Economic impact of adult obesity on health systems: a systematic review

Maria Lucia Specchia¹, Maria Assunta Veneziano¹, Chiara Cadeddu¹, Anna Maria Ferriero¹, Agostino Mancuso¹, Carolina Ianuale¹, Paolo Parente¹, Stefano Capri¹,², Walter Ricciardi¹

1 Department of Public Health - Section of Hygiene, Catholic University of the Sacred Heart, Rome, Italy
2 School of Economics and Management, LIUC University, Castellanza (VA), Italy

Correspondence: Chiara Cadeddu, Department of Public Health - Section of Hygiene, Catholic University of the Sacred Heart, L.go F. Vito, 1 – 00168 Rome, Italy, Tel: +39 06 35 00 15 25, Fax: +39 06 35 00 15 22, e-mail: chiaracadeddu@yahoo.it

Introduction

Obesity represents an important public health issue, so that the World Health Organization (WHO) defines it as the ‘epidemic of the 21st Century’.

According to the Organisation for Economic Cooperation and Development (OECD), from the 1980s, a significant increase in obesity rates was recorded in the majority of OECD countries.² Between 1980 and 2008, in USA and UK, obesity rates have more than doubled among adults. Several papers,³⁵ aimed at explaining the significant obesity rise, have been published during past years, and two theories have been developed to explain the obesity rise within the developed countries: the neoclassical and the behavioural.

According to the neoclassical theory by Philipson,³ the obesity rise is mainly because of the technological progress that led to decreased physical activity, related to the increase of sedentary jobs, and to a marked decrease in food prices. According to the behavioural theory by Cutler et al.⁴, obesity rise depends on the increased caloric intake, owing to the fact that technological progress has caused a decrease in both cost of food and time spent in food preparation, by increasing mass production. On the basis of these considerations, technological change is one of the main causes of obesity growth.³⁵

Given the significant economic and social impact related to the obesity growth, an assessment of its costs would be useful to provide recommendations for policy- and decision-making strategies.⁶

According to the WHO, the cost estimates of obesity epidemic account for several billion dollars per year, with a great impact on medical expenditure, and this trend is still rising worldwide, especially among developed countries. In the USA, obesity caused an increase of almost $40 billion, through 2006, because of medical spending, of which $7 billion was absorbed by prescription drug costs.⁷ In Australia, in 2005, obesity-related costs were of $1721 million, of which, direct medical costs were responsible for $1084 million and indirect costs for $637 million.⁸

The aims of our study were to: (i) carry out a systematic review to assess the economic burden of adult obesity (AO) and overweight in terms of direct and indirect costs and (ii) perform a quality appraisal of the analysed studies.

Methods

Literature search

A systematic review of the AO economic impact was performed. A literature search was carried out on PubMed, Scopus and Cochrane Library databases to retrieve cost-of-illness (COI) analyses focused on adult (aged 18 years or more) overweight or obese people and published up to 2013. COI analyses that considered direct and indirect costs were included. Each included manuscript was independently appraised by three groups of researchers on the basis of the British Medical Journal Drummond’s checklist. Results: Approximately 2044 articles were initially retrieved, and 17 were included in the current review. The included studies showed a medium–high-quality level. The available studies seemed to be heterogeneous both in terms of methodology and results reporting. However, as many studies have been conducted from the payer perspective, just direct medical costs can be considered exhaustive. As only three studies included considered also indirect costs, there is no strong evidence to give a comprehensive picture of this phenomenon also from the societal perspective. Conclusion: The review confirmed that obesity absorbs a huge amount of health-care resources. Further research is therefore needed to better understand the economic impact and to identify and promote public health strategies to tackle obesity.

