

# The economic burden of disease-related undernutrition in selected chronic diseases

---

**Benković, Vanesa; Kolčić, Ivana; Ivičević Uhernik, Ana; Vranešić Bender, Darija; Oreb, Ida; Stevanović, Ranko; Krznarić, Željko**

*Source / Izvornik:* **Clinical Nutrition, 2014, 33, 689 - 693**

**Journal article, Accepted version**

**Rad u časopisu, Završna verzija rukopisa prihvaćena za objavljivanje (postprint)**

<https://doi.org/10.1016/j.clnu.2013.09.006>

*Permanent link / Trajna poveznica:* <https://urn.nsk.hr/urn:nbn:hr:105:584917>

*Rights / Prava:* [In copyright](#) / [Zaštićeno autorskim pravom.](#)

*Download date / Datum preuzimanja:* **2025-02-08**



*Repository / Repozitorij:*

[Dr Med - University of Zagreb School of Medicine  
Digital Repository](#)





## Središnja medicinska knjižnica

**Benković V., Kolčić I., Ivičević Uhernik A., Vranešić Bender D., Oreb I., Stevanović R., Krznarić Ž. (2014) *The economic burden of disease-related undernutrition in selected chronic diseases*. *Clinical Nutrition*, 33(4). pp. 689-93. ISSN 0261-5614**

<http://www.elsevier.com/locate/issn/02615614>

<http://www.sciencedirect.com/science/journal/02615614>

<http://dx.doi.org/10.1016/j.clnu.2013.09.006>

<http://medlib.mef.hr/2252>

University of Zagreb Medical School Repository

<http://medlib.mef.hr/>

## ***The Economic Burden of Disease-Related Undernutrition in Selected Chronic Diseases***

Vanesa Benković<sup>1</sup>, Ivana Kolčić<sup>2</sup>, Ana Ivičević Uhernik<sup>3</sup>, Darija Vranešić Bender<sup>4</sup>, Ida Oreb<sup>1</sup>, Ranko Stevanović<sup>1,3</sup>, Željko Krznarić<sup>4</sup>

<sup>1</sup>Croatian Society for Pharmacoeconomics and Health Economics, Zagreb

<sup>2</sup>Croatian Centre for Global Health, University of Split School of Medicine, Split, Croatia

<sup>3</sup>Croatian Institute for Public Health, Zagreb

<sup>4</sup>Centre for Clinical Nutrition Clinical Hospital Centre, Zagreb

Contact Details: Vanesa Benković (vanesa.benkovic@farmakoekonomika.hr), Ivana Kolčić (ikolcic@mefst.hr), Ana Ivičević Uhernik (ana.ivicevic@hzjz.hr), Željko Krznarić (zeljko.krznaric1@zg.t-com.hr), Darija Vranešić Bender (dvrancesic@vitamini.hr), Ida Oreb (ida.oreb@gmail.com), Ranko Stevanović (ranko.stevanovic@hzjz.hr)

A list consisting of the last name of each author for the purpose of PubMed indexing:

Benković, Kolčić, Ivičević Uhernik, Vranešić Bender, Oreb, Stevanović, Krznarić

**Short title:** The Cost of Disease Related Undernutrition

Non-standard abbreviations: KOL - key opinion leader, CNIPH - Croatian National Institute for Public Health

Address for correspondence: Vanesa Benković, Zelengaj 9, 10000 Zagreb, Croatia;

Telephone: +385 98 9825188 ; Fax: +385 1 4576212; email:

vanesa.benkovic@farmakoekonomika.hr

Conference presentation (poster): Benkovic V, Kolcic I, Uhernik Ivicevic A, Krznaric Z, Bender Vranesic D, Stevanovic R. Cost of disease related malnutrition in Croatia - a hidden

cost in the health care closet wants out. *Value Health*. 2012;15:A327. Presented at: ISPOR Congress, Berlin, 2012.

