Malnutrition underestimated

seo economic research

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The costs of malnutrition and the return on medical nutrition

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Summary

- The total costs of disease-related malnutrition in the Netherlands amounted to € 1.8 billion in 2011 plus non-quantified healthcare costs for persons living at home.
  - Disease-related malnutrition in the Netherlands results in about 400 deaths a year.
  - The average hospital stay of malnourished patients is 28 percent longer than the average hospital stay of non-malnourished patients.
  - Nursing homes spend on average € 10,597 per malnourished person when tackling disease-related malnutrition.
- The use of medical nutrition with sick and malnourished elderly persons results in net benefits between € 1,433 and € 3,105 per person. For each euro that is invested in the treatment of a malnourished person society saves € 1.90 to € 4.20.

Reason for the study

Although the costs of disease-related malnutrition and the costs and benefits of the use of oral nutritional supplements (ONS) are described in various studies, there is no comprehensive study that focuses on the Dutch situation. This is why the Association of Dutch Infant and Dietetic Food Industries (VNFKD) commissioned SEO Economic Research to carry out this comprehensive study. The study answers two research questions:

- What are the costs of disease-related malnutrition for Dutch society?
- What are the costs and benefits of using medical nutrition in cases of disease-related malnutrition?

Malnutrition in the Netherlands

In 2011 malnutrition occurred in 22 percent of the hospital patients and in 17 percent of the residents of residential care and nursing homes. Among elderly persons living on their own malnutrition occurs more frequently with those who rely on home care (17 percent is malnourished) than those who do not rely on this (7 percent is malnourished). Malnutrition in the Netherlands is almost always related to sickness. It often occurs in people who are in poor health and have many functional restrictions. In addition, it occurs relatively often in women, the elderly and less educated people. Malnutrition occurs both during hospital admission and in the periods before and after admission.

The costs of malnutrition

Disease-related malnutrition increases the costs of care in hospitals and nursing and residential care. In addition, malnutrition results in excess mortality. It is estimated that malnutrition in the Netherlands results in more than 400 deaths per year. The effects of malnutrition on the healthcare costs for persons living at home have been not examined sufficiently in order to quantify them. The total costs of malnutrition in the Netherlands amounted to € 1.8 billion in 2011 plus the non-quantified healthcare costs for persons living at home. The higher hospital costs are the largest cost item of malnutrition in the Netherlands (€ 1.1 billion). Moreover, disease-related malnutrition results in costs as a result of excess mortality (€ 183 million) and higher residential care- and

nursing home care costs (€ 523 million). The costs are paid for by malnourished persons (€ 244 million) and the rest of society (€ 1,597 million).

Medical nutrition

Medical nutrition is specifically composed nutrition which is used by patients for treating disease-related malnutrition. Patients with disease-related malnutrition often have an increased need for specific nutrients such as energy, protein and other nutrients, often in combination with a reduced intake as a result of their sickness. It is prescribed by a doctor or dietician when regular or adapted food does not suffice. The use of medical nutrition often starts in hospital and is continued after this at home or in the nursing home or residential care home. Scientific research shows that mortality in elderly persons, the number of readmissions to hospital of malnourished sick persons and the number of complications decrease after the use of medical nutrition. For the time being the available research offers insufficient proof that the use of medical nutrition results in statistically significant improvements in the quality of life and functional outcomes.

The costs an benefits of medical nutrition

The costs and benefits of the use of medical nutrition by malnourished elderly persons who have been admitted to hospital are examined in the cost-benefit analysis. The benefits consist of lower mortality and fewer readmissions. The costs of a treatment amount to about € 740. The use of medical nutrition by patients in the age groups 65-69 and 80-84 years results in net benefits between € 1,433 and € 3,105 per treatment per patient. For every euro that is invested in the treatment of a malnourished person, society saves between € 1.90 and € 4.20. It is estimated that the use of medical nutrition by all sick and malnourished persons over the age of 65 results in total net benefits between € 52 million and € 112 million per year.

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1 Introduction

Disease-related malnutrition is a problem in the Netherlands. What are the costs of malnutrition for Dutch society? What are the costs and benefits of using ONS in cases of malnutrion

Reasons for the study

Malnutrition is a problem in the Netherlands. For example, it is estimated that 22 percent of the Dutch hospital population is malnourished. Studies indicate that this results in complications and slower recovery after of sickness or operations (Halfens et al., 2012).

Medical nutrition is a specifically composed nutrition which is used by patients for the treatment of disease-related malnutrition. Patients with disease-related malnutrition often have an increased need for specific nutrients such as energy, protein and other nutrients as a result of illness, often in combination with decreased intake as a result of illness. It is prescribed by a doctor or dietician when regular or adapted food is not sufficient. At present serious ill patients, such as oncology patients, make use of this. Medical nutrition is available in several forms. This study focuses on ONS as part of dietetic food for medical use.

There are many international studies on the costs of malnutrition and the costs and benefits of the use of ONS. However, there is no comprehensive study on the Dutch situation. This is why the Association of Dutch Infant and Dietetic Food Industries (VNFKD) commissioned SEO Economic Research (SEO) to carry out this comprehensive study. The VNFKD wants to determine whether ONS as part of the treatment of seriously ill malnourished patients is cost-effective.

Research questions

The study answers two research questions:

- What are the costs of disease-related malnutrition for Dutch society?
- What are the costs and benefits of using medical nutrition in cases of malnutrition?

Research methodology

The study consists of a review of the literature and a cost-benefit analysis.

Review of the literature

The review of the literature consists of two parts:

- studying the effects of malnutrition on mortality and healthcare costs.
- studying the effects of ONS on mortality and healthcare use.

Cost-benefit analysis

A societal cost-benefit analysis (SCBA) offers an integrated understanding of the costs and benefits, both from the perspective of various actors and society as a whole. The methodology followed in this study corresponds with the General SCBA guideline which was drawn up by the Netherlands

Bureau for Economic Policy Analysis (CPB) and the Netherlands Environmental Assessment Agency (PBL) (Romijn and Renes, 2013), the application of which is stipulated by the government (Minister of Finance, 2013). The calculations of the costs of malnutrition and the costs and benefits of ONS are based on the outcomes of the review of the literature.

Reader's guide

In Chapter 2 this report first describes the prevalence of malnutrition in the Netherlands, the characteristics of malnourished persons and the effects of malnutrition. Next, Chapter 3 calculates the costs of malnutrition. After this, the effects of ONS are discussed in Chapter 4. Finally, the costs and benefits of ONS are quantified in Chapter 5.

2 Malnutrion in the Netherlands

In 2011 22 percent of hospital patients and 17 percent of residents of care and nursing homes experienced disease-related malnutrition. Moreover, 17 percent of the persons living at home and who receive home care are malnourished. Malnourished persons tend to be very sick, poorly educated, elderly women without a partner. Malnutrition increases the costs of mortality in hospital care, nursing homes and residential care.

This chapter first analyses the prevalence of disease-related malnutrition. This chapter also examines trends in the prevalence of malnutrition (Section 2.1). Next, Section 2.2 lists the characteristics of malnourished persons. Malnutrition in the Netherlands is usually related to sickness and is often accompanied by relatively poor health and substantial healthcare costs. The rest of this report uses the term "malnutrition" to indicate disease-related malnutrition. Section 2.3 offers a summary of the current knowledge of the effects of malnutrition. This section offers a summary of the scientific research on the various costs of malnutrition and discusses the most useful studies. Appendix A contains more detailed information about all examined studies.

2.1 The prevalence of malnutrition

Various definitions of malnutrition are applied. Certain definitions are only based on the length and weight ratio, i.e. the Body Mass Index (BMI).[1] Other definitions are also based on food intake and unintentional weight loss. Box 2.1 offers a summary of various sources and corresponding definitions of malnutrition.

Box 2.1 Various definition of malnutrion

Definition according to the National Care Prevalence Survey (LPZ)

- BMI less than 18.5 (age 65 or younger) or less than 20.0 (age 65 or older), and/or
- BMI 18.5-20.0 (age 65 or younger) or BMI 20.0-23,0 (age 65 or older) in combination with eating little or nothing for three days or eating less than usual for more than one week, and/or
- Unintentional weight loss of more than 6 kilos in the past 6 months or more than 3 kilos in the past month.

Definition according to Longitudinal Aging Study Amsterdam (LASA)

- BMI less than 20.0, and/or
- Unintentional weight loss of at least 5 percent in the past six months.

Definition according to Central Bureau of Statistics (CBS)

- BMI less than 18.5 kg/m2.

Another form of malnutrition is qualitative malnutrition, which happens when there is insufficient intake of proteins, minerals and vitamins. However, this report is based on the above definitions of malnutrition

[1] BMI = weight / height^2

Malnutrition in various sectors

Table 2.1 shows that the prevalence of malnutrition is greatest in hospitals patients (22 percent). Malnutrition also occurs frequently in residents of nursing and residential care homes and users of home care (17 percent). Malnutrition occurs less often in elderly persons who live independently and who do not use home care (7 percent). These differences probably occur because malnutrition is often disease-related.

Table 2.1 Prevalence of malnutrition in various healthcare sectors

	Setting			
	Hospital	**Nursing and residential care Home**	**Home care**	**Independent without home care**
Percentage mailnourished	22%	17%	17%	7%
Years	2012	2012	2010	2005-2006
Dataset	LPZ	LPZ	LPZ	LASA[2]

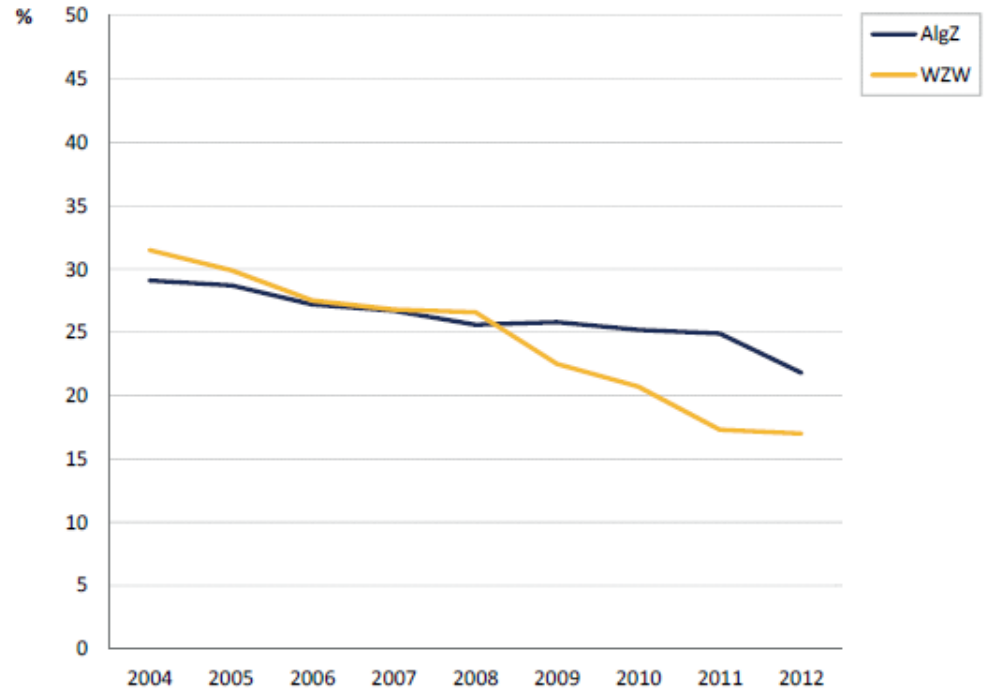
1) The reasearch group only consists of elderly persons.
Source: Health Concil of the Netherlands (2011), Halfens (2012) and Halfens (2010)

Trends in malnutrion

Figure 2.1 shows a slightly downward trend in the prevalence of malnutrition in general hospitals and nursing and residential care homes. Despite this, more than one in five hospital patients and more than one in four residents of nursing homes and residential care homes were malnourished in 2012. A possible explanation for the slight decrease in prevalence is the increased focus on malnutrition, for example through the regular screening and treatment of new patients as part of the performance indicator for hospitals.

