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## **Author Manuscript**

**Faculty of Biology and Medicine Publication**

**This paper has been peer-reviewed but does not include the final publisher proof-corrections or journal pagination.**

Published in final edited form as:

**Title:** The economic cost of hospital malnutrition in Europe; a narrative review

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**Journal:** Clinical Nutrition ESPEN

**Year:** May 2015

**Volume:** 10

**Issue:** 3

**Pages:** e89–e94

**DOI:** <http://dx.doi.org/10.1016/j.clnesp.2015.04.003>

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1 **The economic cost of hospital malnutrition in Europe; a narrative review**

2 **Running title:** cost of malnutrition in Europe

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21 Funding: Saman Khalatbari Soltani is supported by a Swiss Excellence Government  
22 scholarship awarded by Swiss Confederation.

23 Conflict of interest: none.

24 Names for PubMed indexing: Saman Khalatbari-Soltani (Khalatbari-Soltani S), Pedro  
25 Marques-Vidal (Marques-Vidal P).

26 **Abstract**

27 **Background:** Malnutrition among hospitalized patients increases length of stay (LOS) and  
28 carries extra hospitalization costs.

29 **Objective:** To review the impact of malnutrition on hospital LOS and costs in Europe.

30 **Methods:** PubMed and Google Scholar search. All articles from January 2004 until  
31 November 2014 were identified. Reference lists of relevant articles were also manually  
32 searched.

33 **Results:** Ten studies on LOS and nine studies on costs were reviewed. The methods used to  
34 assess malnutrition and to calculate costs differed considerably between studies. Malnutrition  
35 led to an increased LOS ranging from 2.4 to 7.2 days. Among hospitalized patients,  
36 malnutrition led to an additional individual cost ranging between 1640 € and 5829 €. At the  
37 national level, the costs of malnutrition ranged between 32.8 million € and 1.2 billion €.   
38 Expressed as percentage of national health expenditures, the values ranged between 2.1% and  
39 10%.

40 **Conclusions:** In Europe, malnutrition leads to an increase in LOS and in hospital costs, both  
41 at the individual and the national level. Standardization of methods and results reported is  
42 needed to adequately compare results between countries.

43 **Keywords:** malnutrition; prevalence; length of hospital stay; cost; narrative review

44

45 **Abbreviations**

46 Abbreviation used: LOS, length of stay; ESPEN, European Society for Parental and Enteral  
47 Nutrition; DRM, disease related malnutrition; NRS, Nutritional Risk Screening; SGA,  
48 Subjective Global Assessment; NRI, Nutritional Risk Index; MUST, Malnutrition Universal  
49 Screening Tool; BMI, Body Mass Index; DRG, diagnosis-related group.

## 50 **Introduction**

51 Malnutrition is a highly prevalent problem among hospitalized patients and leads to a  
52 considerable adverse health and financial burden (1, 2). Estimates for the worldwide  
53 prevalence of malnutrition range between 20 and 50% of hospitalized patients, depending on  
54 the population under study and the nutritional screening tools used (3).

55 Hospital malnutrition is a result of a complex relation between disease, food and nutrition (4).  
56 According to the European Society for Parental and Enteral Nutrition (ESPEN), malnutrition  
57 consists of both over- and under-nutrition but in this study only under-nutrition will be  
58 considered (3). Indeed, under-nutrition, also known as disease related malnutrition (DRM), is  
59 an urgent public health problem in Europe (5). Hospital malnutrition has been shown to  
60 increase morbidity and LOS, to delay recovery and therefore to result in higher health care  
61 and hospital costs (6-8). Just in Europe, it has been estimated that 20 million patients are at  
62 the risk of malnutrition, with an annual cost up to 120 billion €(9, 10). Notwithstanding its  
63 impact on health, the economic impact of hospital malnutrition has seldom been studied. In a  
64 period where health costs containment is a necessity, better identification of the factors  
65 associated with increasing hospitalization costs is paramount to optimize health care delivery.  
66 Thus, we aimed to review the impact of hospital malnutrition on LOS and health costs in  
67 Europe.

