Best Practice & Research Clinical Endocrinology & Metabolism 27 (2013) 105–115

Contents lists available at SciVerse ScienceDirect

Best Practice & Research Clinical Endocrinology & Metabolism

journal homepage: www.elsevier.com/locate/beem

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Economic costs of overweight and obesity

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Keywords:
obesity
overweight
costs and cost analysis
health expenditures
economic

Obesity has substantially increased in recent decades and is now one of the major global health problems. The large obesity-related health burden negatively impacts many relevant health outcomes (e.g. quality of life, disability, mortality) and leads to increased healthcare utilization. This excess service use is the main driver behind high healthcare costs of obese individuals. Findings indicate that costs rise curvilinearly with increasing body mass index, especially among the obese. As more individuals of a country's population become obese, a larger share of total annual national healthcare expenditure is spent on obesity and obesity-related health problems. In addition to escalating healthcare costs, obesity goes along with indirect costs through decreases in workforce productivity. The empirical evidence has shown beyond doubt that

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1521-690X/$ – see front matter
http://dx.doi.org/10.1016/j.beem.2013.01.002

obesity negatively impacts individuals, healthcare systems, employers, and the economy as a whole. This article provides a brief overview of selected economic consequences associated with excess-weight.

Introduction

Obesity is one of the major public health challenges of our time.[1–3] Although the causes for the marked increases in obesity over the last 30 years are incompletely understood, ecological models plausibly sketch how technological, economic, and ultimately social changes have created an environment ("obesogenic environment") conducive to weight gain.[4] From an economic point of view, these environmental changes have altered the opportunity cost for behaviors related to energy intake (dietary behavior) and energy expenditure (physical activity),[5] promoting a positive energy balance and subsequent weight gain in broad segments of the population.[4–6] The most widely used measure in population based health research, is the body mass index (BMI = kg/m^2).[1,3,7] According to the World Health Organization (WHO), overweight is defined as 25 $kg/m^2 \leq$ BMI $<$ 30 kg/m^2, and obesity as BMI $\geq$ 30 kg/m^2.[7] Obesity may further be subdivided into moderate (class I) obesity: 30 $kg/m^2 \leq$ BMI $<$ 35 kg/m^2, severe (class II) obesity: 35 $kg/m^2 \leq$ BMI $<$ 40 kg/m^2, and morbid (class III) obesity: BMI $\geq$ 40 kg/m^2.

Globally, overweight and obesity have considerably increased since the early 1980s.[3] In 2008, about one-third of the world's adult population ($\sim$1.46 billion) was overweight, whereas the age-standardized prevalence of obesity was 9.8% in men and 13.8% in women; with wide variation between and within countries.[3] Particularly affected are the USA, where 35.5% of men and 35.8% of women were classified as obese in 2010.[3,8] These increases pose large problems for healthcare systems worldwide, since obesity constitutes a serious risk factor for a plethora of health problems.[9,10] While some are simply a consequence of the physical burden of the excess adipose tissue itself (e.g. aches and pains, dyspnea, sleep disturbances), the majority of obesity-related medical conditions result from serious endocrine and metabolic changes (e.g. diabetes mellitus type 2, cardiovascular disease, increased cancer risk).[10] As a result, obesity is inversely associated with a multitude of health-related outcomes.[11,12] Research has shown that obese persons enjoy a lower quality of life,[13] possess more functional limitations,[14] and have a reduced life expectancy.[15] Because of the large number of diseases excess-weight may bring about, obese persons use considerably more healthcare services.[16,17] Against this background obesity must be expected to negatively impact economic outcomes as well.[18,19]

Based upon available literature reviews, augmented with exemplary original research articles, the present study provides an overview of selected economic outcomes associated with overweight and obesity. Section two gives a brief introduction to basic concepts of cost of illness (COI) studies, in which concepts and terms, referred to throughout the remainder of this article, will be introduced. Sections three and four cover the economic impact of excess-weight in adults (in terms of direct and indirect costs), while section five is dedicated to economic consequences of overweight and obesity in children and adolescents. The article closes with a short summary and some recommendations for further research.

