight and obesity classes. For example, the tax on an excessive kilogram of an overweight person ($25 \leq BMI < 30$) should probably bear a smaller tax than for the morbidly obese ($BMI \geq 40$) person because the risks of obesity-related diseases are significantly larger for the morbidly obese than for the modestly overweight people. In case of a tax reduction for normal weight people, the tax reduction should be proportional but the size of the reduction would still need profound determination.

What is more, as overweight and obesity in developed countries are more prevalent among poorer population (Sobal and Stunkard 1989, McLaren 2007), the tax solution would be regressive from the perspective of social policy (Võrk 2012). Whether it is a desirable result for the society, is somewhat unlikely. It is also questionable whether a tax based on such personal data like weight is ethical or not. Another aspect to consider is the fact that simultaneously to tax implementation, people should also be educated on healthy eating and sports as measures to get rid of excessive body weight. A tax is not meant to simply be a punishment for being overweight but rather be an incentive to lose weight and therefore reduce health risks related to overweight.

Lastly, body weight based tax solutions need thorough cost-benefit analysis before implementation. It is possible costs associated with implementation of the tax are larger than the benefit achieved, therefore making the tax economically unreasonable. In conclusion, there are many issues to be considered with body weight based taxes but if done properly, they could reduce the prevalence and the economic burden of overweight and obesity. To sum up, tax solutions are an imperfect solution but can have a moderate positive effect if done correctly.

Limitations

There are some limitations of the study to be considered. The first set of limitations is related to the cost-of-illness method. Firstly, COI studies demonstrate which diseases need more resources for treatment or prevention but fail to determine how resources should be allocated since they do not include benefits. Therefore, cost-benefit or cost-effectiveness analysis would provide valuable extra information. (Segel 2006, Roux and Donaldson 2004) Secondly, COI studies can differ by inclusion of indirect costs, perspective, data sources, time frame (Hodgson and Meiners 1982) and diseases (Kortt et al 1998), making it difficult to compare the results of different studies. Also, exclusion of some diseases would underestimate the overall economic burden of obesity. Thirdly, prevalence based COI studies do not quantify the long-term consequences of chronic conditions such as obesity. (Kortt et al 1998) What is more, many diseases are considerably intertwined but the costs are counted for separately. Therefore, there is a threat of double-counting and overestimation (Roux and Donaldson 2004, Bierl et al 2013). Still, COI studies are an important analytic tool for public health policy if presented with clear explanations (Segel 2006).

Another possible set of limitations is imperfect data. There was no prevalence data of overweight and obesity among patients of chosen diseases available for Estonia, so mostly data from other European countries and in some cases USA had to be used. This limitation can probably create some difference from the actual cost, although we can assume it is not too large since prevalence of overweight and obesity in Europe is pretty similar across countries (see graph 1), so we can assume prevalence among chosen diseases is also similar. In addition to prevalence data, there was no appropriate data to calculate indirect costs of overweight and obesity, so approximate estimation based on direct medical costs had to be used.

There is reason to believe the cost of overweight and obesity in this research might actually be conservative. The direct medical cost of overweight and obesity is based on money spent on healthcare services and medications. However, if the healthcare budget is small, the cost of obesity will also be small. The overall medical expenditures are much lower in Estonia, a small post-Soviet eastern European country, than in more developed European countries like Sweden and Germany (6,2%, 9,7% and 11,3% of GDP respectively, see appendix 3), so in theory the cost of obesity could be greater but Estonia does not spend as much money as the healthcare sector actually needs, making the cost of overweight and obesity artificially smaller. Also, there is a higher risk of 30 diseases associated with overweight and obesity (see illustration 1) but due to data availability only 11 most important diseases were included in this study. Had all diseases been included, the cost of obesity would have been larger. What is more, not all types of cost related to overweight and obesity (for example direct non-medical costs) were possible to include in this study, further increasing the probability of underestimation (Lal et al 2012).

Further Research

Future directions for research include using improved data, specifically prevalence data from Estonia instead of other similar European countries, to get a more precise picture of the burden of overweight and obesity in Estonia, and as a next step conducting cost-effectiveness or cost-benefit analyses for provided tax solutions (Pigouvian taxation of unhealthy food and drink products or body weight based taxes) to see if and how much they would help to alleviate the problem in Estonia.