---

OECD, Organisation for Economic Cooperation and Development
Table 1 The international classification of adult underweight, overweight and obesity according to BMI

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI(kg/m²)</th>
<th>Principal cut-off points</th>
<th>Additional cut-off points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td></td>
<td>&lt;18.50</td>
<td>&lt;18.50</td>
</tr>
<tr>
<td>Severe thinness</td>
<td></td>
<td>&lt;16</td>
<td>&lt;16</td>
</tr>
<tr>
<td>Moderate thinness</td>
<td>16.00–16.99</td>
<td>16.00–16.99</td>
<td></td>
</tr>
<tr>
<td>Mild thinness</td>
<td>17.00–18.49</td>
<td>17.00–18.49</td>
<td></td>
</tr>
<tr>
<td>Normal range</td>
<td>18.50–24.99</td>
<td>18.50–24.99</td>
<td>23.00–24.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>&gt;25</td>
<td>25.00–29.99</td>
<td></td>
</tr>
<tr>
<td>Pre-obese</td>
<td></td>
<td></td>
<td>25.00–27.49</td>
</tr>
<tr>
<td>Obese</td>
<td>&gt;30</td>
<td></td>
<td>27.50–29.99</td>
</tr>
<tr>
<td>Obese class I</td>
<td>30.00–34.99</td>
<td>30.00–32.49</td>
<td></td>
</tr>
<tr>
<td>Obese class II</td>
<td>35.00–39.99</td>
<td>35.00–37.49</td>
<td></td>
</tr>
<tr>
<td>Obese class III</td>
<td>≥40</td>
<td></td>
<td>≥40</td>
</tr>
</tbody>
</table>


COI analyses focused on overweight or obese adults (as defined above: BMI ≥ 25) aged >18 years were considered.

COI analyses that considered the economic burden of AO were included. COI analyses are the first type of economic evaluations performed within the health-care sector, although this kind of analyses are considered partial economic evaluations, as they do not combine costs with outcomes. The main purpose of this kind of analyses is to quantify the economic burden related to a particular disease borne by both health-care sector and society in terms of health-care resources and productivity losses. We included COI analyses focused on both direct and indirect costs, as obesity absorbs also a huge amount of indirect costs expressed in terms of productivity losses due to working days lost and reduced productivity at work. Direct costs refer to cost borne by the Payors (that fall into the health-care setting), on the other hand, indirect costs fall outside the health-care sector and refer to productivity losses due to illness. Direct costs, in turn, can be distinguished into two different categories: medical and non-medical. The first category consists of medical expenditures directly related to the disease in object, expressed in terms of visits to physicians, diagnostic tests, drugs and hospitalizations. The second category refers to travel cost to the physician and to health-care facilities. The quality of the included studies was assessed according to Drummond’s checklist.12 Table 2 depicts the results of the appraisal.

The assessment of the eligibility of the studies, the data analysis and the interpretation of results was independently carried out by three groups of researchers (C.C., A.M.F., S.C.; C.I., M.L.S., A.M.; P.P., M.A.V., W.R.). Articles were included by considering the following criteria:

- assessment of titles and abstracts of articles yielded by the search;
- collection of the full text of potentially relevant COI analyses;
- analysis of the full text with the aim to assess that the included studies matched with the inclusion criteria above reported.

Study analysis and quality appraisal

Each included manuscript was independently appraised by three groups of researchers (C.C., A.M.F., S.C.; C.I., M.L.S., A.M.; P.P., M.A.V., W.R.). Disagreements between the three teams were resolved through discussion.

To assess the AO economic impact, each study was analysed by considering both direct and indirect resources absorbed because of AO-related costs.

Quality appraisal of the COI analyses included in the current review was performed on the basis of the British Medical Journal (BMJ) Drummond’s checklist,12 commonly used to appraise the quality of economic evaluations. This checklist consists of 35 items divided into three main sections: study design (7 items), data collection (14 items) and analysis and interpretation of results (14 items). As in the current review COI analyses, which are partial economic evaluations by definition, were included, items that can be assessed just in the case of full economic evaluations were considered not appropriate (Table 2).

Synthesis of results

The main information was selected independently by the two teams of reviewers and summarized in a Table that considers the following data: country, kind of COI analysis, target population, time horizon, perspective, costs, currency, discount rate and main findings (table 3).

Results

Literature search results

In figure 1, the literature search and the selection process are depicted. About results, of the 2044 potentially relevant articles, after removing duplicates (n = 208), 1722 studies were excluded through title screening because they did not deal with obesity (n = 897) or they were not COI analyses (n = 802) or they did not consider eligible population (n = 23). Of the 114 remaining papers, 66 were excluded through abstracts’ review, as they did not fit the eligibility criteria. Among the leftover 48 studies, 31 papers were rejected because they did not meet inclusion criteria, by reviewing full texts. Finally, 17 COI analyses7–13,24–27 were deemed relevant for the current review (figure 1 – flowchart). The main characteristics of the included papers are reported in table 3.