## 68 **Methods**

### 69 *Literature search strategy*

70 A literature search was conducted in November 2014 using PubMed (MEDLINE) and Google  
71 Scholar electronic databases. The search terms used are summarized in **supplementary file**.  
72 All relevant studies published between January 2004 and November 2014 reporting the

73 associations between malnutrition among hospitalized patients and LOS or cost were  
74 evaluated. The following key terms included “prevalence”, ”length of stay”, ”cost” in  
75 combination with “hospital malnutrition” and “hospital under-nutrition”.

76 Studies were included if they were a) published from 2004 onwards, as older studies might  
77 not correspond to current standards of malnutrition screening and health care delivery and as  
78 costs no longer corresponded to current ones; b) conducted among adults ( $\geq 18$  years old),  
79 with no upper age limit; c) conducted in any European country, as universal health coverage  
80 is available for most European countries and health expenditures would not be influenced by  
81 individual or third party payers; and d) had an English/French/German/Spanish/Portuguese  
82 abstract, as other languages could not be assessed by the authors or related colleagues.  
83 Duplicate publications (i.e. reporting the results of the same study) were excluded.

#### 84 *Data extraction*

85 Titles of articles were analyzed for selecting potentially relevant studies. Then, the abstract  
86 and the full text were examined in terms of the eligibility criteria, and the references were also  
87 searched for other potential studies not covered by the search strategy.

88 Data on study characteristics (author, title, country and publication year), study duration,  
89 number of patients, prevalence of malnutrition, LOS and/or costs related to malnutrition were  
90 extracted by SK, and further confirmed by PMV. Main summary measures were LOS and/or  
91 costs related to malnutrition. Both individual (i.e. patient) and overall (i.e. for the whole  
92 country) costs were considered. As costs were expressed in different currencies, conversion to  
93 Euros (€) was performed using the rates of November 4<sup>th</sup>, 2014 as indicated in  
94 [www.xe.com/currencyconverter](http://www.xe.com/currencyconverter).

## 95 **Results**

### 96 *Impact of malnutrition on length of stay*

97 Ten papers were included (selection procedure on **Figure 1**). Their main characteristics are  
98 summarized in **Table 1**. Three studies were from Germany (7, 12, 16), three from Spain (13-  
99 15), two from Switzerland (16, 17), one from Portugal (6), one from France (18) and one from  
100 Norway (19). Seven studies were multidisciplinary, i.e. conducted in different medical  
101 departments (6, 12-16, 19); the remaining were conducted in a gastroenterology ward (7) , in  
102 a cancer center (18) and in an internal medicine department (17). One article had data on LOS  
103 according to malnutrition status, but it was unclear which definition was applied, so it was not  
104 included; LOS was  $6.3 \pm 4.7$  for well nourished and  $10.6 \pm 12.0$  for malnourished patients,  
105 respectively (20).

106 Four studies used the Nutritional Risk Screening (NRS-2002) (6, 14, 15, 19), three used the  
107 Subjective Global Assessment (SGA) (7, 12, 13), one used both SGA and NRS-2002 (17),  
108 one used the Nutritional Risk Index (NRI) (16) and one study did not report the tools (18).  
109 Prevalence of malnutrition ranged from 19 (7) to 42% (6). These results are in agreement with  
110 a review of malnutrition prevalence in England since 1994 (range 11 to 45%) (21) and with a  
111 collaborative multicentre study including 12 Europe and Middle East countries (32% overall)  
112 (22).

113 In all studies, LOS was significantly longer in malnourished than in well-nourished patients,  
114 the differences ranging from 2.4 (13) to 7.2 days (14) (**Table 1**). Two studies reported a  
115 positive association between malnutrition classification (mild, moderate and severe) and  
116 prolonged LOS (12, 16). In the Switzerland study in 2004, severe malnourished patients had a  
117 five-fold increase of LOS compared to well-nourished patients ( $25.8 \pm 60.6$  vs.  $5.1 \pm 8.2$  days,  
118 respectively) (16).