6. Conclusion and Acknowledgements

Overweight and obesity is a fast-spreading global problem that has gotten more and more attention in the last couple of decades. It is a more severe problem in developed countries although prevalence of overweight and obesity is growing also in the developing world. This has sparked interest among researchers to somehow quantify the cost of excessive body weight on societies. Most studies have been conducted for the USA or Europe, although there are some available for less developed countries as well. In this research paper, the cost of overweight and obesity in Estonia was studied with prevalence based top-down cost-of-illness method and Estonian Health Insurance cost data for healthcare services and medications of 11 diseases associated with excess body weight.

In 2015 the total cost of overweight and obesity in Estonia was €45,5 million (0,22% of GDP, 3,7% of healthcare expenditures, €35 per capita). In the USA such cost has usually been around 1% of GDP and in Europe around 0,5% of GDP. It appears the total cost of overweight and obesity in Estonia – a small post-Soviet eastern European country with relatively poor health indicators and relatively low healthcare expenditures – is more comparable to less developed countries (Thailand, Mexico) than the western world.

The cost of overweight and obesity is comprised of direct medical costs and indirect productivity costs. Indirect costs were estimated approximately based on direct costs due to lack of data. Direct cost was €22,8 million (0,11% of GDP, 1,8% of healthcare expenditure) which again is significantly (2–4 times) higher in Europe and up to 15 times higher in the USA, reaching up to 1,6% of GDP according to some studies. The most costly diseases were type 2 diabetes (€8,3 million) and myocardial infarction (€7,1 million), both strongly associated with obesity.

From these results it seems overweight and obesity is not yet as large of a problem as in other developed countries. However, the increasing prevalence of overweight, obesity and associated diseases give reason to doubt the cost will remain moderate. Perhaps it is more useful to learn from experience of other countries and make effort to eradicate or reduce overweight and obesity with lower cost than wait for the problem to deepen further and cope with it later. In addition to promoting healthy eating and recreational sports, Pigouvian taxation of unhealthy food and drink products and body weight based taxes could be an incentive to make changes towards a healthier lifestyle, therefore reducing the burden on the society.

The author thanks her supervisor Janek Saluse for comprehensive support and directions throughout the entire writing process, Sirly Lätt from Estonian Health Insurance for fast provision of data and Andres Võrk from the University of Tartu for valuable advice.

Appendices

Appendix 1. Summary of empirical cost of (overweight and) obesity studies (compiled by the author)

Authors	Country	Year	BMI criteria	Medical Conditions / Variables included	Cost components	Method	Cost of obesity		
							Abs. values	% of health expend.	% of GDP
Segal et al (1994)	Australia	1990	BMI ≥ 30	• Type 2 diabetes • CHD • Gallstones • Cancers: o Colon o Breast (postmenopausal) • Weight-control efforts	Direct medical costs	COI	\$AU400 million	2%	≈0%
Colagiuri et al (2010)	Australia	2005	BMI ≥ 30	Total medical expenditures (using comparison group)	Direct medical costs	COI	\$AU8,3 billion	7,6%	0,65%
Anis et al (2010)	Canada	2006	BMI ≥ 25	• Type 2 diabetes • Cardiovascular diseases: o Coronary artery disease o Hypertension o Congestive heart failure o Stroke o Pulmonary embolism • Osteoarthritis • Gallbladder disease • Asthma • Chronic back pain • Cancers: o Breast (postmenopausal) o Colon o Endometrial o Oesophageal o Kidney *[continues on next page…]*	Direct medical costs	COI	\$C6 billion	4,1%	0,4%