Most of the studies7–13,24–27 were conducted in the USA, one in Canada,20 two in Brazil,21,22 two in Germany,23,24 one in Japan,19 one in UK,25 one in Australia,26 one in Korea27 and one in China.28 With reference to the perspective, many studies7,13,13–22,25,36,28 were carried out from the Payer’s perspective, two from both societal and Payer’s perspective23,27 and one only from the societal perspective.24 About the type of COI analysis, several studies were retrospective,7,14,17,18,21,22,24–28 four prospective13,16,19,20,23 and one cross-sectional.13 Regarding cost measures, the type of costs mostly considered were direct medical costs; three studies included also indirect costs,23,24,27 and one study took into account also direct non-medical costs.26 All of the studies considering indirect costs7,3,24,27 followed the human capital approach to quantify productivity losses.

Quality appraisal and main results about AO economic burden are reported in the following paragraphs.

Quality appraisal

The quality of the included studies was assessed according to Drummond’s checklist.12 Table 2 depicts the results of the appraisal.

In all of the studies, the research question was stated (item 1), the answer to the study question was given (item 33) and the conclusions followed from the data reported (item 34). All but one study19 stated the economic relevance of the research question (item 2).

In 8897,13,16,18,20–28 studies, limits were clearly explained in the conclusion section (item 35). Just three studies met item 1423,24,27 by reporting productivity changes separately, and only nine studies described methods followed to estimate quantities and unit costs (item 17).7,14,17,19,21,22,25,27 The discount rate (item 23) was stated...
conducted in US in 2005 by Arterburn et al. reported an overall direct medical costs related to overweight, obese I and obese II/III were equal to US$3115, US $3686 and US $4386. Another study that severely obese men led to 84% higher (US $5618) than non-overweight women. overweight and obesity amounted to US$2152 billion in Brazil. In particular, the main cost driver was represented by hospitalizations accounting for US $1473 billion (68.4% of total costs), followed by ambulatory procedures with a related cost of US$679 million (31.6%). According to Onwudiwe et al.4, annual per individual direct medical costs related to overweight, obese I and obese II/III were equal to US$3115, US $3686 and US $4386. Another study conducted in US in 2005 by Arterburn et al.13 reported an overall per capita health-care expenditure for morbidly obese adults of US $1975 (81%) greater than normal weight adults, of US $1735 (65%) greater than overweight adults and US $1415 greater (47%) than adults with class I obesity. Daveigus et al.15 performed a study aimed at assessing obesity costs per gender showing that severely obese men led to 84% higher costs (US $6192) than non-overweight ones and severely obese women 88% higher (US $1975 (81%) greater than normal weight ones. According to Thorpe et al.16 reported that per capita spending among obese people was 37% higher than normal weight ones. According to Finkelstein et al.7, the increased prevalence of obesity in the USA was responsible for almost $40 billion of increased medical spending through 2006, including $7 billion in Medicare prescription drug costs. Another study conducted in the USA showed that the total excess cost owing to overweight and obesity amounted to US$2152 billion in Brazil. In particular, the main cost driver was represented by hospitalizations accounting for US $1473 billion (68.4% of total costs), followed by ambulatory procedures with a related cost of US$679 million (31.6%). According to Onwudiwe et al.4, annual per individual direct medical costs related to overweight, obese I and obese II/III were equal to US$3115, US $3686 and US $4386. Another study conducted in US in 2005 by Arterburn et al.13 reported an overall per capita health-care expenditure for morbidly obese adults of US $1975 (81%) greater than normal weight adults, of US $1735 (65%) greater than overweight adults and US $1415 greater (47%) than adults with class I obesity. Daveigus et al.15 performed a study aimed at assessing obesity costs per gender showing that severely obese men led to 84% higher costs (US $6192) compared with non-overweight ones and severely obese women 88% higher (US $1975 than non-overweight women.