119 No clear trend regarding malnutrition prevalence or its impact on LOS was found within the  
120 10 years period. This unchanged prevalence of malnutrition could be due to the increasing age  
121 of hospitalized patients (23), which could also impact LOS. Still, the fact that LOS among  
122 malnourished patients did not improve during the period analyzed relative to well nourished  
123 patients suggests that nutritional interventions in hospitalized patients are not sufficient.

#### 124 *Impact of malnutrition on hospital costs*

125 Nine papers investigating the economic costs of malnutrition among hospitalized patients  
126 were included (**selection procedure on Figure 2**). Their main characteristics are summarized  
127 in **Table 2**. Except one study conducted in a Gastroenterology Ward (7) all the others were  
128 multidisciplinary (6, 7, 10, 14, 16, 19, 24-26). For nutritional status, one study used the NRI  
129 (16), one the SGA (7), four the NRS-2002 (6, 14, 19, 25), two the Malnutrition Universal  
130 Screening Tool (MUST) (24, 26) and one used Body Mass Index (BMI) and weight loss (10).  
131 Most malnutrition rates ranged from 19 (7) to 44% (10), with the exception of the Croatian  
132 study, which reported a much lower prevalence (3.37%) (25). One paper had data on costs  
133 according to malnutrition status, but it was unclear which definition was applied, so it was not  
134 included; total costs were 1912 €(no standard deviation provided) for well nourished and  
135 2990 €for malnourished patients (20).

136 Most selected studies reported additional costs, defined as the extra cost involved in treating  
137 all malnourished patients in the general population compared to treating the same number of  
138 well-nourished individuals (6, 7, 10, 14, 19, 24, 26). Five studies reported overall costs (10,  
139 16, 24-26), and four studies reported detailed costs (hospital costs, diagnosis, therapies and  
140 medications) (6, 7, 14, 16, 19). Irrespective of the type of costs considered, all studies  
141 reported increased hospital costs due to malnutrition (**Table 2**).

142 Four studies reported individual data. One study conducted in a gastroenterology ward in  
143 Germany reported a 10,268 € additional cost for nutritional support (dietary counseling,  
144 special diet, oral supplementation and enteral/parenteral feeding) for a group of 50 randomly  
145 selected malnourished patients, leading to an average extra cost of 205 € per patient (7). A  
146 study conducted in Portugal used diagnosis-related group (DRG) codes and LOS to calculate  
147 hospitalization costs (6). Patients at nutritional risk had hospitalization costs which were twice  
148 higher than patients not at risk, with an average additional cost of 2,687 € (6). In Spain, costs  
149 were calculated based on average hospitalization costs and the nutritional support provided  
150 (oral supplementation and enteral/parental feeding). Malnourished patients at admission had  
151 an average additional cost of 1,409 € compared to well-nourished patients at admission; the  
152 difference was even higher (5,829 €) between malnourished patients at discharge and well-  
153 nourished patients at admission and discharge (14). Finally, a study conducted in Norway  
154 estimated costs based on a mean daily cost for patients ready to discharge and the average  
155 LOS in hospital over one year. Malnourished patients had 60% higher costs than well-  
156 nourished patients, corresponding to an additional cost of 4,745 € per year (19).

157 Five studies reported costs at the national level. In the study conducted in Switzerland and  
158 Germany, hospital costs for malnourished patients were 3.1 times higher than well-nourished  
159 patients (16), but no precise values were provided. In the United Kingdom, the annual health  
160 care cost of DRM for hospitalized patients was about 3.7 billion £ (4.7 billion €) and the  
161 additional cost was almost 3 billion £ (3.8 billion €). In Ireland, the annual total public health  
162 and social care costs of malnutrition were estimated at 1.4 billion € (10% of the national  
163 health care budget) in all healthcare settings, of which 72 million € (5%) were attributed to  
164 hospitalized patients with DRM (24). In the Netherlands, the total additional costs  
165 (prevention, diagnostic, therapy, rehabilitation and care of the disease or treatment under  
166 consideration) of DRM were estimated at 1.9 billion € (2.1% of the national health



167 expenditure), of which 1.2 billion €(66%) were attributed to hospital settings (10). In Croatia,  
168 the total direct costs of malnourished patients were estimated at 97.35 million €(3.38% of the  
169 national health care budget), of which 32.8 million €(34%) were attributed to hospital  
170 malnutrition, leading to an average cost of malnutrition of 1640.48 €per hospitalized patient  
171 (25).