Appendix 1 continues

Authors	Country	Year	BMI criteria	Medical Conditions / Variables included	Cost components	Method	Cost of obesity		
							Abs. values	% of health expend.	% of GDP
				○ Ovarian ○ Pancreatic ○ Prostate					
				Human capital costs: morbidity included, mortality excluded	Productivity costs	HCA	$C5 billion		0,33%
Janssen (2013)	Canada	2006	BMI ≥ 30	• Endocrine and metabolic disorders ○ Type 2 diabetes ○ Gallbladder disease • Cancer ○ Colorectal ○ Pancreatic • Cardiovascular disease ○ Coronary artery disease ○ Stroke • Lung disease ○ Asthma ○ Pulmonary embolism • Musculoskeletal disorders ○ Osteoarthritis ○ Chronic back pain • Mental health disorders ○ Depression ○ Dementia	Direct medical costs	COI	$C3,9 billion	2,7%	0,26%
				Costs related to disability and lost productivity due to illness or premature death	Productivity costs		$C3,2 billion		0,21%

Appendix 1 continues

Authors	Country	Year	BMI criteria	Medical Conditions / Variables included	Cost components	Method	Cost of obesity		
							Abs. values	% of health expend.	% of GDP
Zhao et al (2007)	China	2003	BMI ≥ 24	• Hypertension • Type 2 diabetes • Coronary heart disease • Stroke	Direct medical costs	COI	$2,74 billion	3,7%	0,18%
Levy et al (1995)	France	1992	BMI ≥ 27	• Hypertension • Myocardial infarction • Angina pectoris • Stroke • Venous thrombosis • Type 2 diabetes • Hyperlipidaemia • Gout • Osteoarthritis • Gall bladder disease • Cancers: o Colon o Breast o Genitourinary • Hip fracture	• Direct medical costs • Productivity costs	COI	FF12,5 billion	2%	0,28%

Appendix 1 continues

<table>
<tr><th rowspan="2">Authors</th><th rowspan="2">Country</th><th rowspan="2">Year</th><th rowspan="2">BMI criteria</th><th rowspan="2">Medical Conditions / Variables included</th><th rowspan="2">Cost components</th><th rowspan="2">Method</th><th colspan="3">Cost of obesity</th></tr>
<tr><th>Abs. values</th><th>% of health expend.</th><th>% of GDP</th></tr>
<tr><td rowspan="2">Konnopka et al (2011)</td><td rowspan="2">Germany</td><td rowspan="2">2002</td><td rowspan="2">BMI ≥ 25</td><td>• Cancers:
o Oesophagus
o Stomach
o Colon
o Liver
o Gallbladder
o Pancreas
o Postmenopausal breast
o Cervix uteri
o Ovary
o Prostate
o Kidney
o Non-Hodgkin’s lymphoma
o Multiple myeloma
o Leukemia
• Endocrine diseases:
o Type 2 diabetes
o Adiposity
o Hyperlipidaemia
• Cardiovascular diseases
o Hypertension
o Coronary heart disease
• Digestive diseases
o Gallbladder disease</td><td>Direct medical costs</td><td>COI</td><td>€4,9 billion</td><td>2,1%</td><td>0,22%</td></tr>
<tr><td>• Sickness absence
• Early retirement
• Early mortality</td><td>Productivity costs</td><td>HCA</td><td>€5 billion</td><td></td><td>0,23%</td></tr>
</table>

Appendix 1 continues

<table>
<tr><th rowspan="2">Authors</th><th rowspan="2">Country</th><th rowspan="2">Year</th><th rowspan="2">BMI criteria</th><th rowspan="2">Medical Conditions / Variables included</th><th rowspan="2">Cost components</th><th rowspan="2">Method</th><th colspan="3">Cost of obesity</th></tr>
<tr><th>Abs. values</th><th>% of health expend.</th><th>% of GDP</th></tr>
<tr><td rowspan="2">Sansores and Gutierrez-Delgado (2015)</td><td rowspan="2">Mexico</td><td rowspan="2">2013</td><td rowspan="2">BMI ≥ 25</td><td>• Diabetes
• Cardiovascular disorders
• Osteoarthritis
• Cancers:
o Esophagus
o Pancreas
o Breast
o Cervix
o Colon</td><td>Direct medical costs</td><td>COI</td><td>≈$1,2 billion</td><td>17%</td><td>0,1%</td></tr>
<tr><td>• Lost income from premature death
• Temporary disability subsidies
• Permanent disability pension
• Opportunity cost for the non-medical care giver</td><td>Productivity costs</td><td>HCA</td><td>≈$2,4 billion</td><td></td><td>0,2%</td></tr>
<tr><td>Seidell and Deeren-berg (1994)</td><td>Nether-lands</td><td>1990</td><td>BMI ≥ 30</td><td>[not specified]</td><td>Direct medical costs</td><td>COI</td><td>DG1 billion</td><td>4%</td><td>0,35%</td></tr>
</table>