2 The LASA dataset focuses on elderly persons.

Figure 2.1 Downward trend in the prevalence of malnutrition in general hospitals AlgZ and living-care-welfare (WZW:nursing and residential care homes).

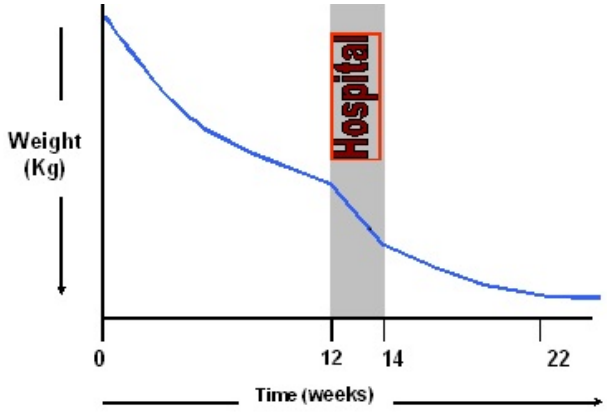


Source: Halfens (2012)

Care process for malnourished patients

Disease-related malnutrition often starts at home and also results in an unwanted loss of weight from a medical viewpoint after admission to hospital and in the period after discharge from hospital if it is not treated. The figure below offers a typical pattern of a sick person whose nutritional condition deteriorates and who then becomes malnourished. In this example the patient is not specifically treated for malnutrition, but only for the medical disorder.

Figure 2.2 Loss of weight occurs during, before and after hospital admission

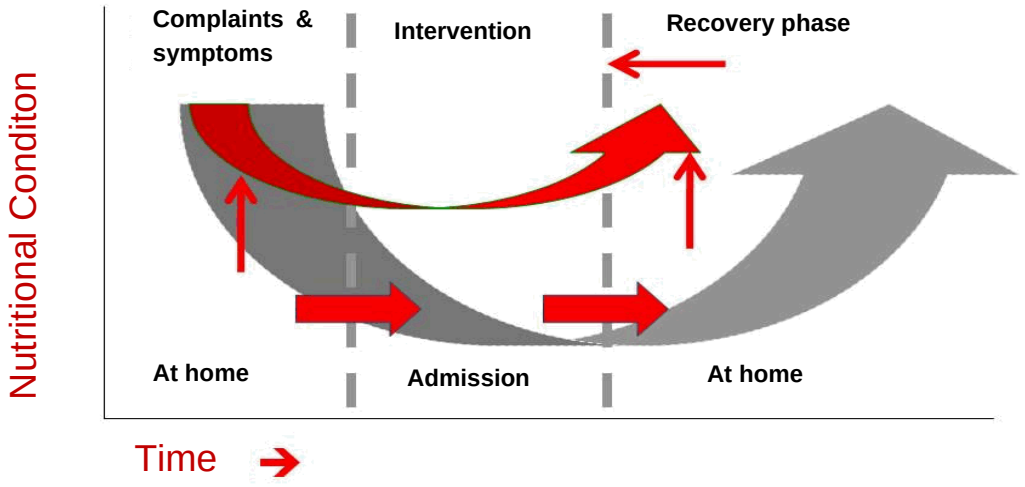


Source: Elia Malnutrition symposium 2003

Early recognition and treatment of malnutrition results in less unwanted weight loss from a medical viewpoint and faster recovery. The grey line in Figure 2.3 shows a possible development of nutritional condition without screening and treatment.

The malnutrition is recognised an treated late and the patien is admitted to hospital in poor nutritional condition. The red line shows the desirable situation in which the patient is screened in the home situation, either at the family doctor practice or by home care. The nutritional condition of this patient remains at a better level and many problems are prevented, according to the guideline for screening and treatment malnutrition (source: Malnutrition Steering Group, 2011)

Figure 2.3 Early recognition an treatment of malnutrition promtes recovery



Source: Malnutrition Steering Group (2011). Guideline on the Screening and treatment of malnutrition

2.2 Characteristics of malnourished individuals

The LPZ (Halfens et al., 2012) and a study of Pirlich et al. (2005) show that the following personal characteristics are related to malnutrition:

- Health status and diseases – People with poor health, diseases, polypharmacy, high care dependence and many functional restrictions are relatively often malnourished. Malnutrition often occurs with disorders such as infectious diseases, cancer, dementia and diseases of the blood and haematopoietic organs.
- Sex – women are relatively often malnourished.
- Age – elderly persons are relatively often malnourished.
- Qualification level – poorly educated persons are relatively often malnourished.
- Single – single persons are relatively often malnourished.

Moreover, Schilp et al. (2011) studied the characteristics of malnourished elderly persons living at home. They show that malnutrition usually occurs in sick persons and is associated with psychiatric problems, chronic diseases and poor physical condition. Moreover, malnutrition occurs relatively frequently in women and lonely persons without a partner

Malnutrition is therefore often disease-related: malnutrition is often associated with other health problems in the Netherlands. It occurs relatively often in vulnerable persons, in particular poorly educated, elderly women without a partner

2.3 Effects of malnutrition

This section offers a summary of the scientific research on the various costs of malnutrition. This section discusses the most useful studies. In these studies malnourished persons are compared with non-malnourished persons who have comparable characteristics. It particularly concerns demographic characteristics and health condition. In studies in which malnourished persons have different characteristics than non-malnourished persons, the effects of malnutrition cannot be distinguished from the effects of age or a disease, for example.

The text examines the effects of malnutrition on mortality, hospital costs and costs of nursing and home care and healthcare for living at home. The effects of malnutrition on labour market outcomes such as productivity were also investigated, but there is not enough information about this. Furthermore, there are also insufficient studies on the effects of malnutrition on quality of life.

Higher mortality as a result of malnutrition

Various studies show that there is a relationship between malnutrition and higher mortality. Berrington de Gonzalez et al. (2010) analysed a dataset of 1.46 million adults. The dataset is based on the data from several studies, in which adults are followed for a number of years (at least five). Malnutrition is only established on the basis of BMI in this study. Unintended weight loss and reduced food consumption are not considered. The analyses are controlled for ethnicity, education level, health and lifestyle among other things. Depending on the age group, they found that a BMI of 15.0-18.5 compared to the optimal range of 22.5-25.0 coincides with 0.7-10.7 additional deaths per year per 1,000 persons within five years (see Table 2.2). This excess mortality increases as the age increases. This is because the general mortality is higher for older persons and the effects of malnutrition are probably more severe (Hébuterne 2001). The excess mortality of malnourished persons decreases over time, but is statistically significantly higher in the malnourished group up to 15 years after the first observation. According to Berrington, de Gonzalez et al. (2010) this may be because malnourished persons start to eat more. It may also mean that the excess mortality is not entirely caused by malnutrition during the first five years, but by a disease that is not observed in the data. If this is the case, this means that the excess mortality shown in Table 2.2 is an overestimate.

Table 2.2 A low BMI results in a greater excess mortality as age increases

Age group	Excess mortality at BMI 15.0 – 18.4 per 1,000 persons within 5 years
20 – 49 years	0.7
50 – 59 years	0.6
60 – 69 years	4.0
70 – 84 years	10.7

Source: Berrington de Gonzalez et al., 2010

In a comparable study, Whitlock et al. (2009) examined a dataset of 900,000 persons from 57 different countries. They controlled for age, sex, smoking/non-smoking and health at the start of the study (persons who die in the first five years are not included). They found that mortality increases as the BMI decreases in persons with a BMI of 22.5 or lower. This is caused in particular by diseases of the respiratory system and lung cancer. The relationship is stronger for smokers than for non-smokers, while the number of smoked cigarettes per smoker does not make a difference. This indicates a relatively large negative effect of smoking on persons with a low BMI.

Lim et al. (2012) investigated the effects of malnutrition at a hospital in Singapore. Malnutrition was established on the basis of the medical history and physical examination of patients. The analyses control for age, sex, ethnicity and health status. They control for health status on the basis of diagnosis-related groups (DRGs). DRGs are comparable with the Dutch system of diagnosis-treatment combinations (DBCs). The analyses show that the mortality within one, two and three years after hospital admission is significantly higher for the malnourished group.

More care for malnourished persons in hospital

The study of Lim et al. (2012) also shows that the healthcare use of malnourished persons is relatively large. They compare the average hospital stay of malnourished and non-malnourished patients in a hospital in Singapore. The study consists of persons between the ages of 18-74 with an average age of 52. Sixty percent of the patients is male. The patients also have other health problems besides malnutrition. The analyses show that the average hospital stay of malnourished patients is 6.9 days. This is 1.5 days more than the average hospital stay of patients with comparable treatments. The average hospital stay of malnourished patients with a comparable disorder is therefore 6.9 / (6.9-1.5) = 1.28 times longer than the average hospital stay of non-malnourished patients. In addition, the risk of readmission for malnourished patients is greater. This may be due to a larger number of complications in malnourished persons.

Kruizenga et al. (2005) studied the effectiveness of early screening and treatment of malnutrition in Dutch hospitals. They found that the average duration of the hospital stay of malnourished patients is on average 1.3 times longer than that of non-malnourished patients. However, the study did not control for the background characteristics of the patients.

Nursing homes have additional costs for malnourished patients

Meijers et al. (2012) quantify the costs of malnutrition in Dutch nursing homes. It hereby concerns persons who also have other health problems besides malnutrition. In order to determine the costs of malnutrition, the investigators conducted interviews with employees of nursing homes and asked about their activities in relation to the treatment of malnutrition. After this they related these activities to costs. They estimated the additional costs to amount to € 10,597 per malnourished person. Most of these funds are spent on the treatment of patients (€ 9,605). The treatment includes consultations with a dietician, following a diet, taking ONS, weight checks and assistance with meals). In addition, the costs include screening and diagnostics (€ 834), multidisciplinary consultations (€ 100) and monitoring (€ 58) of patients.

Still insufficient evidence for increases in general practitioner visits and hospital admissions with regard to malnourished persons living at home

A study by Guest et al. (2011) shows that malnourished persons who live at home see a general practitioner more often and are admitted to hospital more often than non-malnourished persons

who live at home. However, in this study no adjustment is made for the type of disorder or health conditions of patients. This may lead to an overestimation of the effect of malnutrition if malnourished patients with relatively serious disorders are compared to non-malnourished patients with mild disorders.

At present there are not enough studies yet in which an adjustment is made for a sufficient number of characteristics of persons. There are no useful studies on malnutrition among persons living at home, because most studies on malnutrition are carried out in a clinical setting.

Summary

The review of the literature on the effects of malnutrition leads to the following conclusions:

- Malnutrition results in excess mortality.
- Malnourished persons stay in hospital for a longer period.
- Nursing homes incur expenses for combating malnutrition.
- There are not enough studies yet on malnutrition among persons living at home in order to determine the effects of malnutrition on the number of general practitioner visits and hospital admissions for this population

3 Cost of malnutrition

The total costs of malnutrition in the Netherlands amounted to € 1.8 billion in 2011 plus the non-quantified healthcare costs for persons living at home. Higher hospital costs account for € 1.1 billion of this sum.

This chapter calculates the costs of malnutrition in the Netherlands. This is done on the basis of the review of the literature on the effects of malnutrition in Section 2.3. The costs of malnutrition consist of the additional costs caused by malnourished persons because they use more healthcare and die earlier than persons who are not malnourished. The additional healthcare costs caused by malnourished persons include the current costs of combatting malnutrition, including the costs of medical nutrition.

The calculation of the costs of malnutrition is based on the number of malnourished persons in 2011. The costs of malnutrition are calculated over an entire lifespan. Future costs are weighed less in the analysis. This is done by applying a discount rate of 5.5 percent, in conformity with the regulations for social cost-benefit analyses (Romijn and Renes, 2013). On the basis of the review of the literature in Section 2.3 the following costs are calculated:

- Mortality: life expectancy decreases as a result of malnutrition. This leads to a loss of life years, but also to savings on healthcare costs and pension benefits for the missed years of life. Both the costs as a result of mortality and the savings as a result of mortality are quantified.[3]
- Healthcare costs: the hospital costs and costs of nursing and residential care homes are higher for malnourished persons. This excludes the effects of mortality on healthcare costs.