## **Abstract**

### **Background & Aims**

Undernutrition is a common and aggravating problem in people suffering from various chronic diseases as well as a source of material costs. The aim of this study was to investigate the prevalence of disease-related undernutrition among adults in Croatia in the year 2012, as well as the cost of undernutrition associated with tumour cachexia, chronic pancreatitis, inflammatory bowel disease, hepatic encephalopathy, chronic obstructive pulmonary disease, chronic renal insufficiency requiring dialysis, cerebrovascular insult, pressure ulcers, and femoral fractures in the elderly.

### **Methods**

A cost-of-illness analysis was conducted, including direct costs only. The study employed the dominant cost-of-illness method, which restricts the summation of medical expenditure to the disease of interest. The bottom-up, prevalence-based approach was used. The budget holder perspective was employed, and data sources include the list of reimbursed drugs, clinical opinions, and literature.

### **Results**

The prevalence of disease-related undernutrition in people over the age of 20 in Croatia in the year 2012 was estimated to be 33.7/1,000. The total cost of adult malnutrition for selected diagnoses was 97.35 million EUR, accounting for 3.38% of the total Croatian national health care budget. The largest share was used for medications (43%), followed by 34% for hospitalizations, 13% for community health nursing, while parenteral and enteral nutrition contributed with 6% and 1% respectively. The average cost per patient was estimated at 1,640.48 EUR.

## Conclusions

The cost of malnutrition for the selected diagnoses in Croatia was substantial. These health costs will increase due to population ageing, which calls for undernutrition screening in people at risk as well as for effective approaches in nutrition supplementation.

**Keywords:** undernutrition, cachexia, cost of illness, health care costs, Croatia.

## **Introduction**

Despite the modern approaches in food production, an enormous burden of malnutrition, both overnutrition and undernutrition, still exists throughout the world, substantially contributing to the double burden of disease (1). Worldwide estimate of undernourished people in 2010 was 925 million, with 19 million hungry people in the developed countries (2). At the same time, global estimates for 2008 included 1.46 billion overweight adults, with 205 million obese men and 297 million obese women (3). Estimates for Croatia revealed around 20% of obese adults in 2003, with a disturbing increase of 66% in men and 69% in women in the period between 2003 and 2008 (4). On the other hand, undernutrition estimates for Croatia are still insufficient, with only scarce insights, such as the high prevalence of undernutrition in hospitalized gastroenterology patients (5), haemodialysis patients (6) and patients undergoing surgery or oncological treatment (7). Regrettably, undernutrition is often ignored in everyday clinical practice in Croatia (8).

The prevalence of undernutrition in Europe is surprisingly high (9), especially in hospitalized patients (5, 7, 10), but also in people in long-term care institutions (11), home care, and elderly people in community settings (12). A disturbing fact is that undernutrition is associated with many chronic health conditions, like inflammatory bowel disease (IBD), chronic kidney, lung and liver disease, cancers, and many others. Additionally, undernutrition is a well recognized risk factor for adverse health events, increasing morbidity and mortality, hospitalization rates and the length of hospital stay (13, 14). Furthermore, elderly people, the segment of population on a steady increase in almost all countries in the European region of the World Health Organization, are at higher risk of undernutrition (15). These and other consequences lead to increased expenditure in the health care system (9, 10, 12).

Cost-of-illness studies measure the economic burden of a disease and estimate the maximum potential for saving if a disease were to be eradicated or decreased (16). Total costs

comprise direct and indirect cost, depending on whether or not the resources have been expended directly in production of a treatment. Direct costs measure the cost of resources used for the treatment of a particular disease. Nonmedical direct costs include costs for the patient such as transportation costs, costs of diet change or for example home modifications for in-house dialysis machines. Indirect costs measure values of resources lost due to a particular disease (17).