Basic concepts of cost of illness studies

From an economic point of view costs quantify the amount of consumed or lost resources in monetary terms. With respect to COI, direct and indirect costs can be distinguished.[19] While the term direct cost refers to the resources consumed when providing healthcare services (e.g. labor for providing medical services), the term indirect cost refers to the loss in economic production caused by illness (e.g. due to sick leave). Fig. 1 provides an overview of categories of costs of obesity. Costs can be measured from different perspectives. From the societal perspective, all resources consumed/lost should be considered and monetarily valued by market prices reflecting societal opportunity costs, regardless of who experiences these costs. In contrast, from a payer's perspective (e.g. an insurance

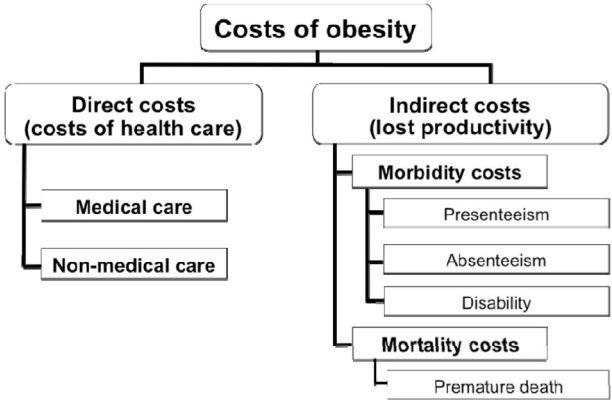

Fig. 1. Cost categories regularly considered in economic research on obesity.

company), costs encompass only the charges or cash benefits paid for healthcare services or compensation of work loss days. COI studies can be based on patient level cost data (so-called bottom-up studies) or aggregate cost data from routine statistics (so-called top-down studies). Typically, bottom-up COI studies report excess costs, which refer to the difference in costs between individuals who are affected by overweight/obesity and those who are not affected. Top-down COI studies usually estimate the shares in disease-specific costs within a population attributable to overweight/obesity (so-called population attributable fractions [PAF][20]) by combining data on the prevalence of excess-weight with relative risks of developing the specific diseases.[20] Finally, prevalence-based COI studies may be distinguished from incidence-based COI studies.[18,21] While prevalence-based COI studies provide cost estimates for prevalent cases over a limited period of time (typically a calendar year), either as per annual capita costs or aggregate annual costs, incidence-based COI studies report cost estimates for incident cases over a longer period of time, ranging from a few years to the entire lifetime (model-based analyses).[22] Irrespective of the methodological approach, COI studies provide a monetized estimate of the resources used to manage the obesity-related health burden. By showing obesity's impact relative to that of other diseases, COI studies can help to establish priorities for research and health service resource use.[19] However, COI studies do not indicate which health technologies work best, since only inputs (costs) are considered.[18] In order to assess the cost-effectiveness of health technologies, alternative interventions have to be compared in terms of both their costs and effects.[23] Findings on the cost-effectiveness of preventive and therapeutic obesity interventions can be found elsewhere.[22,24–28]

Direct cost of obesity

Published studies on the direct cost of overweight and obesity have been summarized in literature reviews.[21,29–34] The available empirical evidence comes almost exclusively from high-income countries, particularly North America and Europe. Comparisons between studies are complicated by differences in study methodology, e.g. BMI-cutoff points, included cost/expenditure categories, populations, data sources.[21,29,35] The following presentation is limited to findings from prevalence-based COI studies.