The costs of malnutrition are broken down for malnourished persons and the rest of society. Mortality as a result of malnutrition, for example, leads to a lower value of life for malnourished persons, while the higher (collectively funded) healthcare costs for malnourished persons must be paid by the rest of society.

Section 3.1 examines the costs of mortality and Section 3.2 examines the costs of the additional use of healthcare. Section 3.3 presents a summary of the various costs. In Section 3.4 a sensitivity analysis is carried out. This section analyses the sensitivity of the results to certain assumptions.

3.1 Mortality

This section quantifies the costs and savings as a result of malnutrition in the Netherlands that are related to mortality. The calculations in this section and in Chapter 5 are based on data from 2011, because this is the most recent year for which the most relevant information is available.

[3] According to the CVZ guidelines for cost-effectiveness research, the savings as a result of mortality should not be included. However, it is correct to include these savings from a welfare perspective, see Krol et al. 2013

Number of malnourished persons in the Netherlands

Table 3.1 shows that there are more than 200,000 malnourished persons in the Netherlands. The prevalence of malnutrition in persons who do not live in nursing or residential care homes is only based on the criterion of a BMI of less than 18.5. This results in an underestimation of the total number of disease-related malnourished persons. The prevalence of malnutrition at nursing and residential care homes is based on the definition of the LPZ 2011 (see Box 2.1).

Malnutrition occurs in particular in young age groups (20-30 years) and in elderly persons (75-85 years). A relatively large part of persons between the ages of 20-30 has a BMI of less than 18.5.

Table 3.1 In the Netherlands there are about 200,000 malnourished persons

Age Group	Population outside nursing or residential care home			Population in nursing or residential care home			Total of number of malnourished persons
	Number[1]	Prevalence of malnutrition[2]	Number of malnourished persons	Number[3]	Prevalence of malnutrition[4]	Number of malnourished persons	
20-25 year	1,034,629	3.8%	39,316	100	17.3%	17	39,333
25-30 year	1,001,438	3.8%	38,055	100	17.3%	17	38,072
30-35 year	1,004,664	1.2%	12,056	100	17.3%	17	12,073
35-40 year	1,120,930	1.2%	13,451	638	17.3%	110	13,562
40-45 yearr	1,295,287	0.7%	9,067	638	17.3%	110	9,177
45-50 year	1,297,654	0.7%	9,084	638	17.3%	110	9,194
50-55 year	1,192,184	1.1%	13,114	4,135	17.3%	715	13,829
55-60 year	1,086,112	0.7%	7,603	4,135	17.3%	715	8,318
60-65 year	1,099,517	0.7%	7,697	4,135	17.3%	715	8,412
65-70 year	779,975	1.1%	8,580	10,585	17.3%	1,831	10,411
70-75 year	619,013	1.1%	6,809	18,505	17.3%	3,201	10,011
75-80 year	463,311	1.7%	7,876	36,010	17.3%	6,230	14,106
80-85 year	297,663	1.7%	5,060	63,165	17.3%	10,928	15,988
Total	12,292,376	1.4%	177,767	142,885	17.3%	24,719	202,486

1,2,3 Source: http://statline.cbs.nl/statweb/;
4 Source: LPZ 2011
Calculations SEO Economic Research

Excess mortality as a result of malnutrition

The effects of malnutrition on mortality are estimated through the study by Berrington de Gonzalez et al. (2010). The study by Berrington de Gonzalez et al. (2010) shows that malnutrition, depending on the age group, results in an excess mortality of 0.6 to 10.7 additional deaths per 1,000 malnourished persons (see Table 2.2). According to Berrington de Gonzalez et al. (2010), there may be an overestimation of mortality, because they found that the additional mortality decreases as people are followed for a longer period. In the calculation of the additional mortality the risk of mortality is therefore adjusted by one third in Table 2.2. Table 3.2 shows that the estimated excess mortality amounts to 401 deaths. This mortality is particularly substantial for the age groups of 70 years and older. This is mainly because the effect of malnutrition on mortality increases with age

Table 3.2 Marlnutrion in the Netherlands results in about 400 additional deaths every year

Age group	Total nuber of malnourished persons	Excess mortality per 1,000 malnourished persons	Excess mortality[1]
20-25 year	39,333	0.47	18
25-30 year	38,072	0.47	18
30-35 year	12,073	0.47	6
35-40 year	13,562	0.47	6
40-45 year	9,177	0.47	4
45-50 year	9,194	0.47	4
50-55 year	13,829	0.40	6
55-60 year	8,318	0.40	3
60-65 year	8,412	2.67	22
65-70 year	10,411	2.67	28
70-75 year	10,011	7.13	71
75-80 year	14,106	7.13	101
80-85 year	15,988	7.13	114
Total	202,486		401

Calculations: SEO Economic Research
The calculation of the excess mortality includes a correction factor of one third in connection with a possible overestimation of the effects of malnutrition.

The costs of excess mortality caused by malnutrition

The excess mortality caused by malnutrition results in different costs. For example, the value of life and contributions to health insurances, AOW [General Old Age Pensions Act] and other pension provisions will cease in case of early mortality. However, the increased mortality also results in savings on healthcare costs and pension benefits for the missing remaining life years. In the text below the following items are quantified successively.[4]

Costs
The value of life,
Non-paid health insurance premiums,
Non-paid AOW contributions and pension benefits,
Non-paid other contributions.

Savings
Care costs,
Pension benefits.

The value of life
The value of life is quantified on the basis of so-called QALYs (Quality-Adjusted Life Year). A QALY is equivalent to one year in full health. The quality of life is expressed as a number between 0 (died) and 1 (perfect health). The advantage of using QALYs is that the value of health gains and an

[4] Appendix B includes a more extensive description of the underlying assumptions and calculations.

increase in life expectancy is summarised in one standard. Moreover, the QALY indicator also implicitly includes items that are difficult to quantify, such as happiness or independence.

A QALY can be valued in money. Hirth et al. (2000) carried out a review of the literature in order to estimate the value of one QALY. The values of a QALY ranged between $ 24,777 and $ 428,286 (1997 USD). On the basis of the study of Hirth et al. a report by the RIVM (National Institute for Public Health and the Environment) concluded that health has an independent economic value of at least € 100,000 per QALY, besides the contribution to the economy through production gains (De Hollander et al. 2006). The CPB (Netherlands Bureau for Economic Policy Analysis) also applies the value of € 100,000 per QALY in a study on the costs and benefits of a smoking ban (Spreen & Mot, 2008). In accordance with these studies the value of a QALY is valued at € 100,000 in this cost-benefit analysis. In the sensitivity analyses this value varies.

The value of life is greatly affected by health. The value of € 100,000 applies to one life year in full health. However, malnourished persons are not healthy. A study among very sick persons shows that their quality of life is about 0.64 (on a scale from 0 to 1) (Kaarlola 2006). The calculations therefore assume that the value of a lost life year as a result of malnutrition amounts to € 64,000.

The value of life is the benefit that persons derive from life (Table 3.3). For example, immaterial benefit stems from leisure time and material benefit from the consumption of goods and services. In the analysis of the costs of malnutrition it is assumed that all the benefits of the malnourished person are part of the value of a QALY. This is why only effects for others are included, besides the value of QALYs. This particularly concerns contributions to and payments from collective schemes. The most important contributions are health insurance premiums, AOW and pension premiums and other payments such as income tax. The most important revenues are pension benefits and healthcare expenses which are funded collectively.

Normally speaking, the payments are received by the rest of society, but these cease in the missing remaining years of life due to excess mortality. This is why excess mortality leads to expenses for the rest of society. The benefits received by malnourished persons from the rest of society present an inverse pattern: in case of an early death this results in savings for the rest of society.

Table 3.3 The total costs of excess mortality as a result of malnutrition consist of the value of QALYs plus contributions by malnourished persons to the rest of society

Cost	Malnourished person	Rest of society	Total
Immaterial benefit:	A		A
Material benefit:			
• Gross income	B		B
• Health insurance contributions	-C	C	
• AOW an pension premiums	-D	D	
• Other contributions	-E	E	
• Savings on healthcare use	F	-F	
• Savings on pension benefits	G	-G	
Total	A+B-C-D-E+F+G (=value of life)	C+D+E-F-G	A+B
Calculated through	Value of QALY's	Total net contributions, see text	Adding up, see Table 3.4

Health insurance premiums

People contribute to the healthcare system. Part of this takes place through the nominal health insurance premium and the deductible. This is on average € 1,328 per year. Another part is paid by employers. They pay 7.75 percent of the gross wage with an income limit of € 33,427 as part of the employer's share of the health insurance premium. When malnourished persons die early, this results in costs for the rest of society because these contributions do not take place.

AOW and pension premiums

Part of the gross wage is allocated to pension provisions. This is about 50 percent of the total taxes withheld in the first tax bracket. In addition, employers contribute part of the income to additional pension schemes. This is about 10 percent of the gross wage. When malnourished persons die before their pensionable age, these payments are not made. This results in costs for the rest of society. When a malnourished person dies after the pensionable age, this has no effects for this cost item. This is because these payments are only made until the pensionable age.

Other contributions

Other contributions are made throughout life, for example, income tax and premiums for the national insurance AWBZ (Exceptional Medical Expenses Act). Moreover, people rely on facilities for which they have to pay a personal contribution, such as the Social Support Act (WMO). The early death of a malnourished person results in costs, because society does not receive these contributions. An estimation of these costs follows from the remaining life expectancy of the persons who died early and the annual average contributions depending on age.

Healtcare use

Persons who die early as a result of malnutrition do not pay healthcare costs during the remaining years of life that will not occur. This results in savings for the rest of society. The quantification of

these benefits is based on the average healthcare costs per age group. Table B.1 in Appendix B presents these healthcare costs.

AOW and pension benefits

The early death of a malnourished person has positive effects for the rest of society, because AOW and pension benefits cease. This is why the death of a malnourished person results in benefits for the rest of society. An estimation of the extent of these benefits follows from the expected number of pension years and the level of AOW and pension benefits.

Results

Table 3.4 presents a summary of the costs of malnutrition for the various items. These costs depend on the age group. This is because age affects the costs of malnutrition in a number of ways. First of all, excess mortality as a result of malnutrition differs per age group. Furthermore, the age in relation to the pensionable age is relevant. In the years before the pensionable age the contributions are relatively large and the persons in question do not receive any pension benefits yet. After the pensionable age the contributions decrease and the persons in question receive pension benefits. The costs of healthcare use also differ between age groups. Finally, the effect of factoring is greater for young age groups, because the costs in the last years of life are relatively far away in the future so they are not weighted as heavily.

In total, the costs of excess mortality as a result of malnutrition amount to € 183 million. The largest cost item is the value of life (€ 244 million). The quantified value of the loss of life years is therefore relatively great. These costs are partly compensated, because the healthcare use (€ 54 million) and pension benefits (€ 30 million) cease in the missing remaining life years. The contributions to health insurance (€ 9 million), AOW and pension premiums (€ 4 million) and other provisions (€ 9 million) jointly amount to more than € 22 million.