When prevalence of undernutrition is combined with high economic costs (9), it is very important to actively search for signs of undernutrition, even for signs of increased risk of undernutrition, especially among the elderly (18). The aim of this study was to estimate the prevalence of specific chronic diseases, which are frequently accompanied with undernutrition, and to estimate the health care expenditure resulting from those conditions in Croatia in 2012..

## **Materials and Methods**

### **Data Collection**

This study includes all of the available real costs. We used the exact number of people with selected diagnoses in 2012, the number of control examinations performed per diagnosis, the medications used, the number of hospitalizations, intensive care unit usage, field nurse visits (community health nursing), and the nutritional support used. The diagnoses and health conditions that were selected in view of their common association with undernutrition are as follows: tumour cachexia due to lung cancer, stomach cancer, oesophageal, colorectal and pancreatic cancers, chronic pancreatitis, inflammatory bowel disease (IBD), hepatic encephalopathy, chronic obstructive pulmonary disease (COPD), chronic renal insufficiency requiring dialysis, cerebrovascular insult, pressure ulcers, and femoral fractures in people over 65 years of age. *The diseases were selected based on the availability of the data, their frequency in clinical setting and availability of therapy, which is covered by general health insurance.*

The sources of these data include: i) Croatian Health Service Yearbook 2011 (19), providing national data on diseases and health conditions recorded in primary and secondary health care; ii) databases from the Croatian National Institute for Public Health (CNIPH), such as the national hospitalization database, the cancer registry, and the data on DRG (diagnose-related group) costing; iii) clinical data from the Centre for Clinical Nutrition, Department of Internal Medicine, University Hospital Zagreb; iv) literature data for estimates which are unavailable for Croatia, like the prevalence of undernutrition in people with certain health conditions; v) data from the national insurer (Croatian Institute for Health Insurance), that is, the exact prices for specific diagnostic and treatment procedures; vi) utilisation of medications, enteral and parenteral supplements used in the model, based on reports from the agencies that oversee those practices (Croatian Institute for Health Insurance and the Agency



for Medicinal Products and Medical Devices). Additionally, the need for medical procedures was coordinated with the principles of good medical practice and the guidelines for the prevention and nutritional therapy of undernutrition (20-23). This was done in order to obtain a result that reflects the real frequency of the use of health services in Croatia. The guidelines were compared to the reality of medical practice in Croatia by doctors involved in the treatment of undernutrition complications (gastroenterologists, oncologists, pulmonologists, and nephrologists). The process of data collection and analysis is shown in the Figure 1.

### **Costing Analysis**

This analysis includes only direct medical costs, namely drug costs, hospitalization costs, intensive care unit usage costs, costs of diagnostic procedures, outpatient care, and home care costs (field nursing). *Non medical direct costs refer to costs that burden the health care system but are not related to medical products and services, such as transportation and research costs.* Because the indirect costs relating to the elderly and the unemployed are inevitably lower (24), this study did not include those costs. Intangible costs were also omitted from this study (such as cost of pain and suffering).

To estimate the direct costs we used the bottom up approach, calculating the average cost of treatment of particular disease and multiplying it by the prevalence of this disease (25, 26). This approach includes various types of health services, in which their costs were added to obtain the average cost of treatment for a particular disease. In the next step, we multiplied the unit cost of a particular treatment by its average yearly utilization to get an average cost estimate of the treatment. This was repeated for each type of health service to obtain the total average cost per case, which was then multiplied by the undernutrition prevalence of each disease to get an estimate of the total direct costs.

The costs of health services were calculated without discounting (the usual process by which the amount of costs is reduced by 2-5% after some time elapses) and without applying the inflation rate.

In the Croatian health care system, primary health care is financed through capitation fees. Thus the costs of primary health care for malnourished patients were not included since it is not possible to determine the ratio of the capitation fee used for undernutrition related treatment.

Given the discrepancies between real-life clinical practice and recommendations and guidelines, we used conservative estimates in order to show the actual situation, which in most cases meant lower consumption of services. To get more real-life costing and resources utilization and frequency data, annual unit cost figures were validated by clinical experts.