Annual per capita cost of obesity

Studies which reported annual per capita expenditures/costs were predominantly bottom-up studies based on surveys or administrative data (healthcare records and other secondary data sources) and examined differences by weight categories (e.g. BMI classes). Based on a review of studies concerned with direct costs of obesity worldwide, Withrow and Alter[29] assert that obese individuals

(BMI $\geq$ 30 kg/m^2) accrued approximately 30% higher medical costs than those with normal weight. In a review of studies concerned with the direct medical costs of overweight and obesity in the USA, Tsai et al.[33] standardized findings from individual studies in order to compute incremental costs per overweight and obese person. They found the incremental per capita cost for overweight to be 9.9% greater, and those for obesity 42.7% greater than the cost of normal weight individuals. While the relationship between excess-weight and costs was slightly j-shaped in some studies, i.e. overweight was not associated with higher (or was even associated with slightly lower) costs, when compared to normal weight,[21,30,33,35] the bulk of bottom-up COI studies observed increasing costs over the whole excess-weight range.[21,33,34,36] Studies which disaggregated obesity (BMI $\geq$ 30 kg/m^2) into classes further reveal that the largest increases in costs occur for obese subjects with BMI $\geq$ 35 kg/m^2.[22,36] For instance, in a study that examined the impact of obesity on healthcare expenditures (payments for office and hospital based care, home healthcare, dental services, vision aids, prescribed medicines) in US adults, Arterburn et al.[36] found that, when compared to normal weight adults, per capita healthcare expenditures were nearly 10% greater for overweight, and around 23%, 45%, and 81% greater for persons with class I, II, III obesity, respectively (Fig. 2). Healthcare costs for morbidly obese, or severely obese individuals with one obesity-related morbidity, have elsewhere been reported as 65–113% higher relative to normal weight individuals.[37] As a consequence of the curvilinear relationship of expenditures with BMI, severely and morbidly obese persons, who account for a relatively small proportion of the total population with excess-weight, incur a substantial amount of the total direct costs associated with overweight and obesity (compare, Fig. 2). Although different in magnitude, the positive association between excess-weight and expenditures/costs has been observed in varying populations (within and across countries) and for different categories of expenditures/costs.[29,30,34,35,38] Studies from the USA suggest that obesity's impact on annual medical spending is especially pronounced for prescription drugs,[22,31] while European studies found that direct costs differ by patient characteristics, e.g. by health-status, socio-demographic, and economic aspects.[34]

Annual aggregate cost of obesity

The vast majority of studies which reported aggregate annual costs of obesity were top-down studies applying PAF,[29] while only few authors utilized primary data.[35,38] PAF-based studies typically reported (aggregate) total or disease-specific costs for various obesity-related disorders from the perspective of the national health system. Despite using the same basic methodology, PAF-based studies differ with regard to the obesity-related diseases included (generally, the more diseases included, the higher the obesity-related

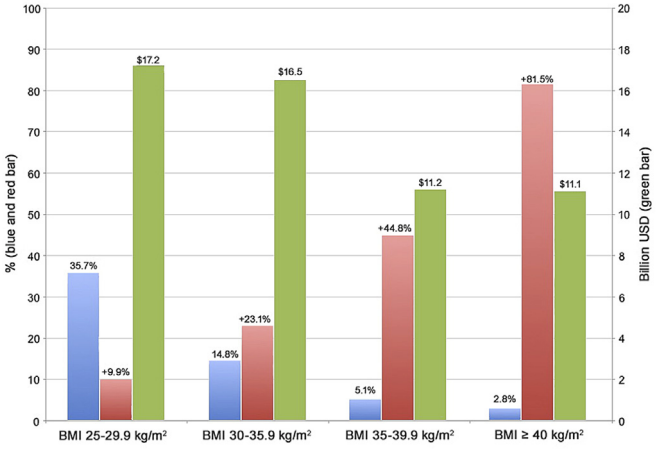

Fig. 2. Prevalence (blue bar), percentage increase in per capita expenditures (compared to BMI 18.5–24.9 kg/m^2; red bar), and aggregate expenditures (in 2000 USD; green bar) (based on data from[36]). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