Table 3.4 The extimated costs of excess mortality caused by malnutrition amount ot about € 183 million every year

Age group	Financial costs per deceased person for the rest of society (in thousands of euros						Immaterial costs per deceased person	Total costs (in thousands of euros)		
	Health insurance premiums	AOW and pension premiums	Other contributions	Healthcare use	AOW-and pension benefits	Subtotal	Lost value of life	Total costs per deceased person	Number of additional deaths per year	Total costs per year
20-25 year	€ 50	€ 65	€ 36	-€ 73	-€ 12	€ 66	€ 1,116	€ 1,182	18	€ 21,272
25-30 year	€ 49	€ 63	€ 35	-€ 76	-€ 15	€ 56	€ 1,101	€ 1,157	18	€ 20,827
30-35 year	€ 48	€ 60	€ 35	-€ 79	-€ 20	€ 43	€ 1,082	€ 1,126	6	€ 6,755
35-40 year	€ 46	€ 56	€ 35	-€ 84	-€ 26	€ 27	€ 1,058	€ 1,085	6	€ 6,511
40-45 year	€ 44	€ 51	€ 34	-€ 90	-€ 34	€ 5	€ 1,027	€ 1,032	4	€ 4,128
45-50 year	€ 42	€ 44	€ 33	-€ 98	-€ 46	-€ 23	€ 987	€ 964	4	€ 3,856
50-55 year	€ 39	€ 35	€ 33	-€ 105	-€ 60	-€ 58	€ 938	€ 880	6	€ 5,281
55-60 year	€ 35	€ 24	€ 32	-€ 113	-€ 80	-€ 102	€ 877	€ 775	3	€ 2,325
60-65 year	€ 31	€ 9	€ 31	-€ 123	-€ 107	-€ 158	€ 803	€ 645	22	€ 14,189
65-70 year	€ 26	€ 0	€ 29	-€ 128	-€ 116	-€ 189	€ 715	€ 527	28	€ 14,743
70-75 year	€ 22	€ 0	€ 25	-€ 142	-€ 100	-€ 194	€ 614	€ 420	71	€ 29,786
75-80 year	€ 18	€ 0	€ 20	-€ 156	-€ 81	-€ 199	€ 502	€ 303	101	€ 30,612
80-85 year	€ 14	€ 0	€ 15	-€ 147	-€ 61	-€ 179	€ 378	€ 199	114	€ 22,735
Total for all additional deceased	€ 9,421	€ 3,870	€ 9,323	-€ 54,178	-€ 29.553	-€ 61,116	€ 244,136		401	€ 183,019

Source: Calculations by SEO Economic Research
The numbers are based on 2011

3.2 Healthcare

Hospital care

The study by Lim et al. (2013) shows that the average hospital stay of malnourished patients is 1.28 times longer than the average hospital stay of non-malnourished patients with comparable characteristics. Kruizinga et al. (2005) found a comparable extension of the hospital stay. The calculation of the effect of malnutrition on the costs of hospital care is based on the assumption that the costs of the entire treatment in hospital would be 1.28 times higher for malnourished persons than for non-malnourished persons.

Table 3.5 and Table 3.6 give a summary of the total hospital costs and the prevalence of malnutrition for the most important disorders in 2011. The first table focuses on the age group between 18-60 years and the second table on the 60+ age group. Applying the costs, the illness-specific prevalence of malnutrition and the difference in costs between malnourished and non-malnourished patients, the costs can be broken down into the expenses for malnourished and non-malnourished patients. The last column shows the additional costs of the malnourished patients as a result of malnutrition. This corresponds with the amount that would be saved if the individual costs of these patients would be equal to the costs of non-malnourished patients. At the bottom of the last column the amount can be seen that would have been saved if no one was malnourished.

The tables show that the additional hospital costs of malnutrition for the age group between 18-60 years amount to € 365 million. The hospital costs for the 60+ age group amount to € 752 million. The most important costs of malnutrition are related to neoplasms (tumours) and disorders in the cardiovascular system. These are also the largest costs of the total hospital care. The combined costs for both age groups therefore amount to about € 1,117 million. This means that the hospital costs of malnutrition are twice as high as the costs related to mortality.

Table 3.5 Hospital costs of malnutrition in 18-60 age group amout to € 365 milion

Disorder	Total costs of deseases[1]	Prevalence of malnutrition (in %)[2]	Total costs of non – malnourished patients	Total costs of malnourished patients	Additional costs of malnourished patients
	(in millions of euros)				
Infectious deseases an parasitic diseases	€ 144	23	€ 104	€ 40	€ 8.7
Neoplasms	€ 1,340	30	€ 865	€ 475	€ 103.8
Endocrine, nutrional and metabolic diseases	€ 170	20	€ 129	€ 41	€ 9,0
Blood and haematopoietic organs	€ 95	44	€ 48	€ 48	€ 10.5
Psychological disorders	€ 331	24	€ 236	€ 95	€ 20.8
Nervous system and senses	€ 724	8	€ 652	€ 73	€ 15.9
Cardiovascular system	€ 1,288	14	€ 1,066	€ 222	€ 48.6
Respiratory tract	€ 359	25	€ 251	€ 107	€ 23.5
Digestive system	€ 716	30	€ 462	€ 254	€ 55.5
Urogenital system	€ 815	10	€ 713	€ 101	€ 22.2
Skin and subcutaneous tissue	€ 209	22	€ 153	€ 55	€ 12.1
Locomotion system and connective tissue	€ 958	11	€ 827	€ 131	€ 28.6
Accident injuries and poisonings	€ 564	4	€ 535	€ 29	€ 6.2
Total					€ 365.4

1 source: www.kostenvanziekten.nl of the RIVM
2 source: Freijer et al.)2013) based on th LPZ 2011
Calculations: SEO Economic Research

Table 3.6 Hospital costs for the 60+ age group amount to € 752 million

Disorder	Total costs of deseases[1]	Prevalence of malnutrition (in %)[2]	Total costs of non – malnourished patients	Total costs of malnourished patients	Additional costs of malnourished patients
	(in miljoenen euro's)				
Infectious deseases an parasitic diseases	€ 128	32	€ 80	€ 48	€ 10.5
Neoplasms	€ 2,068	39	€ 1,137	€ 931	€ 203.6
Endocrine, nutrional and metabolic diseases	€ 165	23	€ 119	€ 46	€ 10.0
Blood and haematopoietic organs	€ 104	30	€ 67	€ 37	€ 8.1
Psychological disorders	€ 159	37	€ 91	€ 68	€ 14.9
Nervous system and senses	€ 1,301	23	€ 941	€ 360	€ 78.7
Cardiovascular system	€ 2,858	22	€ 2,100	€ 758	€ 165.8
Respiratory tract	€ 479	33	€ 294	€ 185	€ 40.5
Digestive system	€ 536	38	€ 300	€ 236	€ 51.6
Urogenital system	€ 799	33	€ 490	€ 309	€ 67.6
Skin and subcutaneous tissue	€ 154	45	€ 75	€ 79	€ 17.3
Locomotion system and connective tissue	€ 900	23	€ 651	€ 249	€ 54.4
Accident injuries and poisonings	€ 572	19	€ 440	€ 132	€ 28.9
Total					€ 751.9

1 source: www.kostenvanziekten.nl of the RIVM
2 source: Freijer et al.)2013) based on th LPZ 2011
Calculations: SEO Economic Research

Care and nursing home healthcare

Malnutrition in nursing homes results in costs. Meijers et al. (2012) calculate that the surplus costs for each malnourished person in a nursing home amount to on average € 10,597. The following analysis is based on this amount. The analysis is also based on the assumption that the costs of malnutrition per patient in a residential care home are equal to the costs of malnutrition per patient in a nursing home.

The analysis makes use of the LPZ from 2011 (Halfens, 2011). According to this study, the prevalence of malnutrition in nursing homes and residential care homes is 17.3 percent. Finally, the analysis is based on the number of persons that have an indication for and/or who make use of a nursing or residential care home, according to the CBS (Central Bureau of Statistics). In total this amounts to 285,135 persons in 2011.[5]

The total costs of malnutrition in Dutch care and nursing homes is equal to the costs for each malnourished person X the number of persons in residential care homes and nursing homes X the prevalence of malnutrition. This corresponds with a total cost of € 10,597 × 285,135 × 17.3 percent = € 523 million. The costs of malnutrition in residential care homes and nursing homes are therefore less than half of the costs of malnutrition in the hospital sector.

Healthcare for persons living at home

The effects of malnutrition for the healthcare costs of persons living at home have not been sufficiently studied yet to quantify them. We did not find literature in which the background characteristics and health situation of malnourished persons are considered, for example. It is therefore not possible to estimate these costs. The costs of this cost item are included in the summary below as a memorandum item. However, the effects of malnutrition on the mortality of persons living at home are included in the calculations.

3.3 Total costs of malnutrition

The table below offers a summary of the costs of malnutrition broken down into various cost items and actors. The value of life lost as a result of mortality is a cost item for malnourished persons. The other costs and savings are revenues are incurred and received by the rest of society.

The total amount shows that the total costs of malnutrition in the Netherlands in 2011 amount to € 1.8 billion, plus the non-quantified costs of healthcare for persons living at home. Hospital care represents the largest cost item (€ 1.1 billion), which equals more than 60 percent, followed by residential care home and nursing home care (€ 523 million). The loss in the value of life is the largest cost item of the additional mortality as a result of malnutrition (€ 244 million). The costs are partly compensated by the termination of the use of healthcare and pension benefits (jointly € 84 million).

5 Source: http://statline.cbs.nl/statweb/

Most of the costs of malnutrition are paid by the rest of society (€ 1,579 million). The additional healthcare costs (€ 1,640 million) more than compensate the savings on mortality (-€ 61 million). The only cost item for malnourished persons is the value of life (€ 244 million).

Table 3.7 The total costs of malnutrition in the Netherlands amounted to more the 1.8 billion in 2011

	Total costs in the Netherlands in 2011 (in millions of euros)		
Cost item	Malnourished person	Rest of society	Total
Costs of mortality:			
• Value of life	€ 244		€ 244
• Health insurance premiums		€ 9	€ 9
• AOW- and pension premiums		€ 4	€ 4
• Other contributions		€ 9	€ 9
• Savings on healthcare use		-€ 54	-€ 54
• Savings on pension benefits		-€ 30	-€ 30
Subtotal	€ 244	-€ 61	€ 183
Costs of healthcare:			
• Costs of hospital care		€ 1,117	€ 1,117
• Costs of nursing and residential care homes		€ 523	€ 523
• Costs of care for persons living at home		PM	PM
Subtotal		€ 1,640+PM	€ 1,640+PM
Total	€ 244	€ 1,579+PM	€ 1,823+PM

Calculations: SEO Economic Research
Explanation: PM (memorandum item) refers to a non-quantified cost item

3.4 Sensitivity analyses

Adjusted values of a QALY

The costs of malnutrition are partly caused by the value of the increased mortality. One QALY is valued in this study at € 100,000. This amount is based on studies by the National Institute for Public Health and the Environment (RIVM) and the Netherlands Bureau for Economic Policy Analysis (CPB) (De Hollander et al. 2006 and Spreen & Mot 2008). It is difficult to establish the actual value of a QALY. Imagine that one QALY has a value of € 50,000. In that case the costs of malnutrition in the Netherlands still amount to € 1.7 billion. Therefore decreasing the QALY value leads to a decrease in the costs of malnutrition, but the total costs remain substantial. With a QALY value of € 150,000 the costs of malnutrition increase to € 1.9 billion. Increasing the QALY value therefore also results in an increase in **the costs of malnutrition.**

Lower costs of malnutrition in nursing and residential care homes

The calculations assume that the costs of malnutrition in nursing and residential care homes amount to € 10,597 per person. This amount is based on a study by Meijers et al. (2012). The study only calculates the costs of malnutrition in nursing homes, but not the costs in residential care homes. These costs may be less than in nursing homes. This is why the costs are halved in this sensitivity analysis. If the costs are € 5,299 per person, the costs of malnutrition in the Netherlands would still amount to € 1,562 million. The costs of malnutrition therefore also decrease in this sensitivity analysis, however the total costs continue to be about € 1.6 billion

Shorter hospital stays of malnourished hospital patients

Higher hospital costs account for more than 60 percent of the costs of malnutrition. The costs are based on the observation that the average hospital stay of malnourished patients is 28 percent longer than the average hospital stay of non-malnourished patients with comparable characteristics. It is assumed that the increase of the hospital stay does not only result in higher costs for patient days, but is also accompanied by a proportional increase in other hospital costs (such as preventive scans, treatment of wound infections and decubitus ulcers). The costs of patient days amount to about 23.5 percent of the total hospital costs.[6] When the hospital costs of malnourished persons for costs other than patient days do not increase by 28 percent but by 21 percent (three fourths of the increase in the costs of patient days), the costs of hospital care decrease from € 1,117 million to € 832 million. The total costs of malnutrition would decrease, but they would still amount to € 1.6 billion. Conversely, when the other hospital costs increase more than the costs of patient days, the costs of hospital care as a result of malnutrition exceed € 1.1 billion (and the total costs of malnutrition exceed € 1.8 billion).

Only value of life with costs of mortality

The calculations of the costs of mortality also include the costs and savings that are not part of the costs related to malnutrition, which arise when a person dies earlier. The manual of the CVZ prescribes that these costs should not be included. When these costs are not considered, the costs of malnutrition amount to € 1,884 million.