This analysis was performed from the budget holder's perspective, using a prevalence-based approach. Prevalence-based costing estimates annual costs, measuring the costs of disease within one year period, regardless of the date of the onset of the disease. This also means that mortality and permanent disability costs are calculated for all patients who die or become disabled in the study year (27). In contrast, we used incidence rate for the malignant diseases, since prevalence figures were not available. Unfortunately, prevalence for most of selected malignant diseases is almost equal to the incidence, especially for pancreatic, oesophageal, and gastric cancers.

## Results

The estimated prevalence of undernutrition which was associated with lung carcinoma, stomach carcinoma, oesophageal, colorectal and pancreatic carcinoma, chronic pancreatitis, IBD, hepatic encephalopathy, COPD, chronic renal insufficiency requiring dialysis, cerebrovascular insult, femoral fractures in people older than 65 years, and pressure ulcers in the adult population of Croatia in 2012 was 33.7/1,000. Undernutrition was most frequently observed in patients diagnosed with IBD (70%), following with patients with chronic renal failure (65%), COPD (50%), and patients with hepatic encephalopathy due to liver cirrhosis (Table 1). The study estimated that 114,220 people in Croatia suffered from selected disease-related undernutrition in 2012, among people diagnosed with selected chronic diseases and older than 20 years (Table 1). The total cost of disease related undernutrition for selected diagnoses in adult population of Croatia in 2012 was estimated at 97.35 million EUR. The average cost of undernutrition per person diagnosed with these selected health conditions was 1,640.48 EUR. The cost structure was set by diagnoses and by health care resources used. In terms of diagnoses, the highest cost share (61.5%) was allocated to people diagnosed with COPD (59,840,456.22 EUR), which is followed by pressure ulcers (21,178,845.00 EUR; 21.8%) and cerebrovascular insult (3,738,638.50 EUR; 3.8%) (Table 1). When individual average costs were explored, the most expensive diagnoses were those related to oesophageal cancer (3,531.62 EUR), lung cancer (3,097.74 EUR), and pancreatic cancer (3,050.58 EUR) (Table 1). The differences in these findings are due to differences in health care utilization for particular diseases and the ratio of the costs identified and paid by the budget holder.

Data analysis revealed that over a half of all the patients had at least one chronic complication due to undernutrition. The shares of costs related to complications due to undernutrition are shown in Figure 2. As far as the types of costs are concerned, the largest

share of total costs (42.6%) was accounted by medications, followed by hospitalization (33.7%) and community nursing (13.1%) (Figure 2). It is interesting to note that only 6.7% of the total amount of money was spent on enteral and parenteral nutrition (Figure 2).

## Discussion

The annual cost associated with adult malnourished patients for the selected diseases was estimated at over 97 million euros. Most of the amount was spent on acute hospitalizations and home care by field nurses, while nutritional support was estimated to amount to less than 10% of all the money spent for undernutrition.

Undernutrition, a condition in which insufficient intake of calories, protein and other nutrients produces a measurable unfavourable impact to tissue, bodily functions, and clinical outcomes, is a frequent problem even in developed European countries (9). For instance, there were 33 million people affected by disease related undernutrition in Europe in year 2012 (9). This study estimated that 114,220 people in Croatia suffered from disease-related undernutrition in mentioned selected chronic diseases for population older than 20 years, with the prevalence of 33.7/1,000.

As in other European countries, the Croatian population is aging continuously, and the 2011 Census recorded 17.7% of the population over the age of 65, which is among the highest shares in Europe. Even though undernutrition may emerge at any age, old age is one of the main risk factors for undernutrition. For example, the risk in persons over the age of 65 is 40% higher than the risk in younger persons (28). Therefore, it is expected that the impact and the frequency of undernutrition will increase in the forthcoming decades, creating a substantial burden of disease and becoming a prominent public health problem.