costs) and BMI cutoff points.[21] Cost estimates are in addition highly dependent on the prevalence of overweight/obesity, which has substantially increased in most countries over the last 30 years.[1] More recent investigations have therefore reported markedly higher expenditures/costs, irrespective of the methodological approach.[21,22,29] Using nationally representative data from the Medical Expenditure Panel Survery (MEPS) and National Health Expenditures Accounts, Finkelstein et al.[38] found that the medical costs of obesity in the U.S. almost doubled in the period 1998 to 2008, from 78.5 billion to 147 billion US-Dollar (in 2008 USD). While the latter value corresponds to 9.1% of all U.S. healthcare expenditures in 2008, prior U.S. studies estimated lower shares, ranging from 5.5% to 7%.[21] Likewise using MEPS data (from the period 2000–2005), but employing an instrumental variable approach (using the weight of a biological relative as an instrument for the weight of the respondent), a recent publication found that total obesity-related medical costs could already have been as high as 190.2 billion USD in the year 2005.[35] This implies that about 20.6% of U.S. healthcare expenditures may have been spent on treating obesity and obesity-related diseases during that year. Despite the marked differences in the estimates of obesity-related medical expenditures/costs reported in individual studies, researchers broadly agree that (the increasing prevalence of) excess-weight in the U.S. population is responsible for a substantial (and increasing) amount of annual national healthcare spending.[33,35,38] Non-U.S. studies have, irrespective of study methodology, reported considerably lower shares, typically in between 2% and 5% of total national healthcare expenditures.[29,39] Two systematic literature reviews concerned with the economic burden and costs of overweight and obesity in Europe found that between 1.9% and 4.7% of total annual healthcare costs, and 2.8% of total annual hospital costs were attributable to overweight and obesity in European countries.[30,34] Similar estimates have been reported for Australia (2% in 1990),[21] Canada (2.4% in 1997), Japan (3.2% in 1997), China (3.4% in 2003),[29] and New Zealand (4.4% in 2006).[40] The lower obesity-related expenditures/costs (expressed as a share of a country's total healthcare expenditures) in non-U.S. studies may in part be explained by the lower prevalence of overweight and obesity (especially severe and morbid obesity) in these countries, but may in addition result from a variety of healthcare system related institutional arrangements, e.g. differences in reimbursement schemes and cost structures.

Indirect cost of obesity

Higher medical expenditures are not the only costs associated with obesity. In addition, excess-weight can go along with indirect costs through decreases in workforce productivity (Box 1).[41,42] The extent to which obesity leads to changes in job performance depends on individual characteristics, especially the degree of excess-weight, on the one hand, and a multitude of work-related characteristics and requirements on the other, e.g. physical strain, stress level, sedentary nature of the job, and company policies.[42] As will be shown below, the economic costs from obesity-related limitations to fulfill job requirements may stretch well beyond the obvious productivity loss experienced by employers. The literature on indirect costs of overweight and obesity, which has been

Box 1 Overweight and obesity among firefighters in the USA.

A recent report prepared for the National Volunteer Fire Council vividly illustrates the consequences of excess-weight among firefighters in the USA.[46] Obesity rates among firefighters are markedly higher than those in the general public. This costs fire departments substantial amounts of money each year, amongst others because obese staff members missed more days from work (absenteeism) due to injury and had higher risks of permanent disability than their normal weight colleagues. Moreover, on-the-job death rates of obese firefighters due to heart attack were much higher than those found for obese police workers with comparable stress levels. The report points out that these trends are likely the consequence of a large percentage of firefighters not meeting minimal standards of physical fitness, while working at a job characterized by high punctual physical and mental strain and stress. In light of findings showing that overweight and obesity can lead to limitations in mobility, physical functions, and instrumental and basic activities of daily living,[14] these workplace outcomes among obese firefighters are not surprising.

summarized in literature reviews,[41–45] focuses on, but is not limited to, four types of productivity losses: presenteeism, absenteeism, disability, and premature mortality.