6 Calculation on the basis of data from the RIVM, Statline and the CVZ

4 Effects of medical nutrition

Medical nutrition is prescribed for the treatment of disease-related malnutrition. Medical nutrition contains a specific combination of energy, protein and other nutrients. Medical nutrition reduces mortality, the number of readmissions and the number of complications. There is not enough evidence yet to conclude that the use of medical nutrition leads to improvements in quality of life or functional outcomes.

4.1 What is medical nutrition?

ONS consists of a specific combination of nutrients like energy, protein, vitamins and minerals. Medical nutrition is used for disease-related malnutrition. Patients with disease-related malnutrition often have an increased need for specific nutrients like energy, protein and other nutrients because of illness, often in combination with reduced intake as a result of illness. Medical nutrition has been developed specifically for patients who are not able to consume, digest or absorb regular food. Adapted medical nutrition is also available for people with food allergies or metabolic diseases. For these situations the composition of the nutrition has been adapted, either by omitting certain components or by including them in such a way that they can be absorbed by the body. Medical nutrition is used when regular or adapted food is not sufficient. Medical nutrition is used by adults, infants and children. Medical nutrition is taken under medical supervision and is prescribed by doctors and dieticians. If there is a medical indication the medical nutrition is covered [in the Netherlands] by basic insurance. The time of use ranges from several weeks to the rest of the person's life.[7] The use of medical nutrition often starts during hospitalization and is then continued at home.

4.2 Effects of medical nutrition

This section provides an overview of the scientific studies that have been done on the effect of medical nutrition. These studies analyse the effects of medical nutrition on various health outcomes, such as mortality, hospital admissions and complications. We looked for recent surveys and meta-studies that presented quantitative summaries of the effect of medical nutrition. In many studies the treatment with medical nutrition starts during hospitalization and is continued at home after discharge from hospital. The section below only discusses the most useful relevant studies. Appendix C contains more detailed information about all the reviewed studies.

The use of midical nutrition by malnourishe elderly persons reduces teh risk of mortality

Milne et al. (2009) examined the available literature on the effects of energy and protein supplements on mortality by means of a systematic Cochrane review. They studied clinical experiments that administered oral supplementation to elderly patients. All the studies were randomised or semi-randomised and they included a total of about 10,200 participants. The

7 Source: www.vnfkd.nl

interventions consisted of the use of liquid medical supplements or enriched solid food. The intervention duration was a minimum of 10 weeks and a maximum of 18 weeks. The control groups consisted of persons who underwent a placebo treatment or regular care, such as no nutritional supplements or alternative supplements. The quality of the studies was evaluated on the basis of the size of the dataset and the comparability of intervention groups and control groups, among other things. The average age in the individual studies was 65-plus. The majority of the participants started the treatment at the hospital (71 percent). A smaller percentage started the treatment at a (14 percent) or at home (15 percent). About two thirds of the studies comprised elderly persons without any specific condition or disease. The other studies consisted of patients with specific conditions, such as COPD or strokes.

The investigators concluded that medical nutrition reduces mortality. The relative risk of mortality is 0.79. This means that the risk of mortality for malnourished users of medical nutrition is 0.79 times the risk of mortality of malnourished non-users. A risk of less than 1 means that the risk of mortality is smaller after the use of medical nutrition.[8]

The number of readmissions to hospital decreases after the use of medical nutrition

Stratton et al. (2013) conducted a systematic review and meta-analysis of the effects of ONS on the number of (re)admissions to hospital. This review is based on six separate studies. In five of these studies, readmission to hospital is investigated as an outcome variable. One of the studies also includes initial admissions. In three of the studies the use of medical nutrition started at the hospital and was then continued at home after discharge from hospital. In the other studies the intake of medical nutrition started at home. The average age of the participants in five of the six studies was 65-plus. In the remaining study the average age was 52. Four of the studies included patients with a mix of diseases and health conditions. The other studies included patients with limb fractures or digestive disorders.

The meta-analysis indicated that the use of ONS resulted in a significant decrease in the number of hospital admissions. The number of patients that was readmitted after the use of medical nutrition was less (23.9 percent) than those patients who did not use medical nutrition (33.8 percent).

The study by Milne et al. (2009) described above not only investigated the effects of medical nutrition on mortality, but also the effects on the length of stay at the hospital. The analysis yielded some evidence for a shorter hospital stay after the use of medical nutrition, but the difference is not statistically significant.

The risk of complications decreases after the use of medical nutrion

Different reviews indicate that the risk of complications decreases after the use of medical nutrition. The study by Milne et al. (2009) found a relative risk of complications of 0.86. This means that the risk of a complication is lower after the use of medical nutrition: the risk of complications after the

[8] Stated as a formula: the relative risk = (risk of mortality with use of medical nutrion) / (risk of mortality wihout use of medical nutrition

use of medical nutrition is 0.86 times the risk without the use of medical nutrition. Subgroup analyses that differentiate between the types of diagnoses that lead to the use of medical nutrition indicate positive effects on patients with hip disorders. The relative risk of complications in this group of patients after the use of medical nutrition is 0.60.

Cawood et al. (2012) present a meta-study of the effects of protein-rich ONS. One of the things they investigated was the effects on the number of complications. This analysis is based on ten individual studies with a total of 1,830 participants. The average age of the study group was 79. The results indicate that the number of complications decreased after the use of ONS: the absolute reduction in complications was 19 percent. This indicates a marked decrease in the number of complications after the use of medical nutrition.

Finally, a survey conducted by Stratton et al. (2007) yields further proof that medical nutrition leads to fewer complications. The survey was based on five studies. The treatment duration ranged from 2-26 weeks in most of the studies. The majority of the participants were hospital patients. The results indicate that the number of complications decreases after the use of ONS. This is due to improved wound healing and fewer infections and decubitus ulcers. There are also fewer complications in patients with hip fractures and those who have had gastric/intestinal surgery.

Insufficient evidence for effect of medical nutrition on quality of life

The available meta-studies do not yet offer sufficient statistical evidence that quality of life improves after the use of medical nutrition. A few of the experiments yielded positive results, but what is lacking is one integrated analysis of the different substudies. For instance, Cawood et al. (2012) highlights several studies that show an improvement in certain aspects of quality of life after the use of medical nutrition. However, this review does not offer an integrated analysis in which the effects of the different underlying studies are analysed together. The meta-study by Milne at al. (2009) described above also states that there is little evidence for positive effects. Moreover, the available studies are too different to be integrated in one analysis.

Insufficient evidence for effect of midical nutrion on functional outcomes

The available scientific studies do not offer unequivocal evidence that medical nutrition leads to a statistically significant improvement in functional outcomes, such as muscle function and mobility. While it is true that effects were observed in a few individual substudies, this is not supported by the outcomes of integrated analyses. For instance, the survey by Beck et al. (2011) concludes that there is some evidence for positive effects of liquid medical nutrition on functional outcomes. This conclusion is based on studies of muscle function and activities of daily living (ADLs). Of the four studies on the effects of medical nutrition on muscle function and ADLs, studies one and two are statistically significant. Milne et al. (2009), on the other hand, conclude that there is little evidence for positive effects of medical nutrition on functional outcomes and that the available studies cannot be analysed in one integrated study.

Summary

The review of the literature on the effects of medical nutrition leads to the following conclusions:

- The use of medical nutrition leads to a decrease in mortality in elderly patients.

- The use of medical nutrition reduces the risk of readmission to hospital and the number of complications.
- There is insufficient evidence that quality of life and functional outcomes improve after use of medical nutrition.

5 Cost-benefit analysis of medical nutrition

The use of medical nutrition by sick and malnourished elderly persons yields a net benefit of € 1,433 to € 3,105 per person. For every euro spent on the treatment of a malnourished person with medical nutrition, society saves € 1.90 to € 4.20. The use of medical nutrition by all sick and malnourished persons age 65 and up will result in an estimated total net benefit of € 52 million to € 112 million.

Improved nutritional status has positive effects on the malnourished person, but also on society as a whole. For example, the patient has an increased life expectancy. Improved health leads to fewer hospital admissions and therefore to lower healthcare costs. This benefits society as a whole. In this chapter the costs and benefits are quantified as much as possible and categorized by type of population group.

The analyses are focused on elderly persons with disease-related malnutrition. Chapter 4 shows that the effect of medical nutrition on multiple health outcomes in this population has been demonstrated. The reviewed studies contained persons who also suffered from other health problems besides malnutrition. Not as much research has been done yet on the effect of medical nutrition in younger age groups, so the costs and benefits for these groups cannot be quantified yet.

The cost-benefit analysis is focused on hospital patients. The majority of the meta-studies listed in Chapter 4 focus on hospital patients as well. These patients suffer from varying disorders and diseases.

5.1 Methodology

Time horizon: costs and benefits calculated over the entire lifespan

An important aspect of the cost-benefit analysis is determining the time horizon (How many years do the costs and benefits last?) The costs of the medical nutrition are incurred in the year of the intervention itself. The positive effects, on the other hand, extend over a longer period. For example, improved nutritional status leads to a higher life expectancy, so the benefits are quantified for the entire lifespan. People prefer good health in the present to good health in the future. In accordance with the General SCBA [Social Cost-Benefit Analysis] guideline, the calculations use a discount rate of 5.5 percent so immediate health is valued higher than future health.

Treatment and target group

The cost-benefit analysis investigates the effects of ONS on malnourished persons. Medical nutrition supplements the body of a malnourished person with calories, proteins and a combination of specific nutrients. Situations where malnourished persons use ONS are compared with situations where these persons are malnourished but do not use ONS. The target group consists of elderly

malnourished persons who have been admitted to a hospital. The use of medical nutrition starts during or right after the hospitalization and is continued at home. This target group was selected because malnutrition is relatively common in this group, and because there are many studies that are focused on this population. The calculations are done separately for patients in two divergent age groups, i.e. 65-69 and 80-84, in order to show that the benefits of medical nutrition are age-dependent. The age-dependency of the benefits is the result of differences in risk of mortality and life expectancy.[9]

Costs and benefits

Based on the review of the literature in Section 4.2, the following costs and benefits are quantified in the analysis:

- Mortality – the life expectancy of elderly persons goes up with the use of ONS.
- Readmission to hospital – the number of readmissions decreases as a result of taking ONS.
- The price of ONS.

In addition, Section 4.2 shows that the number of complications decreases after the use of medical nutrition. This positive effect leads to a decrease in the number of readmissions and is therefore included indirectly in the analysis.

Population groups

The use of ONS by malnourished elderly persons has effects on the following population groups:

- Patients – malnourished elderly persons who consume ONS see positive results from the ONS, i.e. improved health, fewer hospital admissions and increased life expectancy.
- Premium payers – those who pay healthcare premiums experience two opposite effects: they bear the cost of the medical nutrition, but they also profit from the lower hospital costs.

There could also be effects on the informal care network of malnourished persons. Their mental welfare might improve as a result of the improved health of the malnourished persons. The literature provides no information about this, so these effects have not been included.

The assumption is that health insurers, hospitals and manufacturers of medical nutrition will not see any long-term surplus profits. This assumption is in line with the General SCBA guideline. According to this guideline there will only be short-term profits. This means that the cost increase will be passed on entirely to premium payers in the form of higher premiums.

5.2 Breakdown of costs and benefits

Mortality

The use of medical nutrition by malnourished persons reduces the risk of mortality. Milne et al. (2009) found a relative risk of mortality of 0.79. This means that the risk of mortality for

[9] The values for risk of mortality and life expactancy are taken from http://statline.cbs.nl/starweb

malnourished persons is 21 percent less after the use of medical nutrition. This study is largely based on hospital patients.

The use of medical nutrition leads to benefits as a result of a decrease in mortality. The lower mortality rate leads to additional years of life, which are valued in accordance with the QALY method (see Section 3.1). The following analysis is based, like the calculation of the costs of malnutrition, on an average value of € 64,000 for a year of life for a malnourished person.

The following analysis is based on the assumption that the risk of mortality for patients after the use of medical nutrition is equal to the risk of mortality for the entire population in the same age goup.[10] This assumption also applies to the remaining life expectancy.

