



Revisión

Economic benefit of dietetic-nutritional treatment in the multidisciplinary primary care team

Beneficio económico del tratamiento dietético-nutricional en el equipo multidisciplinario de atención primaria

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Abstract

Chronic diseases and aging are placing an ever increasing burden on healthcare services worldwide. Nutritional counselling is a priority for primary care because it has shown substantial cost savings. This review aims to evaluate the evidence of the cost-effectiveness of nutritional care in primary care provided by health professionals. A literature search was conducted using PubMed/MEDLINE between January 2000 and February 2019. The review included thirty-six randomized controlled trials (RCTs) and systematic reviews conducted in healthy people and people with obesity, type-2 diabetes mellitus, cardiovascular risk or malnutrition. All the RCTs and reviews showed that nutritional intervention led by dietitians-nutritionists in people with obesity or cardiovascular risk factors was cost-effective. Dietary interventions led by nurses were cost-effective in people who needed to lose weight but not in people at high cardiovascular risk. Some dietary changes led by a primary care team in people with diabetes were cost-effective. Incorporating dietitians-nutritionists into primary care settings, or increasing their presence, would give people access to the healthcare professionals who are best qualified to carry out nutritional treatment, and may be the most cost-effective intervention in terms of health expenditure. Notwithstanding the limitations described, this review suggests that incorporating dietitians-nutritionists into primary health care as part of the multidisciplinary team could be regarded as an investment in health. Even so, more research is required to confirm the conclusions.

Keywords:

Primary care. Multidisciplinary team. Dietitian-nutritionist. Dietary treatment. Cost-effectiveness.

Resumen

Las enfermedades crónicas y el envejecimiento suponen una carga cada vez mayor para los servicios de salud en todo el mundo. El asesoramiento nutricional es una prioridad para la atención primaria porque ha demostrado ahorros sustanciales de costes. Esta revisión tiene como objetivo evaluar la evidencia de la relación coste-efectividad de la atención nutricional en la atención primaria proporcionada por profesionales de la salud. se realizó una búsqueda bibliográfica utilizando PubMed/MEDLINE entre enero de 2000 y febrero de 2019. La revisión incluyó 36 ensayos controlados aleatorios (ECA) y revisiones sistemáticas realizadas en personas sanas y personas con obesidad, diabetes mellitus de tipo 2, riesgo cardiovascular o desnutrición. Todos los ECA y las revisiones mostraron que la intervención nutricional dirigida por dietistas-nutricionistas en personas con obesidad o factores de riesgo cardiovascular fue coste-efectiva. Las intervenciones dietéticas dirigidas por enfermeras fueron coste-efectivas en personas que necesitaban perder peso pero no en personas con alto riesgo cardiovascular. Algunos de los cambios en la dieta dirigidos por un equipo de atención primaria en personas con diabetes también fueron coste-efectivos. La incorporación de dietistas-nutricionistas en entornos de atención primaria, o aumentar su presencia, daría a las personas acceso a los profesionales de la salud mejor calificados para llevar a cabo el tratamiento nutricional, y resultaría más rentable en términos de gasto en salud. A pesar de las limitaciones descritas, esta revisión sugiere que incorporar dietistas-nutricionistas en atención primaria como parte del equipo multidisciplinario podría considerarse una inversión en salud. Aun así, se requiere más investigación para confirmar las conclusiones.

Palabras clave:

Atención primaria. Equipo multidisciplinario. Dietista-nutricionista. Tratamiento dietético. Coste-efectividad.

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INTRODUCTION

Strong primary health care is the foundation a well-performing health system requires if it is to produce better health outcomes and greater social value (1). An increasing prevalence of chronic and non-communicable diseases (e.g., obesity, cardiovascular disorders, cancer, etc.), together with the increase in aging, are placing an ever increasing burden on healthcare services worldwide. Rethinking the primary care model to include multidisciplinary teams is vital if quality and efficiency are to improve (2).

In a multidisciplinary context, nutritional care is a priority in primary health care. However, despite the evidence that dietary counselling not only prevents chronic diseases but also improves their management and the quality of life of an ageing population, there are fewer dietary health professionals in primary care than other professionals. In countries such as Argentina, Australia, Canada, The Netherlands, New Zealand, United Kingdom (UK) and the United States of America (USA) dietitians-nutritionists have already been incorporated into the health system, where they are the leading agents in charge of dietetic and nutritional care to promote health and to prevent and treat diseases (3). However, only 3 % to 16 % of dietitians-nutritionists in Australia (4), Canada (5), New Zealand (6), UK (7), and the USA (8) are registered to work in primary care, while in The Netherlands this percentage is 55 % (9). There are some obstacles to dietitians-nutritionists providing nutritional care in primary health care. For example, traditionally, general practitioners and nurses have provided nutritional care despite their not being experts in nutritional counselling and not having enough time to do it (10,11), and in some countries there is a limited access to these treatments (9).