## 172 **Discussion**

173 Our results indicate that malnutrition carries a considerable economic burden, with an  
174 additional cost ranging between 1640 and 5829 €per hospitalized patient and an overall cost  
175 ranging between 2.1 and 10% of the national health expenditures.

### 176 *Impact of malnutrition on length of stay*

177 Malnutrition led to an increased LOS, ranging from 2.4 to 7.2 days. Relative to well-  
178 nourished patients, the average LOS increased by 30-100% in malnourished patients, a value  
179 in line with one recent review which also reported 40-70% longer LOS in malnourished  
180 patients (27). This longer LOS is due to the classic adverse effects of malnutrition such as  
181 increased risk of infection or pressure ulcer, impaired wound healing, immune suppression  
182 and muscle wasting (28), leading to delayed recovery and increased risk of complications  
183 (29). Indeed, increased LOS is one of the major components of the additional costs related to  
184 malnutrition (26). Conversely, the beneficial effects of nutritional intervention on clinical  
185 outcomes of malnutrition have been manifold documented (29, 30), leading to a significant  
186 reduction of LOS and consequently in total costs (31, 32). Thus, early malnutrition  
187 intervention may be really beneficial to improve outcomes and health care costs.

189 Malnutrition led to an additional increase in costs among hospitalized patients ranging  
190 between 1640 (25) and 5829 €(14) per patient. Taken together, malnutrition-related costs  
191 represented between 2.1 and 10% of the national health expenditure. However, this large  
192 difference between two European countries of similar population size and economic wealth is  
193 very likely due to the different statistical models and the assumptions used and not the true  
194 burden of disease. Thus, malnutrition among hospitalized patients is a far from trivial  
195 condition, leading to a considerable health and economic burden. Moreover, the reported costs  
196 are likely to be an underestimate as not all increased treatment costs were included (25).

197 While the consequences of malnutrition on health have been documented in a large number of  
198 studies, the number of studies assessing the economic impact of malnutrition is considerably  
199 smaller. It is also important to mention that harmonizing and comparing the results between  
200 studies and countries is difficult, due to differences in health care systems, cost calculations  
201 and reporting monetary units (£, \$, €). For instance, some studies used administrative data (6),  
202 while others assessed directly the costs of nutritional therapy (7); some studies reported total  
203 costs while others reported extra costs at admission and/or discharge. Hence, it would be of  
204 interest that future studies on the costs of malnutrition use a standard definition of  
205 malnutrition and indicate how the differences between well-nourished and malnourished  
206 patients were computed. It is also important that studies report their results in a standardized  
207 manner: although monetary units (i.e. €) might be important for local health administrators,  
208 they might not be of much help for other countries as health costs vary between countries.  
209 Thus, other cost-related units could be used, such as LOS, nutrition interventions (i.e. number  
210 of nutritional supplements used, enteral/parental nutrition, and consultations by dieticians...)  
211 or DRGs. Still, it should be noted that the DRG system changes slightly between countries so  
212 that direct comparisons might not be achievable (33). Further, as some DRGs change

213 according to presence/absence of malnutrition, it would be important to include malnutrition  
214 diagnosis codes in the patients' file in order to better evaluate the real economic burden  
215 related to malnutrition.

216 Despite the different methods used to estimate malnutrition-related hospitalization costs, all  
217 studies indicate that the total costs of malnutrition are extremely important and largely  
218 outweigh those related to obesity (5, 26). Thus, screening at admission and early treatment of  
219 malnutrition could lead to considerable health savings (5, 32, 34). Indeed, Elia et al. (2005)  
220 reported that an investment of 5 million £ (6.4 million €) in nutritional intervention would  
221 result in a saving of 50 million £ (63.7 million €) per year, corresponding to a 1% reduction in  
222 malnutrition-related costs.