Appendix 1 continues

Authors	Country	Year	BMI criteria	Medical Conditions / Variables included	Cost components	Method	Cost of obesity		
							Abs. values	% of health expend.	% of GDP
Swinburn et al (1997)	New Zealand	1991	BMI ≥ 30	• Type 2 diabetes • CHD • Hypertension • Cancers: o Breast (postmenopausal) o Colon	Direct medical costs	COI	$NZ135 million	2,5%	0,3%
Lal et al (2012)	New Zealand	2006	BMI ≥ 25	• Type 2 diabetes • Stroke • CHD • Hypertension • Osteoarthritis • Cancers: o Breast o Colon o Endometrial o Kidney	Direct medical costs	COI	$NZ624 million	4,4%	0,38%
				All of the above and: • Productivity losses HCA: o Premature deaths o Short-term absenteeism costs • OR • Productivity losses FCA: o Premature deaths o Recruitment and Training costs o Short-term absenteeism costs	• Direct medical costs • Productivity costs	COI HCA or FCA	$NZ722–849 million	5,1%–6%	0,44%–0,52%

Appendix 1 continues

Authors	Country	Year	BMI criteria	Medical Conditions / Variables included	Cost components	Method	Cost of obesity		
							Abs. values	% of health expend.	% of GDP
Krysanova and Žuravleva (2015)	Russia	2013 (?)	BMI ≥ 25	• Stroke • Heart attack • Type 2 diabetes	Direct medical costs	COI	364 billion rubles ($6,8 billion)	5%	0,33%
Borg et al (2005)	Sweden	2002	BMI ≥ 25	Total medical expenditure of obese or overweight compared to normal weight group	Direct medical costs	Regress. analysis	$269 million	2,3%	0,21%
				Cost due to premature mortality	Productivity costs		$367 million		0,29%
Pitaya-tienanan et al (2014)	Thailand	2009	BMI ≥ 25	• Cancers: o Colon o Breast o Endometrial • Hyperlipidemia • Type 2 diabetes • Depression • Hypertension • CHD • Pulmonary embolism • Stroke • Gall bladder disease • Osteoarthritis	Direct medical costs	COI	THB5,6 billion ($333 million)	1,5%	0,06%
				• Absenteeism • Premature mortality	Productivity costs	HCA	THB6,6 billion ($392 million)		0,07%

Appendix 1 continues

Authors	Country	Year	BMI criteria	Medical Conditions / • Variables included	Cost components	Method	Cost of obesity: Abs. values	Cost of obesity: % of health expend.	Cost of obesity: % of GDP
House of Commons Health Commit-tee (2004)	UK	2002	BMI ≥ 30	• Type 2 diabetes • Hypertension • Angina pectoris • Myocardial infarction • Cancers: o Endometrial o Colon o Rectal o Ovarian o Prostate • Osteoarthritis • Gout • Stroke • Gallstones	Direct medical costs	COI	£990–1220 million	2,3%–2,6%	0,17%–0,2%
Ellison et al (2015)	UK	2015	BMI ≥ 25	[not specified]	Direct medical costs	[not specified]	£5 billion	4,3%	0,4%
Colditz (1992)	USA	1986	BMI ≥ 27,8 for men BMI ≥ 27,3 for women	• Type 2 diabetes • Cardiovascular disease • Gallbladder disease • Hypertension • Cancers: o Breast o Endometrial o Colon	• Direct medical costs • Productivity costs	COI	$39 billion	5,5%	0,49%