Data Collection
8 The sources of effectiveness estimates used are stated
9 The details of the design and results of effectiveness study are given (if based on a single study)
10 Details of the method of synthesis or meta-analysis of estimates are given
11 The primary outcome measures for the economic evaluation are clearly stated
12 Methods to value health status and other benefits are stated
13 Details of the sources from whom evaluations were obtained are given
14 Productivity changes (if included) are reported separately (if based on an overview of a number of effectiveness study)
15 The relevance of productivity changes to the study question is discussed
16 Quantities of resources are reported separately from their unit costs
17 Methods for the estimation of quantities and unit costs are described
18 Currency and price data are recorded
19 Details of currency of price adjustment for inflation or currency conversion are given
20 Details of any model used are given
21 The choice of model used and the key parameters on which it is based are justified

Analysis and Interpretation of Results
22 Time horizon of costs and benefits is stated
23 The discount rate is stated
24 The choices of rates are justified
25 An explanation is given if costs/benefits are not discounted
26 Details of statistical tests and confidence intervals are given for stochastic data
27 The approach to sensitivity analysis is given
28 The choice of variables for sensitivity analysis is justified
29 The ranges over which the variables are varied are stated
30 Relevant alternatives are compared
31 Incremental analysis is reported
32 Major outcomes are presented in a disaggregated as well as aggregated form
33 The answer to the study question is given
34 Conclusions follow from the data reported
35 Conclusions are accompanied by the appropriate caveats

Each number represents the combined score across all 17 included studies.

Daviglus et al.15 performed a study aimed at assessing obesity costs per gender showing that severely obese men led to 84% higher costs (US $6192) compared with non-overweight ones and severely obese women 88% higher (US $1975 than non-overweight women.

Thorpe et al.16 reported that per capita spending among obese people was 37% higher than normal weight ones. According to Finkelstein et al.7, the increased prevalence of obesity in the USA was responsible for almost $40 billion of increased medical spending through 2006, including $7 billion in Medicare prescription drug costs.

Another study conducted in the USA showed that the total excess cost owing to overweight and obesity amounted to US$2152 billion in Brazil. In particular, the main cost driver was represented by hospitalizations accounting for US $1473 billion (68.4% of total costs), followed by ambulatory procedures with a related cost of US$679 million (31.6%). According to Onwudiwe et al.4, annual per individual direct medical costs related to overweight, obese I and obese II/III were equal to US$3115, US $3686 and US $4386. Another study conducted in US in 2005 by Arterburn et al.13 reported an overall per capita health-care expenditure for morbidly obese adults of US $1975 (81%) greater than normal weight adults, of US $1735 (65%) greater than overweight adults and US $1415 greater (47%) than adults with class I obesity. Daveigus et al.15 performed a study aimed at assessing obesity costs per gender showing that severely obese men led to 84% higher costs (US $6192) compared with non-overweight ones and severely obese women 88% higher (US $1975 than non-overweight women.

Thorpe et al.16 reported that per capita spending among obese people was 37% higher than normal weight ones. According to Finkelstein et al.7, the increased prevalence of obesity in the USA was responsible for almost $40 billion of increased medical spending through 2006, including $7 billion in Medicare prescription drug costs.

Another study conducted in the USA showed that the total excess of medical care expenditures was on average of $15,000 for each overweight individual and $26,000 for each obese individual.17 Wee et al.18 reported a mean annual health-care expenditure of $2970 among normal-weight adults, mean expenditures were $3038 for overweight adults and $4333 for obese adults. The study by Janssen et al. showed that in Ontario the physician average costs were $4275$ for males and 5785 for females in overweight adults and 4758$ for males and 6825 for females in obese ones.20 A study conducted in the UK from the National Health System (NHS) perspective highlighted overweight and obesity cost accounting for £5.1 billion.25