Analysis 1: age 65-69

The average risk of mortality for someone in the 65-69 age category is 1.2 percent. The remaining life expectancy is 18.2 years. Based on the assumptions listed above, the risk of mortality for users of medical nutrition is also 1.2 percent. The risk of mortality for non-users of medical nutrition is (1 / 0.79) × 1.2 percent = 1.52 percent. This calculation uses the above mentioned result from Milne et al. (2009). The use of medical nutrition therefore leads to a risk of mortality decrease of 1.52 percent - 1.2 percent = 0.32 percent.

The cost of a person in the 65-69 age group who is deceased is (rounded) € 527 thousand (see Table 3.4). The benefits of the use of medical nutrition consist of the value of a deceased person times the reduction in risk of mortality. A 0.32 percent decrease in the risk of mortality therefore has a benefit of €1,674. This is the balance of patient benefits as a result of living longer (€ 2,275) and the costs for premium payers as a result of healthcare costs and pension payments during the additional years of life (€ 601).

Analysis 2: age 80-84

The average risk of mortality for all persons in the 80-84 age category is 6.3 percent. The remaining life expectancy is 7.8 years. The abovementioned assumptions indicate that the risk of mortality for users of medical nutrition is also 6.3 percent. The risk of mortality for non-users of medical nutrition is (1 / 0.79) × 6.3 percent = 8.0 percent. The use of medical nutrition therefore leads to a risk of mortality decrease of 8.0 percent - 6.3 percent = 1.7 percent.

The value of a person in the 80-84 age group who is deceased is (rounded) € 199 thousand (see Table 3.4). The benefits of the use of medical nutrition consist of the value of a deceased person times the decrease in risk of mortality. A 1.7 percent decrease in risk of mortality therefore has a benefit of € 3,346. This is the balance of patient benefits as a result of living longer (€ 6,345) and the costs for premium payers as a result of healthcare costs and pension payments during the additional years of life (€ 2,999).

[10] This assumption has been cross-checked with the study by Potters et al. (2001). This is one of the underlying studies of the review of Milne et al. (2009). The assumption seems fairly realistic

Summary of results

The use of medical nutrition by hospital patients ages 65-69 and 80-84 leads to a decrease in mortality valued at € 1,674 and € 3,346.

The benefits increase as the patients get older. This is because the risk of mortality increases with age. A decrease in the risk of mortality percentage therefore has a greater effect.

Hospital care

The survey by Stratton et al. (2013) shows that the use of ONS reduces the risk of readmission to hospital. The decreased risk of readmission may be due to a lower risk of complications as a result of improved nutritional status. The study is based largely on older hospital patients: the average age in five of the six underlying studies is 65-plus. The proportion of the number of patients who were readmitted is 23.9 percent for users and 33.8 percent for non-users of ONS. This shows that the use of medical nutrition reduces the risk of readmission by 33.8 - 23.9 = 9.9 percent.

The average cost of hospitalisation in 2010 was €4,975.[11] After adjustment for inflation this is equivalent to € 5,089 in 2011. We can conclude from these numbers that the use of medical nutrition by hospitalized patients leads to a savings of 9.9 percent × € 5,089 = €502 on the hospital costs of admission.

The price of medical nutrition

There is no standard price for treatment with medical nutrition. This is because there is so much variety in the types of products and the duration of use. The type and brand of ONS depends on the clinical picture and the individual situation of the patient. As there is no standard price, we used the price of a representative treatment for the analysis. This representative treatment is based on the duration and composition of an average treatment consisting of calories, proteins and a specific combination of nutrients.

A treatment with medical nutrition lasts about ten weeks and contains the right nutrients, including proteins, and a caloric value of 850 kilocalories per day. This is equivalent to about three bottles of ONS per day. Stratton et al. (2013) report that a standard treatment ranges from six weeks to three months.

There is also variation in the prices of the different products. The average price listed by health insurers in 2014 for a bottle of liquid nutrition is € 1.77. This is equivalent to a daily cost of representative treatment of € 1.77 × 3 = € 5.31. The total cost of a representative treatment of 10 weeks is about € 371.70 (€ 5.31 per day × 7 days × 10 weeks = € 371.70).[12]

Added to this amount are the costs incurred by doctors, nurses, dieticians and home care workers in the course of initiating and monitoring the use of medical nutrition. Meijers et al. (2012) estimate that the additional cost of malnourished patients in nursing homes is € 10,600 per patient. Part of this cost is for ONS. For patients who use ONS all year long, the cost is estimated at € 1,930 (based

11 Source: http://www.skipr.nl/actueel/id8045-ziekenhuisopname-duurder-ondanks-korter-verblijf.html

12 These costs are in line with the average cost of a treatment with ONS of € 316, according to the 2012 GIPeilingen [publication of the drug information system of the Dutch National Health Care Institute

on € 371.70 for 10 weeks, converted to cost per year). The other costs are mostly personnel costs. The costs of diagnostics, multidisciplinary consultation and monitoring of patients alone are € 995: 55 percent of the cost of the ONS itself. Then there are the costs related to weight management and determining the right dosage of the ONS. Based on these data we estimate that the cost of administering ONS is about equal to the cost of the ONS itself. This leads to a total cost for one treatment with medical nutrition of 2 × € 371.70 = € 743.40.

5.3 Total costs and benefits

Table 5.1 and Table 5.2 provide an overview of the total benefits to society of the use of medical nutrition by malnourished patients in the 65-69 and 80-84 age groups who have been admitted to a hospital. The cost of one treatment is € 743. The quantified net benefits are € 1,433 for patients in the 65-69 age group and € 3,105 for patients in the 80-84 age group. This means that every euro spent on the treatment of patients aged 65-69 yields € 1.90 (€ 1,433/€ 743). For 80-84 year olds the yield is € 4.20 per invested euro (€ 3,105/€ 743).

Table 5.1 The net benefits of medical nutrition for hospital patients ages 65 -69 are € 1,433 per treatment

	Patient	Premium payer	Total
Mortality	€ 2,275	-€ 601	€ 1,674
Hospital readmission		€ 502	€ 502
Price of medical nutrion		-€ 743	-€ 743
Total	€ 2,275	-€ 842	€ 1,433

Source: SEO Economic Research
Benefits (+) and costs (-)

Table 5.2 The net benefits of medical nutrition for hospital patients ages 80 – 84 are € 3,105 per treatment

	Patient	Premium payer	Total
Mortality	€ 6,345	-€ 2,999	€ 3,346
Hospital readmission		€ 502	€ 502
Price of medical nutrion		-€ 743	-€ 743
Total	€ 6,345	-€ 3,240	€ 3,105

Source: SEO Economic Research
Benefits (+) and costs (-)

According to a global estimate, the total net benefits are € 52 million to € 112 million per year. According GIPeilingen, € 23.7 million was spent in 2012 on ONS at home for people ages 65 and older. At a net benefit of € 1.90 per invested euro, the total net benefits are € 52 million per year. At a net benefit of € 4.20 per invested euro the total net benefits are € 112 million per year.

Sensitivity analysis: value of a QALY

The decreased mortality of malnourished patients who take medical nutrition is one of the causes of the positive net benefits of medical nutrition. In this study, one QALY is valued at € 100,000. The net benefits of medical nutrition go down as the QALY value decreases, because the value of decreased mortality goes down. As in the sensitivity analysis in Chapter 3, this values changes to €

50,000. In that case the net benefits of medical nutrition are € 295 for the 60-65 age group and –€ 68 for the 80-84 age group. In other words, the net benefits for the 65-69 age group remain positive, but they are negative for the 80-84 age group. In this the case the costs of the use of medical nutrition outweigh the benefits. The effects of the decreased QALY value are greater for patients in the 80-84 age group, because the value of a person who is deceased in this age group is determined to a large extent by the "value of life" item. This is the only item that is affected by the adjusted QALY value. At a QALY value of € 150,000 the net benefits of medical nutrition for hospital patients are € 2,570 in the 65-69 age group and € 6,277 in the 80-84 age group.

Value of life only with benefits of decreased mortality

The calculation of the costs and benefits of medical nutrition also includes the costs and savings beyond the malnutrition-related costs that occur when someone lives longer as a result of malnutrition [sic]. When these costs are not taken into account in line with the guidelines of the CVZ [Dutch Healthcare Insurance Board], the quantified benefits are € 2,033 for patients in the 65-69 age group and € 6,104 for patients in the 80-84 age group

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Appendix A Consequences of malnutrion: scientific literature

The table on the next page provides an overview of the available (scientific) literature that quantifies the cost of malnutrition. Each article is listed with the first author of the publishing organisation, the year of publication, the type of publication or name of the scientific journal, the aim, the method, the outcome variables, the control variables and the main results of the study.

Tabel A. 1 Overview of the literature on the costs of malnutrition

Authors, year	Journal/type of publication	Aim and method	Outcome variables	Control variables	Results (malnourished vs. not malnourished)
Correia & Waitzberg, 2003	Clinical Nutrition	The study analyses the effects of malnutrition on mortality, morbidity, healthcare use and healthcare costs by means of a multivariate model analysis. To this end the investigators use the data from hospitals and the recorded nutritional status. Then they estimate the healthcare costs by looking at the information from insurers.	Morbidity, mortality, length of stay at the hospital (LOS) and costs	Age, particular diseases and treatments	Malnutrition-related mortality: 12.4% vs. 4.7% Relative risk of complications (RR): 1.60. LOS: average of 16.7 vs. 10.1 days Hospital costs for malnourished patients: increase to 308.9%
Lim et al., (2012)	Clinical Nutrition	Study on the prevalence of malnutrition and the effects on healthcare use, healthcare cost and mortality. The study is conducted in a tertiary hospital in Singapore. It is a prospective cohort study with a matched case control study.	LOS, readmission within 15 days, difference between actual and average costs within a Disease Related Group (DRG), mortality within 1, 2 and 3 years	Age, sex, ethnicity and DRG	LOS: 6.9 days Readmission within 15 days (adjusted RR): 1.9 Difference between actual and average costs within a DRG: significantly higher (p=0.014) Mortality within 1 year: 34% vs. 4.1% “ “ 2 years: 45.6 vs. 6.7% “ “ 3 years: 48.5% vs.9.9%
Kruizenga et al., 2005	The American Journal of Clinical Nutrition	This study calculates the costs and effectiveness of early screening and treatment of malnourished hospital patients. To this end an intervention group of 297 patients is compared with a control group of 291 patients. The intervention group was screened at the time of admission and received standardised treatment. The control group only received the standard hospital care.	LOS	It is a controlled trial with a historic control group.	LOS: 1.3 The average duration of the hospital stay for malnourished patients is 1.3 times the duration of the stay for non-malnourished patients. This difference has not been adjusted for background characteristics.
Ethgen, 2005	Value in Health (abstract)	This study analyses the administration at 26 Belgian hospitals. The aim is to quantify the impact of hospital malnutrition. To this end patients with a secondary diagnosis of being underweight or of weight loss are studied.	Cost per stay: total and broken down into medications, procedures and hotel costs	Patients are grouped on the basis of age, sex and APR-DRG (a specific classification of conditions).	Malnutrition is associated with higher average costs: Total € 1,152 Medications € 264 Procedures € 137 Hotel costs € 754

Authors, year	Journal/type of publication	Aim and method	Outcome variables	Control variables	Results (malnourished vs. not malnourished)
Preaud et al., 2011	Value in Health (abstract)	The investigators study the clinical and economic impact of malnutrition in postoperative colon cancer patients. The study is based on a prospective study of others.	Postoperative morbidity, mortality, LOS and the setting of the discharge from hospital.	The two groups have similar characteristics, except that malnourished persons undergo more emergency surgical procedures.	Number of complications: no differences Mortality: increase 7.4% vs. 4.1% LOS: increase of 3.1 days Delay in return home after admission: 69.9% vs. 54.2% Costs: increase of approx. € 3,154 per patient
Alvarez-Hernández, 2012	Nutrición Hospitalaria	This study investigates the percentage of malnourished persons in Spanish hospitals and the effects on healthcare use and costs. The analyses are based on a national, cross-sectional, observational, multi-centre study which records the nutritional status at the time of admission and discharge from hospital. It is not a trial.	Malnutrition-related complications, LOS and costs	Unclear	LOS for malnourished persons is longer, particularly for persons who were not malnourished yet at the time of admission (causality issue): 15.2 vs. 8.0 days. Cost increase: € 5,829
Health Council, 2011	Policy advice	Among other things, the Health Council investigates the association between different indicators of malnutrition and health. The indicators of malnutrition are low BMI, weight loss and reduced food consumption. This is a review of the literature. It does not involve a trial.	Mortality		There is a relationship between malnutrition and mortality. The Health Council is cautious when speaking about causality, because weight loss and reduced food consumption often occur in sick persons and persons with psychosocial problems.
Berrington et al., 2010	The New England Journal of Medicine	The study is based on a large dataset which consists of 19 studies from the American Cancer Institute. The study investigates the relationship between BMI (and therefore with malnutrition) and mortality. The sample consists of 1.46 million people and is restricted to white adults. It concerns BMIs of 15.0-18.4 and 18.5-19.9. The analyses are based on Cox regression models and hazard ratios. The analysis differentiates between smokers and non-smokers. Also, to prevent bias, persons who were suffering from cancer or heart disease at the start of the study were excluded.	Mortality	Age, study, physical activity, alcohol consumption, education and marital status	Hazard ratios: 1.47 for women with BMI 15,0-18.4 (reference: BMI 20.0-22.4), 1.14 for women with BMI 18.5-19.9. Hazard rates for men are comparable. Conclusion of the authors: there may be a relationship between underweight and mortality.