Appendix 1 continues

<table>
<tr><th rowspan="2">Authors</th><th rowspan="2">Country</th><th rowspan="2">Year</th><th rowspan="2">BMI criteria</th><th rowspan="2">Medical Conditions / Variables included</th><th rowspan="2">Cost components</th><th rowspan="2">Method</th><th colspan="3">Cost of obesity</th></tr>
<tr><th>Abs. values</th><th>% of health expend.</th><th>% of GDP</th></tr>
<tr><td rowspan="2">Wolf and Colditz (1998)</td><td rowspan="2">USA</td><td rowspan="2">1995</td><td rowspan="2">BMI ≥ 29</td><td>• Type 2 diabetes
• Cardiovascular disease
• Gallbladder disease
• Hypertension
• Cancers:
o Breast
o Endometrial
o Colon
• Musculoskeletal disease</td><td>Direct medical costs</td><td rowspan="2">COI</td><td>$52 billion</td><td>5,7%</td><td>0,75%</td></tr>
<tr><td>All of the above + productivity costs (morbidity & mortality)</td><td>• Direct medical costs
• Productivity costs</td><td>$99 billion</td><td>10,9%</td><td>1,44%</td></tr>
<tr><td>Finkel-stein et al (2003)</td><td>USA</td><td>1998</td><td>BMI ≥ 25</td><td>Total medical expenditures grouped by insurance category</td><td>Direct medical costs</td><td>4-equation regression</td><td>$78 billion</td><td>9,1%</td><td>1,26%</td></tr>
<tr><td>Finkel-stein et al (2009)</td><td>USA</td><td>2008</td><td>BMI ≥ 30</td><td>Total medical expenditures grouped by insurance category</td><td>Direct medical costs</td><td>4-equation regression</td><td>$147 billion</td><td>10%</td><td>1,13%</td></tr>
<tr><td>Cawley and Meyer-hoefer (2012)</td><td>USA</td><td>2008</td><td>BMI ≥ 30</td><td>• Total medical expenditures
• 3rd party medical expenditures</td><td>Direct medical costs</td><td>IV</td><td>$210 billion</td><td>20,6%</td><td>1,61%</td></tr>
</table>

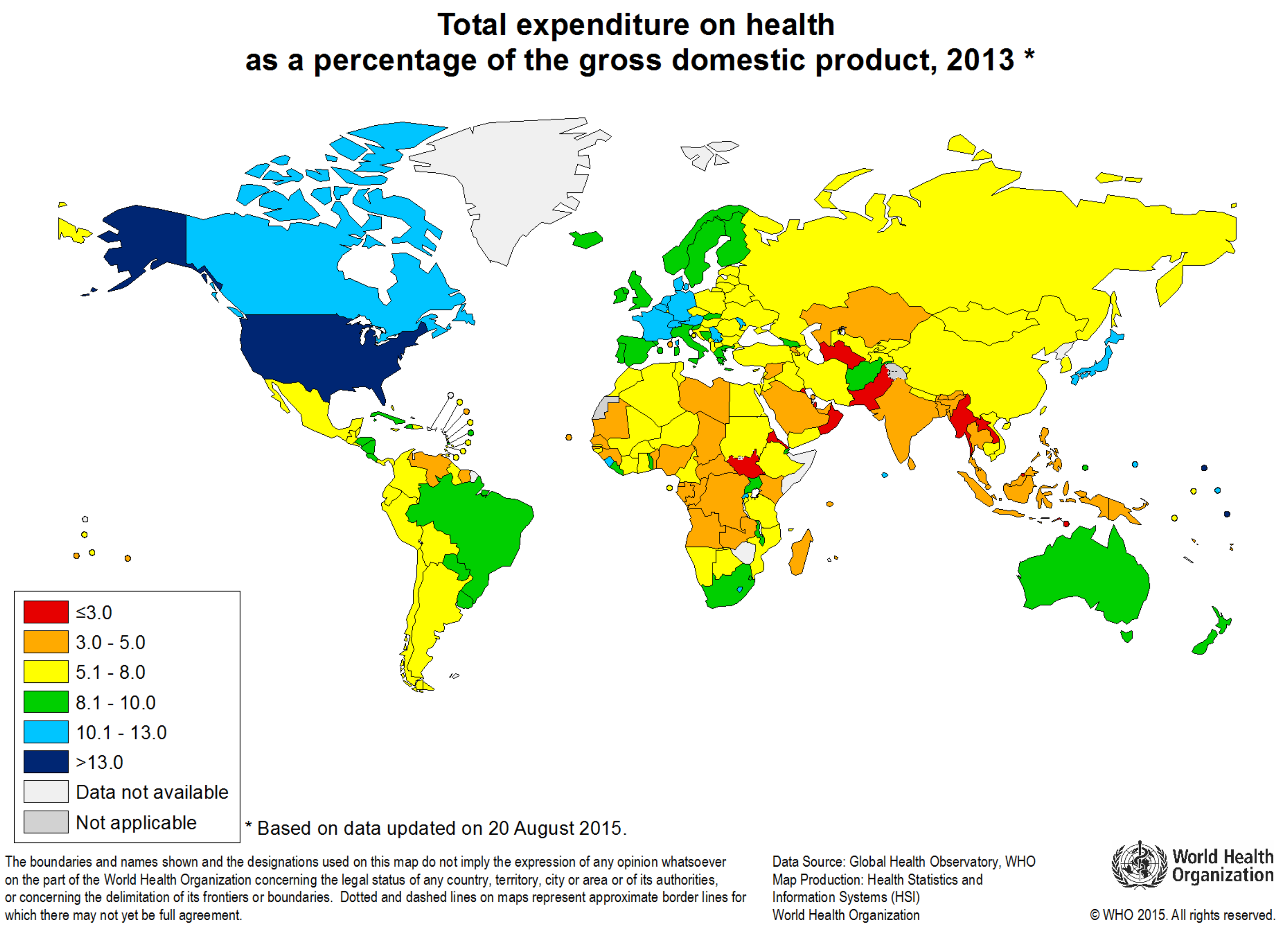
Notes: COI – cost-of-illness method, HCA – human capital approach, IV – instrumental variable approach