The retrospective COI analysis, by Sichieri et al.22, aimed at highlighting the economic impact of hospitalizations in adult people (>20 years) in Brazil, showed that in 2001 overall costs of overweight and obesity were equal to 3.02% and to 5.83% of total hospitalization costs among men and women, respectively. A COI carried out in China by Zhao et al.28 reported an amount of total medical cost because of overweight and obesity equal to 21.11 billion Yuan (RMB) (US $2.74 billion), accounting for 3.7% of national total medical costs in 2003.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Type of COI analysis</th>
<th>Population</th>
<th>Time horizon</th>
<th>Perspective</th>
<th>Costs considered</th>
<th>Currency (year)</th>
<th>Discount rate</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahia et al. 2012</td>
<td>Brazil</td>
<td>Retrospective</td>
<td>Overweight and obese people</td>
<td>2008–10 (3 years)</td>
<td>Brazilian Health System (SUS)</td>
<td>Direct costs (hospitalization and ambulatory costs)</td>
<td>US$ (2010)</td>
<td>Not stated</td>
<td>Estimated total costs in one year with all diseases related to overweight and obesity = US$2 152 102 171. Hospitalizations = US$147 792 952 (68.4% of total costs) and ambulatory procedures = US$67 353 348.</td>
</tr>
<tr>
<td>Onwudie et al. 2011</td>
<td>USA</td>
<td>Retrospective</td>
<td>Overweight and obese adult</td>
<td>2002 (cross-sectional)</td>
<td>Medicare</td>
<td>Direct medical costs</td>
<td>US$ (2002)</td>
<td>Not stated</td>
<td>Pattern between unadjusted BMI and Medicare expenditure: overweight $3115 (reference), obese I $3686 (P &lt; 0.0039), and obese II/III $4386 (P &lt; 0.0000), persisting after accounting for height loss: overweight $3165 (reference), obese I $3915 (P &lt; 0.0010) and obese II/III $4385 (P &lt; 0.0004) compared with overweight. In older adults, minimal cost is found in overweight subjects with higher spending in the obese category.</td>
</tr>
<tr>
<td>Colagiuri et al. 2010</td>
<td>Australia</td>
<td>Retrospective</td>
<td>Overweight and obese people</td>
<td>2005</td>
<td>Third payer</td>
<td>Direct medical and non-medical costs and government subsidies</td>
<td>AUD$ (2005)</td>
<td>Not stated</td>
<td>The total direct cost in Australia in 2005 for overweight or obese people aged 30 years was $18.8 billion (95% CI, $16.9–$20.8 billion) — $10.5 billion for the overweight ($7.8 billion direct health and $2.7 billion direct non-health) and $8.3 billion for those who were obese ($6.6 billion direct health and $1.7 billion direct non-health). Furthermore, $18.7 billion (95% CI, $17.5–$19.9 billion) and $13.6 billion (95% CI, $12.5–$14.6 billion) were spent in government subsidies on the overweight and the obese, respectively.</td>
</tr>
<tr>
<td>Jansenn et al. 2008</td>
<td>Canada</td>
<td>Retrospective</td>
<td>Overweight and obese people</td>
<td>2002–03</td>
<td>Third payer</td>
<td>Direct costs (physician costs)</td>
<td>Canadian $ (no year)</td>
<td>Not stated</td>
<td>The physician average costs according to BMI category in overweight adults by gender were respectively $427 (95% CI, $392, $467) for males and $578 (95% CI, $542, $613) for females. In obese adults the same average costs were $475 (95% CI, $434, 518) for males and $682 (95% CI, $639, 738) for females. The physician average costs according to age category (young adults: 18–39 years, middle-aged: 40–59 years, older: 60+ years) in overweight adults were respectively $307 (95% CI, 279, 339), $477 (95% CI, 444, 512) and $844 (95% CI, 785, 902). In obese adults, the same average costs were $395 (95% CI, 310, 408), $547 (95% CI, 502, 595) and $1029 (95% CI, 935, 1121) for young adults, middle-aged and older, respectively.</td>
</tr>
<tr>
<td>Kuriyama et al. 2006</td>
<td>Japan</td>
<td>Prospective</td>
<td>Overweight and obese people</td>
<td>1995–8</td>
<td>Not indicated</td>
<td>Direct medical costs</td>
<td>US$ (no year)</td>
<td>Not stated</td>
<td>U-shaped association between BMI and total medical costs, with mean total costs that were 9.8% greater among the overweight and 22.3% greater among the obese. Overall per capita health-care expenditures for morbidly obese adults were $1975 (81%) greater than normal weight adults, $1735 (65%) greater than overweight adults and $1415 greater (47%) than adults with class I obesity.</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Type of COI analysis</th>
<th>Population</th>
<th>Time horizon</th>
<th>Perspective</th>
<th>Costs considered</th>
<th>Currency (year)</th>
<th>Discount rate</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daviglus et al. 2004</td>
<td>US</td>
<td>Prospective</td>
<td>Overweight and obese people ≥ 18 years</td>
<td>1984–2002</td>
<td>Medicare</td>
<td>Not indicated</td>
<td>US$ (2005)</td>
<td>Not stated</td>
<td>Total charges for severely obese men were $6192 more (84% higher) than for non-overweight men; total charges for severely obese women were $5618 more (88% higher) than for non-overweight women.</td>
</tr>
<tr>
<td>Kang et al. 2011</td>
<td>Korea</td>
<td>Retrospective</td>
<td>Adult obese and overweight people ≥ 20 years</td>
<td>2005</td>
<td>Payer (National insurance) and society</td>
<td>Direct costs (inpatient care, outpatient care and medication) and indirect costs (loss of productivity because of premature deaths and inpatient care, time costs, traffic costs and nursing fees).</td>