Authors, year	Journal/type of publication	Aim and method	Outcome variables	Control variables	Results (malnourished vs. not malnourished)
Whitlock, 2009	The Lancet	This study investigates the relationship between BMI and cause-specific mortality. The sample consists of 900,000 observations and comprises 57 separate studies. The analyses take into account disease at the start of the study by excluding those who die during the first 5 years of follow-up. The analyses also differentiate between smokers and non-smokers.	Cause-specific mortality	Age, sex, smoking, study	BMIs below 22.5 are inversely related to mortality. This is primarily because of a strongly inverse relationship with respiratory disease and lung cancer. These relationships are much stronger for smokers than for non-smokers, while the cigarette consumption per smoker is not related to the BMI. The excess mortality below 22.5 is actually caused entirely by smoking-related diseases. The underlying mechanism is not entirely clear yet.
Guest et al., 2011	Clinical Nutrition	The study investigates the effects of identification of malnutrition by general practitioners in the UK on clinical outcomes and healthcare use. For this analysis a database of 1,000 records of malnourished patients is matched with non-malnourished persons. This is not a controlled experiment. The outcomes are measured six months after the diagnosis.	Consultations with general practitioner, hospital admissions, mortality and costs.	Matching is done on the basis of age, sex, general practitioner and follow-up date	Number of consultations with general practitioner 18.90 vs. 9.12 Risk of hospital admission 13% vs. 5% Costs of treatment (in six months) £ 1,753 - £ 750 Mortality 13% - 2%

Appendix B Summary of calculations of costs of malnutrition

This appendix presents the underlying assumptions and steps for the calculations of the costs of malnutrition in Chapter 3. First the general assumptions and the specific assumptions of the different costs are listed. Then we discuss how we arrived at the amounts for the different costs in Table 3.4.

The assumptions

General assumptions

- The life expectancy for malnourished persons, if they do not die prematurely from malnutrition, is equal to the average life expectancy for persons in the same age group. These data for the Dutch population can be found on Statline.
- The gross income of malnourished persons during their working years is € 20,000. This is lower than the modal income, but higher than the minimum wage. This wage also takes into account the inactive part of the population. In addition, malnourished persons may be overrepresented on the low end of the job market because of their characteristics (see Section 0).
- The pensionable age is 65.
- The discount rate is 5.5 percent.
- The calculations are based on information from 2011.
- The tax rate is 20 percent. This percentage is based on the personal tax allowance and the income tax plus social insurance contributions totalling 37 percent in the first bracket. These persons do not pay any tax in the second bracket due to the amount of their gross wages.

Value of life

- A completely healthy life year has a QALY value of € 100,000.
- The average health of the population is about 0.8 on a scale from 0 to 1 (Szende & Williams, 2004).
- The health of malnourished persons is about 80 percent of the average level of health of the population. This assumption takes into account the fact that malnutrition is often disease-related and occurs often in weaker persons (Kaarlola 2006).
- These assumptions lead to a life-year value of € 100,000 × 0.8 × 80% = € 64,000 for a malnourished person.

Healthcare costs

- The healthcare costs are based on information from the RIVM [National Institute of Public Health and Environmental Protection]. This information is available at www.kostenvanziekten.nl. These costs account for the largest share of the healthcare sector (including hospital, elderly and social care) and amount to € 89 billion a year. The costs are broken down by age group. The average healthcare costs per person were calculated using the population numbers provided by Statline. The table below presents the average healthcare costs for the different age groups.

- The assumption is that the healthcare costs in the missing remaining life years of persons who die prematurely due to malnutrition would be equal to the average cost for the population. This may be an underestimation of the costs because of the characteristics of malnourished persons.
- This information is used to calculate, for each age group, the average healthcare costs that would not be incurred as a result of the premature death of malnourished persons. These costs increase as the age of death decreases, because the remaining life expectancy is greater than for older persons.

Table B. 1 The annual healthcare costs increase with age

Age group	Healthcare costs per person per year
20-24	€ 3,179
25-29	€ 3,468
30-34	€ 3,519
35-39	€ 3,396
40-44	€ 3,441
45-49	€ 3,894
50-54	€ 4,400
55-59	€ 5,019
60-64	€ 5,478
65-69	€ 6,885
70-74	€ 8,535
75-79	€ 11,842
80-84	€ 17,695
85-89	€ 27,714

Sources: www.kostenvanziekten.nl and http://statline.cbs.nl/statweb

Health insurance premiums

The contributions to health insurance consist of three components:

- The nominal healthcare premium. The average annual amount is € 1,126.
- The deductible. The maximum deductible is € 170. On average, people pay 60 percent of their deductible per year.
- The income-dependent part of the healthcare premium is 7.75 percent of the gross wages.

AOW [General Old Age Pensions Act] and pension premiums

The AOW and pension premiums consist of two components:

- The part of the gross wages that people contribute towards their AOW. In the first bracket this is about half of the total taxes withdrawn.
- Employees take out about 10 percent of the gross wages for pension provisions.

The contributions to the AOW and other pension provisions take place until pensionable age.

Other contributions

- In addition to AOW premiums, people also pay income tax and premiums for other social provisions. These contributions make up about 50 percent of the total taxes withdrawn in the first bracket

- Once they reach pensionable age, elderly people may start using provisions that are subject to a deductible. The calculations assume a percentage of 10 percent of the gross wages for these provisions.

Pension income

- Once they reach pensionable age, people receive a pension. In terms of gross wages, this pension is equivalent to 65 percent of the last-earned gross wages.

The calculations

- For each age group we estimated the effects of a deceased person on the different costs. The relevant factors in this context are age and whether or not the person reached pensionable age.
- For example: A deceased person in the 30-34 age group still has (65 - 32.5 =) 32.5 working years left, and the life expectancy is 49.7 years. The number of expected pension years is (32.5 + 49.7 - 65 =) 17.2 years. These data and the assumptions listed above are then used to calculate the costs of malnutrition per malnourished person for the different age groups. Then the discount rate is factored in with these costs, resulting in the total costs per age group of an person who dies because of malnutrition.
- These amounts and the estimated numbers for excess mortality due to malnutrition (Table 3.2) are then used to calculate the total costs for the different age groups and for the population as a whole.

Appendix C Effects of medical nutrition: scientific literature

The table on the next page provides an overview of the available (scientific) literature that quantifies the costs and benefits of ONS. Each article is listed with the first author of the publishing organisation, the year of publication, the type of publication or name of the scientific journal, the aim, the method, the outcome variables, the control variables and the main results of the study. The table also contains information about the quality of the study, categorised by level (see Table C.1). The articles are at the highest level as much as possible.

Table C. 1 The quality of the information is categorised by level (A1 – D1)

Level	Description
A1	Review of at least two independently conducted studies at the A2 level
A2	Randomised, double-blind compartive study of sufficient size
B	Compartive study, e.g. a cohort study
C	Non- comparitive study
D	Expert opinion

Table C. 2 Overview of literature on the costs and benefits of ONV

Authors, year	Journal/ type of publication	Quality	Aim and method	Outcome variables	Control variables	Results (treatment vs. control groups)
Amoud-Battandier et al., 2004	Clinical Nutrition	B	This study attempts to estimate the costs of malnutrition and related diseases in older patients who live in the community and to determine the impact of nutritional support. To this end an observational, prospective cohort study with 12 months of follow-up was conducted. 2 groups of general practitioners were selected based on historic prescription behaviour: physicians who hardly ever (group 1) or frequently (group 2) prescribe ONS. The sample consists of 378 malnourished elderly persons age 70 and older.	Nutritional status, malnutrition-related diseases and healthcare use	The groups are balanced for age, sex, BMI, but differ in terms of housing and nutritional status.	After control for background characteristics the nutritional situation in group 2 improved significantly more than in group 1. The costs per patient in group 2 are lower (€ 723). This is due to the lower costs of hospital care (€ 551), nursing (€ 145) and other medical care. After subtraction of the additional costs, this leads to (insignificant) savings of € 195.
Beck et al., 2011	The European e-Journal of Clinical Nutrition and Metabolism	A1	This is a review of the effect of ONS on weight and functional outcomes in elderly residents of nursing homes. The review consists of 8 studies.			Weight change: positive effect in 6 of the 8 studies. Muscle function: positive effect in 2 of the 4 studies. ADLs: 1 of the 4 studies found a positive effect on ADLs. There is a need for more randomised studies.
Cawood et al., 2012	Ageing Research Reviews	A1	Review and meta-analysis of studies on the effects of high-protein ONS. This analysis is based on 35 RCTs with a total of 3,790 participants.			Increased protein/energy intake ($p<0.001$) Fewer complications: odds ratio (OR) 0.68 Fewer readmissions: OR 0.59 Stronger grip: 1.76 kg Little reduction in normal food intake and weight improvement ($p<0.001$).
Cepton, 2006	Study report (abstract)	D (not peer-reviewed)	This study investigates the costs of malnutrition in Germany and the money that could be saved by prescribing ONS. To this end the study refers to multiple clinical studies that analyse the effects of ONS.			Decreased length of stay at the hospital (LOS) and number of complications Decreased length of stay leads to a savings of € 700 - € 2,200 per patient.