Undernutrition is an exacerbating factor in people suffering from chronic diseases and in patients recovering from a disease, trauma and surgery, closing the toxic circle which aggravates health and further reinforces undernutrition. High undernutrition prevalence is found in patients suffering from malignancies and from gastrointestinal, haematological, neurological and respiratory diseases (5, 29). This was the main reason to include patients suffering from tumour cachexia, chronic pancreatitis, IBD, hepatic encephalopathy, COPD,

chronic renal insufficiency requiring dialysis, cerebrovascular insult, pressure ulcers, and femoral fractures in the elderly in this study.

Clinical consequences of undernutrition are weight loss, growth and development disorders in paediatric patients, and a number of diseases and problems requiring additional treatment and resulting in additional health care costs. All of the above have a significant impact on the quality of life and functional abilities of undernourished persons. Since undernutrition usually affects persons with compromised health and the elderly, it may be assumed that undernutrition may affect the pharmacokinetics and pharmacodynamics of drugs. Absorption, distribution, metabolism, and transport and excretion of drugs may be affected. This is yet another source of health problems and costs. Despite the high incidence and the health consequences, undernutrition is often absent as a diagnosis and is thus rarely treated adequately. This contributes to an increase in costs for health care, since treating people with developed undernutrition is much more expensive compared to prevention of undernutrition and its detection in an early stage. Prevention and early detection would contribute to substantial economies, both in health improvement and maintaining the quality of life, and in the amount of money spent. Unfortunately, undernutrition remains an insufficiently recognized problem in Croatia, both clinically and in terms of public health, the consequences of which are considerable both for individuals and for the community. This is supported by the result that only 6.7% of the money was spent on nutritional support in patients diagnosed with serious chronic diseases, like carcinomas, chronic kidney, liver and lung diseases. Nutritional intervention may come in various forms, from preparation of tasty and healthy meals and helping the patients during the meals to application of individually adapted nutrition, such as enteral nutrition. These procedures require minimum investment but promise substantial benefits.

Literature reveals that undernutrition increases costs of hospitalization by a minimum of 20% (30). British Association for Parenteral and Enteral Nutrition (BAPEN) demonstrated that the cost of undernutrition in the UK was >£7.3 billion per annum (29). A recent study from the Netherlands estimates that total additional costs of managing adult patients with disease related malnutrition amounted to 1.9 billion EUR in 2011, which accounted for 2.1% of the total Dutch national health expenditure (9). The cost associated with disease related undernutrition in Croatia was, in absolute units, lower than in the Netherlands, but it accounted for a greater share in the total Croatian national health care budget (3.38%).

Cost-of-illness studies can demonstrate which diseases may require increased allocation of prevention or treatment resources, but they are limited in determining how resources are to be allocated because they do not measure benefits. In addition, these studies employ varying methods, which can limit the comparability of findings (24).

The costs that were not analyzed in detail in this study are the costs for which detailed specification was not possible or those that could not be definitely assigned to undernutrition, such as lower pharmacotherapy outcome due to poor nutritional status. This analysis can therefore be said to be fairly conservative. Since health economics divides costs into direct (costs inside health system) and indirect costs (costs outside the system, such as productivity loss, decreased quality of life, and premature death), this study for the most part did not analyze indirect costs and was performed from the perspective of the Croatian Institute for Public Health Insurance. Also, there is a possibility that different undernutrition criteria were used in different centres within the country. In Croatia, mostly NRS2002 is used for assessment of undernutrition (5). We have performed validation by clinical experts to evade the measurement bias, as well as to confirm the validity of clinical data. Despite these limitations, this is the first study of this kind in Europe, bringing estimates of prevalence and

health care costs associated with specific chronic diseases, which are most commonly accompanied with undernutrition. These results could serve as the first step necessary in the advocacy process for reducing the burden and the associated costs of undernutrition in Croatia, which were shown to be substantial.



**Acknowledgments**

We thank Suzana Bertović, who edited the manuscript, for her professional language support.