Presenteeism

Presenteeism refers to costs accrued by employees unable to work at full capacity (or reduced productivity), possibly while working in times of illness.[47] Only few studies have examined the relationship between excess-weight and reduced work productivity and/or associated costs. Even though overall results are inconclusive at this point,[41] findings from two more recent studies suggest a positive association between obesity and presenteeism. In a survey of 2983 employees from seven companies and public administrations in Belgium, BMI was positively associated with presenteeism (defined as at least two occasions of working despite illnesss).[48] A study with office and plant-based workers from eight manufacturing companies in Kentucky, USA, found that moderately or extremely obese workers (BMI $\geq$ 35 kg/m^2) experienced the greatest health-related work limitations, particularly regarding time needed to complete tasks and the ability to perform physical job demands.[49]

Absenteeism

Absenteeism, often measured as sick leave or sickness absence, is defined as time absent from work because of illness,[48] and is, probably due to the relative ease of measurement, the most frequently investigated measure of indirect costs of overweight and obesity.[41–43,45,48] At least two systematic literature reviews exclusively concerned with the relationship between (excess-)weight and absenteeism have been published.[43,45] Depending on the perspective taken, costs as a result of absenteeism arise through lost productivity and/or as a consequence of increased pay-outs for sick leave.[41] The evidence from studies using cross-sectional or longitudinal data, as well as those following a PAF approach, almost exclusively found that overweight, but especially obese employees had taken more sick leave, and had higher sick leave attributable costs than their normal weight colleagues, irrespective of occupational group.[39,41–43,45] Several studies observed an elevated risk of sick leave with increasing degrees of obesity.[41,43,45] For instance, in a retrospective cohort study with 11.728 healthcare and university employees from Duke University and Duke University Health System, USA, the rate ratio relative to normal weight (BMI 18.5–24.9 kg/m^2) for lost workdays ranged from 3.39 (BMI 30–34.9 kg/m^2) to 8.04 (BMI $\geq$ 40 kg/m^2).[50] Another common finding was a more pronounced association of excess-weight and lost workdays for long- compared to short-spells, despite varying definitions of short and long spells.[43,45] Interestingly, European studies generally found a much greater number of obesity-related sick leave days (per person year) than studies from the USA (approximately 10–50 days compared with 1–8 days),[43] possibly as a result of differences in employment protection legislation. Annual excess costs of absenteeism per obese person have been estimated at 45 USD in France, 364 USD in China, and up to 1033 USD (BMI $\geq$ 40 kg/m^2) in the USA (in 2007 USD).[41] These individual costs add up to several hundred million on the national level. Due to the high prevalence of obesity in the USA, nationwide annual costs due to obesity-related absenteeism have been estimated at 6.38 billion USD (in 2007 USD).[41]

Disability

Disability refers to short- and long-term absence from the labor market, due to a physical or mental incapability to meet occupational demands. Depending on the perspective of the analysis, disability costs arise when illness-related long-term absence from the workplace leads to productivity losses or disability payments from insurance companies and/or the government.[41] Literature reviews concerned with the relation between excess-weight and (costs accrued by) disability concordantly concluded that overweight and obese individuals have increased risks for short- and long-term disability, and are more likely to receive disability payments/pensions.[41,42,44] Even though effects were typically less pronounced (and insignificant in some studies) for overweight individuals, overall a j-shaped association was found between BMI and work disability.[41,44] After adjustment for a variety of confounders,

the odds ratios or relative risks for missed work owing to disability ranged from 1.15 to 2.8 for obese relative to non-obese persons.[41] Thus, moderately overweight persons are not necessarily at higher risk for work disability, but the risk is substantially increased for obese employees, especially those with musculo-skeletal, circulatory, and mental disorders.[44,51] The total lost productivity costs of work disability are sizable.[39,41] For instance, lost productivity costs of early retirement attributable to overweight and obesity in the German working population were estimated at 594 million Euro in 2002 (in 2002 EUR).[39]

Premature mortality

Premature mortality refers to lost productivity costs resulting from obesity-related excess mortality.[41,52] Large prospective population based studies with long follow-up periods have shown that mortality progressively increases with BMI (especially for persons with BMI $\geq$ 30),[52,53] and that time lived with obesity is directly associated with the risk of mortality (dose–response relationship).[54] For severely obese individuals with BMI $\geq$ 40 kg/m^2, reductions in median survival are comparable to those found for smoking.[31,52] The majority of studies quantifying costs from premature mortality used a PAF approach.[34,41] In these studies, indirect costs from premature mortality are typically the largest contributor to total indirect costs.[39] For the United States, lost productivity costs of early death attributable to obesity were estimated at 625 USD per obese person, or 30.15 billion USD on the national level (in 2007 USD).[41]