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Chapman et al., 2009	The American Journal of Clinical Nutrition	B	An RCT on the effects of providing oral nutritional supplementation (testosterone and nutritional supplements). The supplements were given for 1 year to 49 malnourished persons who were randomly assigned to 4 groups: no special treatment, testosterone supplement, nutritional supplement, nutritional supplement and testosterone/nutritional supplements.	Risk of hospital admission, length of stay at the hospital and duration until hospital admission	Random allocation to groups via a stratification system	Compared to the group without special treatment, the group that received testosterone and nutritional supplements had significantly fewer hospital admissions (0 out of 11 people vs. 9 out of 13) and LOS (total of 0 days vs. 74). The group which received only a nutritional supplement had only 5 hospital admissions (out of 13).
Elia et al., 2005	Study report (abstract)	D (review, not peer-reviewed)	This study quantifies the costs of malnutrition in the United Kingdom and presents a cost analysis of the use of ONS. The cost analysis is partially based on a review of published studies. The results present an overview of the savings that are presented in the different studies for different outcomes.			Hospital setting, surgical procedures: £ 1,166 (daily hospitalisation costs), £ 363 (additional daily hospitalisation costs) and £ 321 (complication costs) Hospital setting, non-surgical procedures £ -246, £ 330 and £ 2,080 (all on the basis of average daily hospitalisation costs) Hospital setting, non-surgical procedures, mix of surgical and non-surgical procedures £ - 1,306 (daily hospitalisation costs) and £ - 942 (additional daily hospitalisation costs) Residential care setting, short-term postoperative ONS: £ 688 (daily hospitalisation costs) and £ 359 (additional daily hospitalisation costs)

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Freijer et al., 2012	Frontiers in Pharmacology	C	This study quantifies the budgetary effects in the Netherlands of prescribing ONS to elderly persons who receive residential care (community dwelling). The authors formulated an economic model that calculates the budget impact of ONS in cases of disease-related malnutrition. A crucial assumption is that ONS leads to an average savings of 25%. This percentage is based on the scientific literature. This study does not conduct or analyse a trial.	The healthcare budget that is allocated for this sector		The use of ONS by all patients in this sector who qualify for its use leads to an annual savings of € 13 million. The reduction in disease-related costs is € 70 million, while the costs of ONS are € 57 million.
Freijer et al., 2013	Journal of the American Medical Directors Association	A1	This is a review of studies that investigate the economic impact of medical nutrition, including ONS. The review is based on 8 articles. The selection is made using the Quality of Health Economic Studies instrument.			3 studies indicate savings after the use of medical nutrition. 1 study shows that the costs per unit of clinical or functional improvement are not significantly higher. 4 studies show higher costs per unit of clinical or functional improvement, but these higher costs are within the predetermined limits.
McMurdo et al., 2009	Journal of the American Geriatrics Society	B	The aim of the study is to determine whether giving ONS to malnourished elderly hospitalised patients improves their muscle function and reduces disability. It is an RCT without a placebo group. There are 250 participants. The intervention consists of ONS at 600 kcal/day. The control group also receives a supplement of 200 kcal/day.	Weight, ADL Barthel index, grip strength, the Sitting-Rising test, general physical activity, falling and health-related quality of life.	The randomisation was stratified.	Grip strength: increase of 1.52 kg General physical activity: moderate improvement (P value 0.02) Weight gain: insignificant, unless the sample is restricted to those who fully comply with the instructions (1.17 kg). Barthel ADL index, the Sitting-Rising test, number of falls and health-related quality of life: no differences

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Milne et al., 2009	Cochrane review	A1	This review investigates trials that are focused on improving nutritional status and clinical outcomes by means of supplementation with additional protein and energy. (Semi-)randomised experiments with oral protein and energy supplementation for the elderly are included in this analysis. Studies based on groups that are recovering from cancer-related treatments or critical care are excluded from the analyses. A total of 10,187 randomised participants are included. The maximum duration of the interventions is 18 months. The majority of the trials are of moderate quality.			Average weight gain: 2.2% Relative risk (RR) of mortality: the RR is significantly lower in previously malnourished elderly persons (RR = 0.79). Risk of complications: lower (RR = 0.86). Functional status and length of stay (LOS): limited effects.
Milte et al., 2013	European Journal of Clinical Nutrition	A1	The aim of this review of to identify the cost-effectiveness of the use of protein and energy supplements. The review is based on 16 studies and is qualitative in nature.			The cost-benefit analyses indicate that the LOS and user intensity of the healthcare system decrease. Protein and energy supplementation in the treatment or prevention of malnutrition may be a way to improve the wellbeing of patients and reduce healthcare costs.
Neelemaat et al., 2012	Clinical Nutrition	B	The aim of this study is to determine from a societal perspective whether the treatment of malnourished elderly persons is cost-effective. It is an RCT. The sample consists of 210 malnourished elderly patients who have been admitted to a hospital. There is no placebo group. The intervention group receives nutritional supplementation, including ONS, and the control group receives standard care. The follow-up is 3 months. The authors use an intention-to-treat analysis.	QALYs, physical activity and functional limitations	The groups are randomised.	Functional limitations: a significant decrease (-0.72). The treatment is cost-effective at a standard ceiling ratio of € 6,500. QALYs and physical activity: no significant improvements.

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Neelemaat et al., 2010	Journal of the Medical Directors Association	B	See Neelemaat et al., 2012 (No.13)	Body weight, functional limitations, physical performance, physical activity, fat-free mass and grip strength.	See Neelemaat et al., 2012 (No. 13)	Body weight: a significant increase in body weight of 3.4 kg in the highest weight category. Functional limitations: a significant decrease in the number of functional limitations, if the patients who already received nutritional support before the start of the study are excluded. Physical performance, physical activity, fat-free mass and grip strength: no significant differences.
Nieuwenhuizen et al., 2010	Clinical Nutrition	A1	The review analyses the studies for the possible treatment options for elderly persons and patients who need nutritional support. One of these options is ONS. This review also contains a meta-analysis of 24 trials and 2,387 patients.			Mortality in hospital patients and malnourished elderly persons: a significant decrease. Weight gain: average of 2.4% LOS: decrease of 6 days (insignificant)
Norman et al., 2011	European Journal of Clinical Nutrition (abstract)	B	This study investigates the cost-effectiveness of a three-month intervention with ONS. The sample consists of 114 patients with gastrointestinal disease. The people are randomly assigned to an intervention group or a control group. The people in the intervention group receive ONS and dietary advice; the people in the control group receive only dietary advice.	Quality of life and cost-effectiveness of the treatment	The two groups differ at the non-QALY baseline (measured with the SF-36 Survey).	After three months of intervention the quality of life of the intervention group was significantly higher (0.731 vs. 0.671). This is combined with significantly higher costs: incremental cost-effectiveness ratio of € 9,497. Cost-effectiveness: the treatment is cost-effective (€ 12,099 per additional QALY).

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Nuijten & Freijer, 2010a	Value in Health (abstract)	B	The study attempts to quantify the health-economic impact of ONS from a societal perspective. The study focuses on elderly persons in residential care in Germany. The effects are determined by comparing patients who all suffer from disease-related malnutrition. Some of them have used ONS, while others have not. The costs of the treatment are determined on the basis of a linear analytic decision-making model that shows the costs. Clinical odds and the use of medical devices are determined on the basis of clinical trials and the scientific literature. The study is not a trial itself.	Total costs of treatments. These are broken down into the cost of healthcare and ONS	Unknown	The use of ONS reduces the total cost per patient from € 16,617 to € 15,453, i.e. it results in a savings of € 1,164. In other words, the lower healthcare costs compensate for the cost of ONS.
Nuijten & Freijer, 2010b	Value in Health (abstract)	B	The approach of this study is similar to Nuijten & Freijer (2010a), but the healthcare sector setting is different: this study focuses on patients in an outpatient setting in Germany.	Total costs of treatments. These are broken down into the cost of consultations, hospitalisation and ONS	Unknown	The use of ONS reduces the total cost per patient from € 1,376 to € 1,197, i.e. it results in a savings of € 179. In other words, the lower healthcare costs compensate for the cost of ONS.
Nuijten & Freijer, 2010c	Value in Health (abstract)	B	The approach of this study is similar to Nuijten & Freijer (2010a), but this study focuses on the budgetary consequences of giving ONS to elderly persons in residential care in the Netherlands.	The budget allocated for care in the residential sector.	Unknown	The use of ONS by all patients who qualify for its use leads to an annual savings of € 13.3 million. The reduction in healthcare costs is € 70.3 million, while the cost of ONS is € 57.0 million.
Nuijten & Freijer, 2010d	Value in Health (abstract)	B	The approach of this study is similar to Nuijten & Freijer (2010a), but this study focuses on the health-economic impact of giving ONS to elderly persons in residential care from the perspective of Dutch society.	Total costs of treatments. These are broken down into the cost of healthcare and use of ONS	Unknown	The use of ONS reduces the total cost per patient from € 1,353 to € 1,180, i.e. it results in a savings of € 173. In other words, the lower healthcare costs compensate for the cost of ONS.
Nuijten & Freijer, 2010e	Value in Health (abstract)	B	The approach of this study is similar to Nuijten & Freijer (2010a), but this study focuses on patients in a hospital setting rather than a residential care setting.	Total costs of treatments. These are broken down into the length of stay and the use of ONS	Unknown	The use of ONS reduces the total cost per patient from € 4,105 to € 3,967, i.e. it results in a savings of € 138. In other words, the lower healthcare costs compensate for the cost of ONS.

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Nuijten & Mittendorf, 2012	Aktuelle Ernährungsmedizin	B	The approach of this study is similar to Nuijten & Freijer (2010a)	Total costs of treatments. These are broken down into the cost of hospitalisations and ONS.	Unknown	The use of ONS leads to an average savings of € 234 per patient. The savings are the result of a decrease in the number of hospitalisations (average of € 768). The average cost of ONS is € 534.
Persson et al., 2007	Clinical Nutrition	B	This study analyses a trial with a combined approach for malnourished patients with protein and energy deficiencies. The approach consists of oral supplementation, among other things. The sample consists of 108 persons that are randomly assigned to an intervention group or a control group. The analysis is done on the basis of an intention-to-treat analysis. The follow-up is 4 months.	Weight, ADLs, quality of life, biochemical indicators and mental health.	The participants are randomly assigned to a group.	Significant effects: weight (3 kg), number of ADLs (difficult to quantify). No significant effects: quality of life, biochemical indicators and mental health.
Philipson et al., 2013	American Journal of Managed Care	B	This study analyses the effects of the use of ONS by hospitalized patients on healthcare use and related costs. The analysis is based on a matched sample of ONS and non-ONS users in a total of 1.2 million hospital episodes. The fraction of the number of hospital admissions with ONS is used as an instrumental variable. They use this instrument because the use of ONS is not randomized.	LOS, hospitalization costs and readmission within 30 days.	Propensity score matching is performed. Matching is done on the basis of demographics (age, type of insurance, marital status, ethnicity and sex), morbidity and health covariants. The model also takes hospital characteristics and time effects into account.	LOS decreases by 2.3 days (21.0%) and the hospitalisation costs decrease by $4,743 (21.6%). The risk of readmission after a short period (<30 days) decreases by 2.3% when the sample is restricted to those who are readmitted.

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Smedley et al., 2004	British Journal of Surgery	B	The study investigates the effects of pre- and postoperative ONS on clinical outcomes and healthcare costs. The study focuses on patients who undergo surgery on the lower gastrointestinal tract. N=152. There are 4 groups: ONS before surgery (group 1), ONS after surgery (group 2), ONS before and after surgery (group 3), control group (group 4).	Weight changes, complications, LOS, nutritional intake, anthropometric characteristics, quality of life and cost information.	Stratification on the basis of BMI, weight loss history and age.	Weight loss: significantly less weight loss in groups 2 and 3 vs. the control group. Minor complications: fewer minor complications in group 2 (0.37) and group 3 (0.31) vs. the control group (0.68). Other outcomes: no significant differences in the other outcomes.
Starke et al., 2011	Clinical Nutrition	B	The study analyses the effects of person nutritional support in hospital patients on clinical outcomes and quality of life. ONS is a component of this support. The study is an RCT. The sample consists of 132 persons who are at risk of malnutrition. The control group consists of persons who receive standard hospital care.	Quality of life (measured with the Short Form 36 Questions Score), complications, antibiotics and readmissions.	The randomisation is done with a computer program.	Higher quality of life: 37% - 32% Fewer complications: 6.1% - 19.7% Fewer antibiotics courses: 1.5% - 12.1% Fewer readmissions: 26.6% - 45.9%

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Stratton & Elia, 2007	Clinical Nutrition Supplements	A1	This is a review of 13 reviews that were published up to 2006. This review compares the use of ONS for disease-related malnutrition with the standard care.	The focus is on clinical outcomes.		The review indicates lower mortality in acutely ill patients, hospitalised patients and elderly persons with health conditions. The review also shows a reduction in the number of complications, particularly in acutely ill patients, elderly persons and patients who undergo surgery. ONS has a positive effect on body weight. It is difficult to include functional limitations in the review, because the studies all use very different definitions. There are not enough studies that use blinding.
Stratton et al., 2013	Ageing Research Reviews	A1	This meta-analysis quantifies the results of combating disease-related malnutrition with ONS. To this end the investigators conducted a systematic review of the effects of ONS on hospital admissions. The hospital admissions include initial admissions and readmissions.			A meta-analysis based on 6 RCTs (N=852) shows that the proportion of patients who are admitted is significantly lower after the use of ONS (OR: 0.59). A larger meta-analysis of 8 RCTs (N=999) which includes additional data also shows a significant reduction in the number of hospital admissions (effect size: -0.23). The majority of the studies (75%) focus on elderly persons who are older than 65 (effect size: -0.18).

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