**Statement of Authorship**

VB designed the study, collected the data, performed the statistical analyses, drafted the paper, and approved the final manuscript; IK participated in the interpretation of the results, drafted the paper, is responsible for the contents of the final version of the manuscript; AIU, ŽK, DVB, participated in the design and data collection, read and approved the final manuscript; IO, RS participated in the design of the study, read the paper and approved the final manuscript.

**Sources of Funding**

This study was supported by Abbott Laboratories, Zagreb, and the Croatian Society for Pharmacoeconomics and Health Economics. These sponsors had no influence and were not involved in the study design, data collection, analysis and interpretation of data, the writing of the manuscript, or the decision to submit the manuscript for publication.

**Statement of Any Conflicts of Interest:** N/A.

## References

1. Kolcic I. Double burden of malnutrition: A silent driver of double burden of disease in low- and middle-income countries. *J Glob Health*. 2012;2:20303.
2. FAO. Hunger at a glance: key numbers in the 2010 SOFI report 2010; Available from: [http://www.fao.org/fileadmin/user\\_upload/newsroom/docs/2010\\_hunger\\_facts.pdf](http://www.fao.org/fileadmin/user_upload/newsroom/docs/2010_hunger_facts.pdf).
3. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet*. 2011;377:557-67.
4. Milanović SM, Uhernik AI, Fister K, Mihel S, Kovac A, Ivanković D. Five-year cumulative incidence of obesity in adults in Croatia: the CroHort study. *Coll Antropol*. 2012;36 Suppl 1:71-6.
5. Vranešić Bender D, Krznarić Z, Colić Barić I. Assessment of nutritional status of gastroenterology patients in Croatia. *Coll Antropol*. 2010;34:1329-34.
6. Sincić BM, Orlić L, Jurisić DE, Kendel G, Gombac E, Kvenić B, et al. Nutritional risk screening in hospitalized and haemodialysis patients. *Coll Antropol*. 2007;31:435-9.
7. Juretić A, Vegar V, Predrijevac D, Pavlica V, Dosen D, Sustić A, et al. Nutritional screening of patients undergoing surgery or oncological treatment in four Croatian hospitals. *Croat Med J*. 2004;45:181-7.
8. Pavic T, Ljubicic N, Stojšavljevic S, Krznaric Z. Nutritional screening model in tertiary medical unit in Croatia. *Ann Nutr Metab*. 2012;61:65-9.
9. Freijer K, Tan SS, Koopmanschap MA, Meijers JM, Halfens RJ, Nuijten MJ. The economic costs of disease related malnutrition. *Clin Nutr*. 2013;32:136-41.

10. Alvarez-Hernández J, Planas Vila M, León-Sanz M, García de Lorenzo A, Celaya-Pérez S, García-Lorda P, et al. Prevalence and costs of malnutrition in hospitalized patients: the PREDyCES®Study. *Nutr Hosp.* 2012;27:1049-59.
11. Törmä J, Winblad U, Cederholm T, Saletti A. Does undernutrition still prevail among nursing home residents? *Clin Nutr.* 2012;S0261-5614:00222-1.
12. Guest JF, Panca M, Baeyens JP, de Man F, Ljungqvist O, Pichard C, et al. Health economic impact of managing patients following a community-based diagnosis of malnutrition in the UK. *Clin Nutr.* 2011;30:422-9.
13. Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin Nutr.* 2003;22:235-9.
14. Lim SL, Ong KC, Chan YH, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. *Clin Nutr.* 2012;31:345-50.
15. Margetts BM, Thompson RL, Elia M, Jackson AA. Prevalence of risk of undernutrition is associated with poor health status in older people in the UK. *Eur J Clin Nutr.* 2003;57:69–74.
16. Segel JE. Cost-of-Illness Studies - A Primer 2006. Available from: [http://www.rti.org/pubs/coi\\_primer.pdf](http://www.rti.org/pubs/coi_primer.pdf).
17. Kirschstein R. Disease-Specific Estimates of Direct and Indirect Costs of Illness and NIH Support: Fiscal Year 2000 Update. Available from: <http://ospp.od.nih.gov/ecostudies/COIreportweb.htm>.
18. Skates JJ, Anthony PS. Identifying geriatric malnutrition in nursing practice: the Mini Nutritional Assessment (MNA®)-an evidence-based screening tool. *J Gerontol Nurs.* 2012;38:18-27.