<td>US$ (2005)</td>
<td>6% (future earnings)</td>
<td>Direct costs of overweight and obesity were estimated at ~US$1081 million (men: US$497 million, women: US$584 million), and indirect costs were estimated at ~US$706 million (men: US$527 million, women: US$178 million). Total obesity and overweight-related costs were ~US$1787 million (men: US$1081 million, women: US$706 million). These total costs represented about 0.22% of the gross domestic product and 3.7% of the national health-care expenditures in 2005.</td>
</tr>
<tr>
<td>Wolfenstetter et al. 2012</td>
<td>Germany</td>
<td>Prospective (based on retrospective data: 1995–2005)</td>
<td>Adult obese people ≥ 35 years</td>
<td>Not defined</td>
<td>Payer and society</td>
<td>Direct costs (inpatient: hospital and rehabilitation and outpatient: GPs, specialists and indirect costs)</td>
<td>€ (2005)</td>
<td>NA</td>
<td>The predicted average adjusted total direct costs per year were of €1218 (€1442) for healthy weight people, €1093 for overweight and €1040 for obese people. An overweight patient was estimated to be responsible for higher indirect costs (€2474) compared with healthy weight people (€2136).</td>
</tr>
<tr>
<td>Sichieri et al. 2007</td>
<td>Brazil</td>
<td>Retrospective</td>
<td>Adult obese and overweight people 20-60 years</td>
<td>One year (2001)</td>
<td>Payer</td>
<td>Direct medical costs (hospitalization)</td>
<td>US$ (2001)</td>
<td>NA</td>
<td>Overall costs of overweight and obesity were equal to 3.02 and to 5.83 % of the total hospitalization costs among men and women, respectively.</td>
</tr>
<tr>
<td>Finkelstein et al. 2009</td>
<td>US</td>
<td>Retrospective</td>
<td>Obese adults (BMI &gt; 30) aged more than 18 years</td>
<td>1998–2006</td>
<td>US payers (Medicare, Medicaid and private insurers)</td>
<td>Direct medical costs (inpatient, outpatient, emergency room, office-based, dental, vision, home health and prescription)</td>
<td>US$ (2008)</td>
<td>NA</td>
<td>The increased prevalence of obesity was estimated to be responsible for almost $40 billion of increased medical spending through 2006, including $7 billion in Medicare prescription drug costs. It was estimated that the medical costs of obesity could have risen to $147 billion per year by 2008.</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Type of COI analysis</th>
<th>Population</th>
<th>Time horizon</th>
<th>Perspective</th>
<th>Costs considered</th>
<th>Currency (year)</th>
<th>Discount rate</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Konnopka et al. 2010&lt;sup&gt;44&lt;/sup&gt;</td>
<td>Germany</td>
<td>Retrospective</td>
<td>German overweight and obese population (BMI &gt;25) aged &gt;15 years</td>
<td>2002</td>
<td>Societal</td>
<td>Direct costs (inpatient and outpatient treatment, rehabilitation and non-medical costs) and indirect costs (sickness absence, early retirement and mortality using the human capital approach)</td>
<td>€ (2002)</td>
<td>0–3–10%</td>
<td>Obesity caused 4854 million EUR in direct costs corresponding to 2.1% of the overall German health expenditures in 2002 and 5019 million EUR in indirect costs.</td>
</tr>
<tr>
<td>Scarborough et al. 2011&lt;sup&gt;15&lt;/sup&gt;</td>
<td>UK</td>
<td>Retrospective</td>
<td>Overweight and obese people (age not specified)</td>
<td>2006-07</td>
<td>NHS</td>
<td>Direct medical costs (not specified)</td>
<td>£ (2006)</td>
<td>N.A.</td>
<td>Overweight- and obesity-related costs were estimated to account for £5.1 billion.</td>
</tr>
<tr>
<td>Yang et al. 2008&lt;sup&gt;17&lt;/sup&gt;</td>
<td>US</td>
<td>Retrospective</td>
<td>Medicare beneficiaries aged 65 years or older</td>
<td>1992–2001</td>
<td>US payers</td>
<td>Direct medical costs (outpatient, inpatient, drugs and nursing home)</td>
<td>US$</td>
<td>N.A.</td>
<td>The total excess of medical care expenditures could be $15 000 of every overweight individual, and $26 000 of every obese individual on average.</td>
</tr>
<tr>
<td>Zhao et al. 2008&lt;sup&gt;24&lt;/sup&gt;</td>
<td>China</td>
<td>Retrospective</td>
<td>Adult obese and overweight people</td>
<td>2002–03</td>
<td>Third payer</td>
<td>Direct medical costs (outpatient visits, physician services, inpatient stays, rehabilitation services, nursing fees and medications)</td>
<td>US$ (2003)</td>
<td>N.A.</td>
<td>The total medical cost attributable to overweight and obesity was estimated at 21.11 billion Yuan (RMB) (<del>$2.74 billion) accounting for 25.5% of the total medical costs for the four chronic diseases, or 3.7% of national total medical costs in 2003. The medical cost associated with overweight and obesity could increase to 37 billion Yuan (RMB) (</del>$4.8 billion), a 75% increase, if the epidemic developed speedily and the ratio of overweight to obesity approached. The weighted mean annual health-care expenditure (in December 2003 dollars) was $3338 per person before adjustment. In comparison with a mean expenditure of $2970 among normal-weight adults, mean expenditures were $3038 for overweight adults and $4333 for obese adults.</td>
</tr>
<tr>
<td>Wee et al. 2005&lt;sup&gt;18&lt;/sup&gt;</td>
<td>US</td>
<td>Retrospective</td>
<td>Obese adults ≥18 years (age group: &lt;35, 35–54, 55–64 or 65 years or above)</td>
<td>2003</td>
<td>Payer</td>
<td>Direct medical costs (inpatient, outpatient, prescription and emergency)</td>
<td>US$ (2003)</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