### 223 *Limitations*

224 This review has several limitations. Firstly, no data were available for many European  
225 countries. This was somewhat unexpected for some countries such as Denmark, Sweden and  
226 Finland, as their health data management system would facilitate such calculations, at least  
227 regarding the costs of nutritional therapy. Thus, it is difficult to determine the impact of  
228 malnutrition on medical economic outcomes for a large number of European countries.  
229 Secondly, several definitions of malnutrition were applied, possibly leading to different  
230 prevalence rates and thus different costs. Still, our results suggest that malnutrition is  
231 associated with increased hospitalization costs irrespective of the definition applied. Thirdly,  
232 each study used its own cost assessment method, thus precluding direct comparison of results.  
233 Indeed, the heterogeneity of the cost calculations in the individual studies, such as cost of  
234 hospitalization vs. cost of nutritional treatment; calculation for a small patient group vs. for a  
235 whole country, is a main limitation of this paper. We thus believe that the recommendations  
236 for reporting results provided above will facilitate comparison of future studies.

237 *Conclusion*

238 In Europe, the economic impact of hospital malnutrition is considerable, both at the individual  
239 and the national level. Standardization of methods and results reported is badly needed to  
240 adequately compare results between countries.

241 **Competing interests**

242 All authors declare no competing interests.

243 **Acknowledgments**

244 The authors' responsibilities were as follows—SKS: performed the literature search, prepared  
245 the tables and drafted the manuscript. PMV: conceived the study, participated in its design  
246 and coordination and helped to draft the manuscript. All authors read and approved the final  
247 manuscript.

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341 **Tables:**

342 **Table 1:** Characteristics of the studies assessing the impact of malnutrition in hospital length of stay

Author (ref)	Country	N	Nutritional screening tool	Prevalence of malnutrition (%)	Length of Stay (days)		
					Mal-nourished	Well-nourished	Difference
Planas et al. (13)	Spain	400	SGA	26.7	7.3 ± 6.2	4.9 ± 5.1	2.4
Kyle et al. (16)	Switzerland	652	NRI	24.0	10.2 ± 16.0*	5.1 ± 8.2	5.1
					25.8 ± 60.6**		20.7
	Germany	621			11.8 ± 7.7*	9.1 ± 7.7	2.7
					17.8 ± 14.7**		8.7
Ockenga et al. (7)	Germany	541	SGA	19.0	11 ± 9	7.7 ± 7	3.3
Pirlich et al. (12)	Germany	1886	SGA	27.4	15*/17**	11	4.6
Nadine et al. (17)	Switzerland	102	SGA & NRS-2002	28.0	9	6	3.0
Amaral et al. (6)	Portugal	469	NRS-2002	42.0	14.7 ± 12.5	7.6 ± 8.3	7.1
Pressoir et al. (18)	France	1545	NR	30.9	19.3 ± 19.4	13.3 ± 19.4	6.0
Burgos et al. (15)	Spain	796	NRS-2002	28.9	10.5 ± 9.5	7.7 ± 7.8	2.8
Alvarez-Hernández et al. (14)	Spain	1597	NRS-2002	23.7	15.2	8.0	7.2
Tangvik et al. (19)	Norway	3271	NRS-2002	29.0	8.32 ± 0.32	5.03 ± 0.12	3.3

343 N, number of patients; SGA, Subjective Global Assessment; NRI, Nutritional Risk Index; NRS-2000, Nutritional Risk Screening; NR, not

344 reported. Normal nutritional status vs. moderate\* to severe\*\* malnutrition; All differences between malnourished and well-nourished patients are

345 significant.