19. Croatian National Institute for Public Health. Croatian Health Service Yearbook 2011. Zagreb: Croatian National Institute for Public Health; 2012.
20. Lochs H, Dejong C, Hammarqvist F, Hebuterne X, Leon-Sanz M, Schütz T, et al. ESPEN Guidelines on Enteral Nutrition: Gastroenterology. *Clin Nutr.* 2006;25:260–74.
21. Anker SD, John M, Pedersen PU, Raguso C, Cicoira M, Dardai E, et al. ESPEN Guidelines on Enteral Nutrition: Cardiology and pulmonology. *Clin Nutr.* 2006;25:311-8.
22. Arends J, Bodoky G, Bozzetti F, Fearon K, Muscaritoli M, Selga G, et al. ESPEN Guidelines on Enteral Nutrition: Non-surgical oncology. *Clin Nutr.* 2006;25:245-59.
23. Volkert D, Berner YN, Berry E, Cederholm T, Coti Bertrand P, Milne A, et al. ESPEN Guidelines on Enteral Nutrition: Geriatrics. *Clin Nutr.* 2006;25:330-60.
24. Drummond M. Cost-of-Illness Studies: A Major Headache? *Pharmacoeconomics.* 1992;2:1-4.
25. Bloom BS, Bruno DJ, Maman DY, Jayadevappa R. Usefulness of US Cost-of-Illness Studies in Healthcare Decision Making. *Pharmacoeconomics.* 2001;19:207-13.
26. Liu JL, Maniadakis N, Gray A, Rayner M. The Economic Burden of Coronary Heart Disease in the UK. *Heart.* 2002;88:597-603.
27. Hodgson TA. Annual Costs of Illness Versus Lifetime Costs of Illness and Implications of Structural Change. *Drug Information Journal* 1988;22:323-41.
28. Russell CA, Elia M, on behalf of BAPEN and collaborators. Nutrition screening survey in the UK in 2008: hospitals, care homes and mental health units. A report by the British Association for Parenteral and Enteral nutrition (BAPEN). Redditch: BAPEN; 2009.
29. Elia M, Stratton RJ, C. R, Green CJ, Pang F. The cost of disease-related malnutrition in the UK and economic considerations for the use of oral nutritional supplements (ONS) in adults. Redditch: BAPEN; 2005.

30. Amaral TF, Matos LC, Tavares MM, Subtil A, Martins R, Nazaré M, et al. The economic impact of disease-related malnutrition at hospital admission. *Clin Nutr.* 2007;26:778-84.