N.A., Not Available; 95% CI, 95% confidence interval.
A study conducted in Japan in 2006 highlighted that mean direct total costs were 9.8% greater among the overweight and 22.3% greater among the obese compared with normal weight people.

**Direct medical and non-medical costs**

Colagiuri et al. reported that in Australia in 2005 total direct cost due to overweight and obesity was $18.8 billion. In particular, overweight accounted for $10.5 billion ($7.8 billion direct medical and $2.7 billion direct non-medical) and obesity for $8.3 billion ($6.6 billion direct medical and $1.7 billion direct non-medical).

**Direct costs and indirect costs**

A retrospective COI analysis by Kang et al. in 2011 estimated direct costs of overweight and obesity in Korea equal to $1081 million (men: $527 million, women: $554 million) and indirect costs of overweight and obesity in Korea equal to $1081 million (men: $527 million, women: $554 million).

During the obesity epidemic growth, the increased caloric intake, thus emphasizing the role of lifestyle factors. The last played an important role in raising obesity and, consequently, the risk of developing comorbidities.

**Discussion**

Given the significant increase in the obesity rates recorded during the past 30 years, especially in the developed countries, and overweight and obesity represent a priority public health issue. On the one hand, particular attention has been paid to this phenomenon by policy- and decision-makers, on the other hand, several attempts were made by researchers to investigate the obesity epidemic, analysing its causes and consequences. In particular, the neoclassical and the behavioural theories by Philipson and Cutler, aforementioned, converge to technological progress as one of the main causes of obesity growth, because of the consequent decreased physical activity and the increased caloric intake, thus emphasizing the role of lifestyle factors. The last played an important role in raising obesity and, consequently, the risk of developing comorbidities.

The concepts behind these theories represent the pillar of public health strategies aimed at reducing the epidemiological and economic burden related to obesity. With reference to the latter, the aim of this review was to address the AO and overweight both in terms of direct and indirect costs and to provide a quality appraisal of the reviewed studies.

This represents the first systematic review on adult obese and overweight people that matches both systematic search and quality appraisal of literature on the basis of Drummond and Jefferson BMJ referee checklist. We previously published a similar paper, but focused on a childhood population.