346 **Table 2:** Characteristics of the studies assessing the impact of malnutrition in hospital costs

Author	Country	Discipline	N	Nutritional screening tool	Study period	Prevalence (%)*	Malnutrition related costs
<b>Individual data</b>							
Ockenga et al. (7)	Germany	Gastroenterology	50	SGA	1 year	19.0	10,268 €additional cost for nutritional support among 50 patients
Amaral et al. (6)	Portugal	Multidisciplinary	469	NRS-2002	11 months	42.0	4,890 €for malnourished 2,201 €for well-nourished 2,687 €additional cost
Alvarez-Hernández et al. (14)	Spain	Multidisciplinary	468	NRS-2002	6 months	24.4	12,237 €for malnourished 6,798 €for well-nourished 5,829 €additional cost
Tangvik et al. (19)	Norway	Multidisciplinary	3279	NRS-2002	1 year	29.0	15,394 \$ for malnourished 9,460\$ for well-nourished 5,934\$ (4,745 €) additional cost/year
<b>Overall data</b>							
Kyle et al. (16)	Switzerland Germany	Multidisciplinary	652 621	NRI	-	24.0	3.1 times higher in malnourished vs. well-nourished
Elia et al. (26)	United Kingdom	Multidisciplinary	1.29 million	MUST	1 year	28.0	Total cost: 3.7 billion £ (4.7 billion €) Additional cost: 3 billion £ (3.8 billion €) annually
Rice et al. (24)	Ireland	Multidisciplinary	1602	MUST	1 year	36.3	Total cost: 1.4 billion € 10% of the health-care budget 5,357 €additional cost of DRM

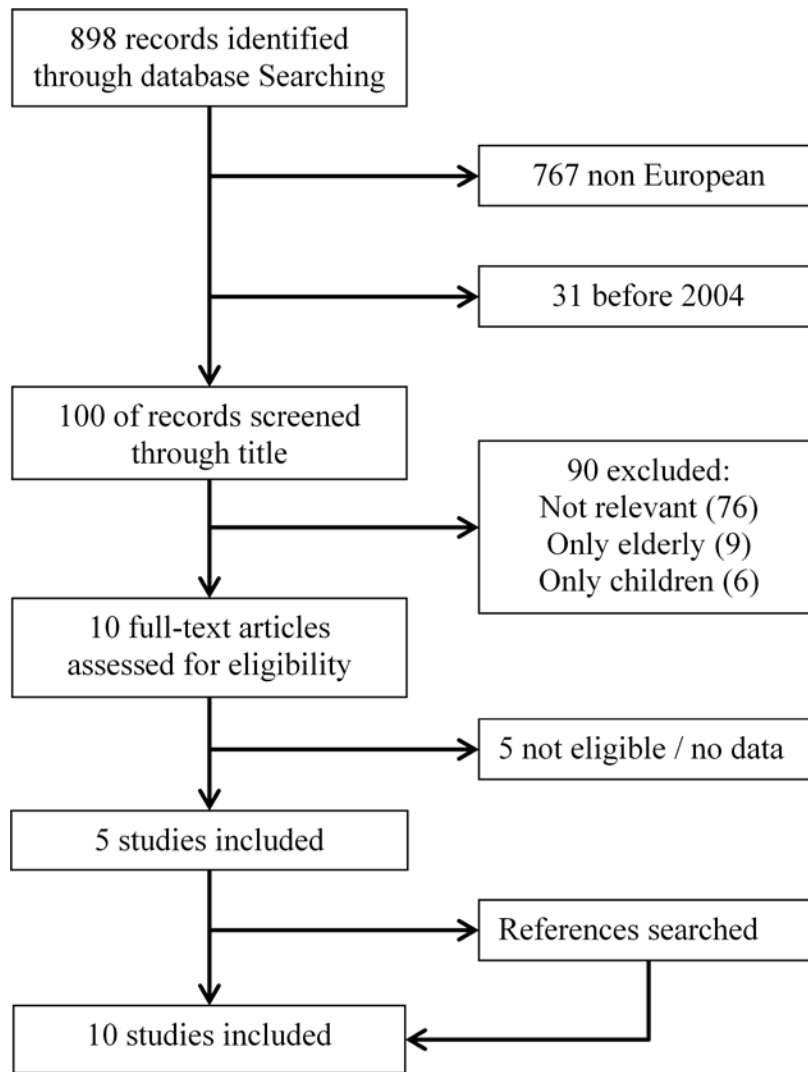
Freijer et al. (10)	The Netherlands	Multidisciplinary	14 million	BMI < 18.5 OR -18.5 < BMI < 20 +3 days of no food intake or less than normal during a week or weight loss of 6 kg in the past 6 months or >3 kg in the past month	1 year	4 to 44	Additional 1.2 billion € in hospital setting 66% of total expenditures on DRM
Benković et al. (25)	Croatia	Multidisciplinary	NR	NRS-2002	1 year	3.37	Total cost: 97.35 million € in one year 3.38% of national health care budget 1640 € average cost per patient