## Figure and Table Legends

Table 1 Prevalence of undernutrition and cost by a diagnosis in EUR

Table 1 Prevalence of undernutrition and cost by a diagnosis in EUR

Diagnosis	Prevalence of undernutrition within a diagnosis N (%)	Total cost per diagnosis in EUR (%)	Average cost per patient with listed diagnosis in EUR
Lung carcinoma	727 (29.0)	3,024,227.05 (3.1)	3,097.74
Colorectal carcinoma	952 (31.2)	2,253,050.93 (2.3)	1,071.52
Stomach carcinoma	293 (29.0)	558,998.57 (0.6)	2,468.81
Pancreatic carcinoma	204 (29.0)	724,546.39 (0.7)	3,050.58
Oesophageal carcinoma	64 (29.0)	105,509.97 (0.1)	3,531.62
Inflammatory bowel disease	2,100 (70.0)	2,789,931.26 (2.9)	1,328.54
Chronic pancreatitis	489 (32.6)	622,805.53 (0.6)	1,143.15
Liver cirrhosis -- hepatic encephalopathy	945 (50.0)	1,019,994.39 (1.0)	1,344.28
Chronic renal failure requiring dialysis	2,826 (65.0)	1,270,348.36 (1.3)	1,070.07
Cerebrovascular insult	4,174 (35.0)	3,738,638.50 (3.8)	895.75
Chronic obstructive pulmonary disease	80,878 (50.0)	59,840,456.22 (61.5)	739.88
Femur fracture (aged >65 years)	194 (24.0)	225,317.53 (0.2)	544.87
Pressure ulcers	20,374 (10.0)	21,178,845.00 (21.8)	1,039.48
Total	114,220	97,352,669.71	1,640.48

Figure 1 The process of data collection and analysis

CNIPH - Croatian National Institute for Public Health (Croatian Health Service Yearbook 2010)

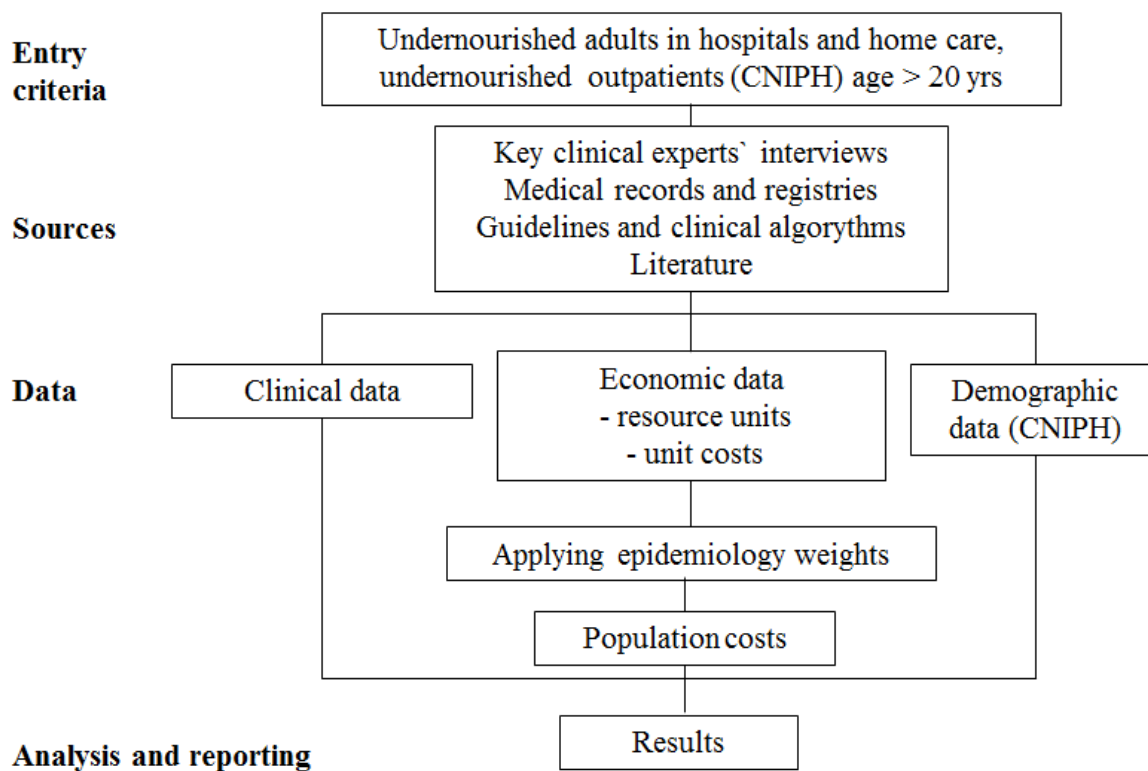


Figure 1. The process of data collection and analysis

Figure 2 Structure of disease-related undernutrition costs