The economic impact of obesity in children and adolescents

The prevalence of overweight and obesity in children and adolescents has substantially increased in recent decades.[55–57] Similar to adults, obese children and adolescents are also faced with increased risks to contract obesity-related diseases, many of which may already develop during childhood/adolescence.[55,58] Affected youth are in addition at greatly increased risk of becoming obese adults, with those who were obese during childhood being much more likely to suffer from obesity-related morbidity in adulthood (even when excess-weight childhood weight is later lost).[55,59] The economic impact of children's excess-weight stems from the costs of obesity-related healthcare use (during childhood), possible lost productivity costs of legal guardians (e.g. parents), as well as long-term direct and indirect costs resulting from obesity-related morbidity and mortality in adulthood.

Studies on the economic consequences of overweight and obesity in childhood and adolescence have been summarized in systematic reviews.[55,59–61] The great majority of COI studies was published within the last ten years, comes from high-income countries (particularity the USA[61]), followed a prevalence-based approach, and applied descriptive and/or regression-analytical methods to monetarily quantify the medical burden of childhood overweight and obesity. While some studies estimated total healthcare costs, many others were limited to specific cost categories, i.e. primary care and outpatient costs, in-patient costs, pharmaceutical costs.

The available reviews concordantly concluded that the findings on the association of excess-weight and healthcare costs/expenditures in childhood are inconclusive.[55,59–61] Irrespective of the cost categories analyzed, the majority of available studies reported significant excess costs (with wide variation of cost/expenditure estimates between studies), however.[55] Yet, some studies found non-significant or no excess costs for overweight and/or obese, compared to normal weight children.[55,59] For instance, Hampl et al.,[62] who analyzed data from 8.404 individuals aged 5–18 years from a large pediatric integrated delivery system in the USA, found that those diagnosed with obesity (overweight) during a healthy child visit had 172 USD (28 USD) higher annual healthcare expenditures than normal weight children (in 2003 USD). Two further studies from the USA found higher healthcare expenditures, which were significant only for subgroups of the total sample, i.e. adolescents aged 14–18 years (220 USD [in 2006 USD])[63] and girls aged 12–19 years (790 USD [in 2003 USD]),[64] while another study from the USA found no association between weight and expenditures in adolescents aged 12–19 years.[65] The reasons why individual studies have produced such heterogeneous results remain largely unexplored, but this observation implicates that the findings of a particular study may not be generalizable beyond the study population.[59] In-patient costs for obese children and adolescents have, as a result of an increase

in hospitalizations for conditions closely associated with obesity (probably in large part due to increases in prevalence), substantially increased over time, as has been shown in studies from the USA[66] and Ireland.[67]

In addition to increased healthcare costs/expenditures, childhood obesity may also bring about indirect costs, most of which will be accrued in the long-term (in adulthood). The short-term indirect costs resulting from childhood obesity are limited to productivity losses experienced by legal guardians like parents and other individuals taking care of obese children (since most children and adolescents do not participate in the workforce). One study from Germany estimated the impact of obese children and adolescents aged 3-17 on the indirect costs of their parents.[68] By evaluating parent's time losses from work and other activities (like household production) used to care for their obese children, the authors found that, compared with normal weight children, indirect costs tended to be 101 EUR higher annually for parents with obese children, although this result was not statistically significant (in 2007 EUR).[68]

Excess-weight may lead to marked indirect costs in the long-run (in adulthood) by two routes. First, obesity in childhood is the greatest predictor of obesity in adulthood, and those obese as children are much more likely to suffer from obesity-related morbidity and mortality as adults,[55] which can bring about indirect costs through decreases in (work-related) productivity; as described in Section 4. Second, childhood obesity may negatively influence overall educational performance (quantity and quality of schooling) and in this way, indirectly, work-related productivity in adulthood. A recent systematic review on the relationship between obesity and educational attainment was inconclusive, however.[69] Although the majority of included studies observed a weak negative association between obesity and educational attainment, i.e. higher weight was associated with lower educational attainment, while differences between the educational attainment of overweight and normal weight children were marginal, this effect was insignificant in many studies, while some other studies even reported a positive relationship. Even though these results indicate a likely link between obesity and the educational experiences of students,[31] further research is necessary to clarify this relationship, and its potential impact on productivity losses in adulthood.