Although several potentially relevant articles have been identified, just 17 studies met the inclusion criteria of the current systematic review, of which the majority have been carried out in the USA, where the obesity epidemic represents a huge problem to deal with. On the whole, AO absorbs a significant amount of healthcare resources. However, as many studies have been carried out from the payer perspective, just direct medical cost estimates can be considered exhaustive. In fact, only three studies included also indirect costs. Therefore, strong evidence is not available to give a comprehensive picture of this phenomenon and, to reliably quantify AO social impact, further studies focused on indirect costs are needed, also considering that the last are estimated by Konnopka et al to be higher than direct ones. The studies included in the current review show that obesity costs are higher than overweight costs, apart from the study by Wolfenstetter showing that average annual direct costs were slightly higher in the case of overweight rather than in the obese group (€1093 for overweight and €1040 obese people). However, these data are justified by an intrinsic study limitation, as also reported by authors.

With reference to the quality of included studies, our results show a medium–high-quality level mainly depending on the lack of sensitivity analyses and of the productivity loss estimates (indirect costs) in almost all studies.

The studies included in the current review show that obesity and overweight are responsible for a significant economic burden from both Payors’ and societal perspectives. The results of our review show that it would be useful to prevent obesity among people to save a significant amount of resources. COI analyses, by providing a picture of the magnitude of a particular phenomenon, are useful in supporting evidence-based policies for decision makers. However, a significant limit related to COI analyses is represented by the fact that they do not include also outcome measures (as full economic evaluation) and do not provide any information regarding alternative programmes. Hence COI analyses cannot support the allocation of health-care resources among alternative projects.

---

**Limitations of the included studies**

Six studies used a self-reported height and weight for prevalence of obesity, which could have brought to results not really representative of the whole population of a country.

In nine studies, the obesity-expenditure relationship may have been confounded by unmeasured comorbidities or obesity complications.

In seven studies, the data considered for the analysis accounted for specific samples of population (e.g. Medicare beneficiaries, specific nationality or race, etc.), which could have brought to results not really representative of the whole population of a country.

All but three studies did not consider indirect costs in their analysis. Moreover, Janssen only included physician costs which, within Canada, only represent 13.9% of direct medical care expenditures and 7.3% of total (direct + indirect) health-care costs.
The results of this review could be affected by some limitations. The first one is represented by the fact that the studies included do not assess the long-term effects related to obesity, which should be analysed to have a more detailed picture of the obesity epidemic. The second limitation may be related to a potential publication bias because of the relatively small number of published COI studies in this field. Moreover, only three of 17 studies assessed both direct and indirect costs giving a more comprehensive assessment of the AO economic burden. Third, COI studies do not try to explain the rise in obesity rates. Finally, the lack of sensitivity analysis in most of the studies represents another limitation as, to give strong recommendations, the robustness of base case results should be investigated.

On the basis of the above reported considerations, it would be necessary to promote further research in this field with the aim to increase commitment and awareness among the community. To this purpose, further COI analyses should be conducted, aimed at assessing also indirect costs, as they play an important role in terms of economic burden. In fact, the productivity loss owing to obesity and obesity-related diseases should be investigated to have a more comprehensive view of the whole phenomenon. Moreover, sensitivity analyses should be carried out together with COI studies to assess the robustness of the base case results. Finally, a wider time horizon should be considered to allow taking into account all the consequences related to the obesity epidemic.

In addition, stronger evidence on the economic burden of AO could support policy- and decision-makers in intensifying public health strategies aimed to promote positive lifestyles and behaviours and planning and providing appropriate and targeted services.

In conclusion, further research is needed to better understand the AO economic impact and to identify and promote public health strategies to tackle obesity.

Conflicts of interest: None declared.

Key points
- Obesity is considered a priority public health problem to tackle, especially in developed countries.
- Further COI analyses, aimed at assessing also indirect costs, should be conducted to have a more comprehensive view of the whole phenomenon.
- Stronger evidence on the economic burden of AO could support policy and decision makers in intensifying public health strategies and providing appropriate and targeted services.

References
1. OECD. Fat not fat. http://www.oecd.org/document/31/0,3746,en_2649_33929_ 45999775_1_1_1,00.html (23 September 2010, date last accessed).