Appendix 2. Direct medical cost data for chosen obesity-related diseases

Illness	Code (ICD-10)	Services		Medications				Total medical cost (€)
		No of patients	Sum of services (€)	No of patients	Paid by EHI (€)	Paid by patients (€)	Total (EHI + patients) (€)	
Cancers								
Cancer of colon	C18	2 207	4 954 419	1 197	765 147	31 394	796 541	5 750 961
Breast cancer	C50	5 649	9 248 583	3 847	1 022 805	70 855	1 093 659	10 342 242
Endometrial cancer	C55	13	5 492	1	0	3	4	5 496
		Total	*14 208 494*		*1 787 952*	*102 252*	*1 890 204*	*16 098 698*
Endocrine diseases								
Type 2 diabetes	E11	45 507	4 200 845	60 642	15 444 006	2 477 098	17 921 105	22 121 949
Hypercholesterolemia (and other lipidaemias)	E78	27 037	319 392	65 113	1 255 453	1 358 071	2 613 524	2 932 915
		Total	*4 520 236*		*16 699 459*	*3 835 169*	*20 534 628*	*25 054 865*
Cardiovascular diseases								
Hypertension	I10	106 214	2 515 196	131 503	4 699 454	3 992 609	8 692 062	11 207 258
Myocardial infarction (acute + subsequent)	I21, I22	3 677	18 359 033	2 341	59 292	64 022	123 314	18 482 347
Coronary heart disease	I25	15 328	7 336 135	12 241	294 732	310 964	605 696	7 941 831
Stroke	I64	93	14 349	11	165	276	441	14 789
		Total	*28 224 712*		*5 053 642*	*4 367 870*	*9 421 513*	*37 646 225*
Digestive diseases								
Gallstones	K80	8 063	4 523 477	1 847	17 141	27 623	44 764	4 568 241
Musculoskeletal disorders								
Osteoarthritis	M15	20 370	959 834	29 645	398 955	645 358	1 044 313	2 004 148
		TOTAL (€)	**52 436 754**		**23 957 150**	**8 978 273**	**32 935 423**	**85 372 176**

Source: Estonian Health Insurance

Appendix 3. Total expenditures on health as a percentage of GDP



Source: WHO database

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