Summary

This article provides a brief overview of selected economic outcomes associated with obesity. Empirical findings have shown beyond doubt that a strong positive association exists between excess-weight and medical expenditures/costs. While this relationship seems less pronounced for children and adolescents,[55,59] empirical evidence convincingly indicates that costs increase in curvilinear fashion for adults with BMI $\geq$ 25 kg/m^2.[35] The high and increasing prevalence of overweight and obesity in many countries, especially severe and morbid obesity[70] has created a situation where a substantial amount of national healthcare expenditures, and likely increases thereof over time, are attributable to excess-weight.[21,22,29–36] Recent evidence from the USA indicates that up to 20% of total annual U.S. healthcare expenditures, around 190 billion USD, may have been spent on obesity-related medical care in 2005.[35] Since obesity's economic impact is not limited to healthcare costs, the overall excess-weight related economic burden is even higher. Findings from various countries suggest that the indirect costs may equal or even exceed the direct obesity-related costs.[34] Indirect costs arise from decreases in workforce productivity, either at work (presenteeism) or because employees are unable to work (absenteeism, disability, premature mortality).[41] While a positive association between obesity and presenteeism, absenteeism, disability, and premature mortality has been repeatedly found for obese subjects (BMI $\geq$ 30 kg/m^2), with elevated risks for severely and morbidly obese individuals, the evidence is less conclusive for persons in the overweight range.[7] The detrimental influence of obesity on labor productivity was found for further work-related outcomes, e.g. workplace injuries and recovery time,[42] insurance premiums,[41] and workers compensation claims, however.[41,42] As all economic and societal costs of overweight and obesity are hardly ever included in COI studies, the total obesity-related economic impact is likely more far-reaching.[71]

In order to fight the huge economic burden of overweight and obesity, cost-effective interventions should be implemented. The last two decades of obesity research have seen the development of a wide variety of preventive and therapeutic interventions,[24,72–75] and subsequent economic evaluations

(cost-effectiveness analyses) have identified interventions which offer good value (health improvements) for the money invested (intervention costs).[22,24–28] Recent findings have shown that preventive, e.g. advertisement regulation for children and adolescents,[76] as well as therapeutic, e.g. bariatric surgery for severely and morbidly obese persons,[24] interventions can be cost-saving within a few years after the intervention. Thus, at least for some population groups there seem to exist promising ways to cut back the economic burden of obesity.

Practice points

- To detect obesity early, at best before the manifestation of related disorders, physicians should routinely screen patients for obesity by calculating the BMI. Patients with BMI $\geq$ 30 kg/m^2 should be made aware of possible health consequences, and, depending on the country-specific guidelines (e.g.[8]) and availability of interventions, offered appropriate interventions, e.g. comprehensive behavioral intervention, or bariatric surgery for patients with BMI $\geq$ 40 kg/m^2.
- In order to fight the huge and far-reaching economic burden of overweight and obesity, cost-effective preventive and therapeutic interventions should be developed and implemented.

Research agenda

- Future research on costs of overweight and obesity should investigate the development of costs over the life cycle and their determinants using longitudinal study designs more frequently.
- Population attributable risk estimates applied in top-down COI studies should be in concordance with the latest and most appropriate epidemiological findings, especially with regard to the interaction between obesity-related diseases.

Conflict of interest statement

TL, DS, AK, SRH, and HHK have nothing to declare.

Acknowledgments

This work was supported by the Federal Ministry of Education and Research (BMBF), Germany, FKZ: 01EO1001. The BMBF had no further role in the study design; in the collection, analyses and interpretation of data; in writing the report; and in the decision to submit the paper for publication. The publication of study results was not contingent on the sponsor's approval.

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