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347 NRI, Nutritional Risk Index; SGA, Subjective Global Assessment; NRS-2002, Nutritional Risk Screening; MUST, Malnutrition Universal

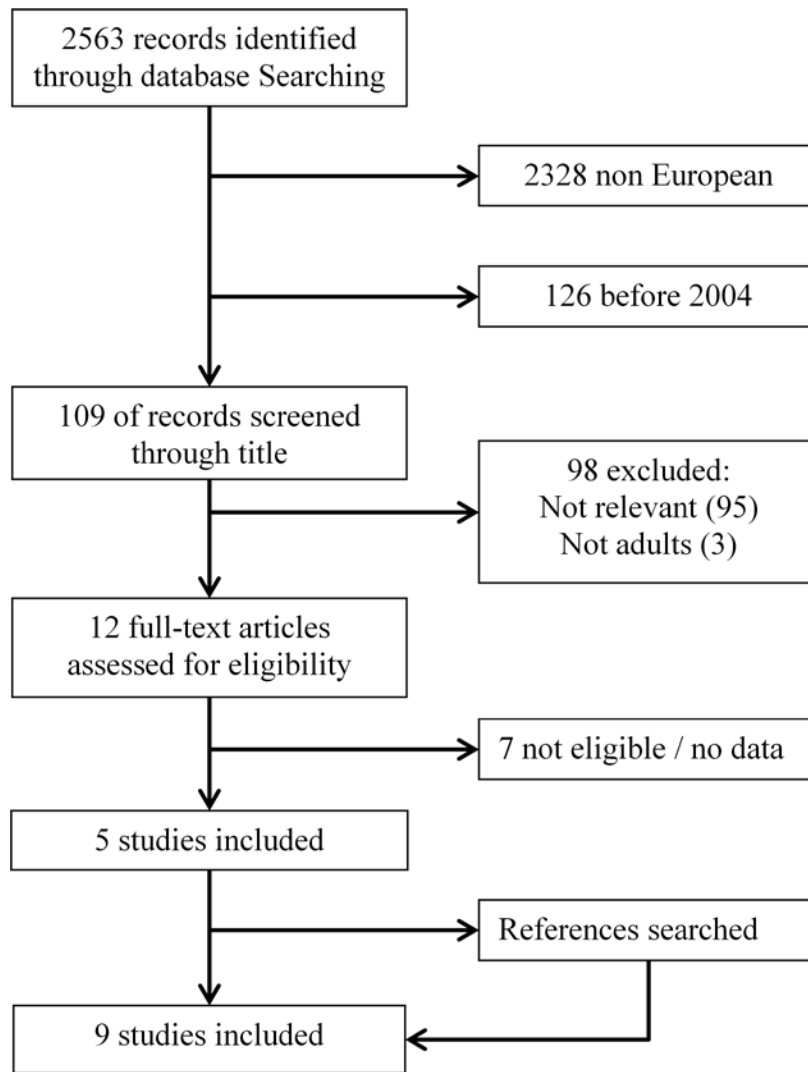
348 Screening Tool; BMI, Body Mass Index; DRM, Disease related malnutrition.

349 \*Prevalence of malnutrition



350

351 **Figure 1:** selection procedure for the papers on length of stay



352

353 **Figure 2:** selection procedure for the papers on cost of malnutrition