Several studies have shown that incorporating dietitians-nutritionists into primary care results in substantial savings in medication, medical visits, and hospital admissions. For example, in New Zealand, for every dollar invested in dietary treatment there is a saving of \$ 6.40 in medication and hospital care (12). In people with hypercholesterolaemia, each dollar spent on dietary counselling saves \$ 5 in statin therapy and other interventions (13). The Dutch Dietitian Association has demonstrated that for each euro invested in dietary treatment savings of up to € 4 on other healthcare costs are obtained (14). In Spain, the College of Dietitians-Nutritionist of Catalonia (CODINUCAT) and the Spanish Association of Dietitians-Nutritionists (AEDN) have made great efforts to raise the figure of dietitians-nutritionists incorporated into primary care in Catalonia. In 2008 and 2009 they proposed including dietitians-nutritionist in the Catalan and the Spanish Health Systems (15,16). However, currently, dietitians-nutritionists are not included in the services of the Catalan and the Spanish primary care systems. There are only isolated experiences in primary care centres managed by private companies that offer dietetic and nutrition services through self-management systems or through complementary health services that are not funded by the public purse. In Spain, the PREDIMED (Prevention with the Mediterranean Diet) study, which has become a worldwide reference, has shown that a dietary intervention with the Mediterranean diet carried out by a dietitian-nutritionist in primary care can reduce the risk of

cardiovascular disease and associated mortality by 30 % (17). However, this study did not assess cost-effectiveness.

Therefore, primary care should consist of multidisciplinary teams that include dietitians-nutritionists (2). The aim of this review was to evaluate the cost-effectiveness of the nutritional care provided by dietitians-nutritionists or other health professionals in Primary Health Care to prove the importance of nutritional treatment and the incorporation of dietitians-nutritionists in the primary care system in Spain.

MATERIALS AND METHODS

The main purpose of this paper was to systematically review the studies that have analyzed the cost-economic benefits of dietary treatment in Primary Health Care. A literature search was carried out in PubMed/MEDLINE for all systematic reviews and randomized controlled trials (RCTs) published between January 2000 and February 2019. The strategy was to search for all articles on the economic benefits of dietary/nutritional treatment in primary care. We conducted the search with the following key words: *Diet Therapy* or *Nutritionists* or *Diet* or *Dietician* or *Diet Therapy* or *Dietary Treatment* or *Dietary Intervention* or *Diet Advice* or *Diet Intervention* or *Dietary Counseling* or *Nutritional Counseling* or *Nutritional Intervention* or *Dietetic* or *Dietitian* or *Nutritional Treatment* or *Dietary Treatment* or *Lifestyle Intervention*; and *Primary Health Care* or *General Practice* or *Primary Care* or *Primary Health Care* or *General Practice*; and *Cost-Benefit Analysis* or *Economic Savings* or *Cost Savings* or *Cost Effectiveness* or *Cost Benefit*. The search was limited to English-language papers and conducted by two independent investigators. All titles and abstracts were analyzed in order to determine which studies matched the established criteria. Finally, a manual search for cited references and other documents of interest was performed.

RESULTS

A flow chart of the literature selection process is shown in figure 1. A total of 36 RCTs and/or systematic reviews were included.

STUDIES ON WEIGHT EXCESS AND COST BENEFIT OF DIETETIC/NUTRITIONAL TREATMENT

The studies reporting on the cost-benefit analysis of dietetic treatment in overweight patients are shown in table I. Three of them are reviews or systematic reviews (18-20), one is a cost-benefit analysis (14), and eight are RCTs (21-29). The reviews included studies conducted by several health professionals; the cost-benefit analysis assessed the benefits of having a dietitian-nutritionist treating subjects with overweight/obesity and associated comorbidities; and, among the eight RCTs, only one was led by dietitians-nutritionists (29) and the others by several health professionals (18), weight-loss coaches (23), psychologists (25), nurses (26), or a non-specified primary care team (24).

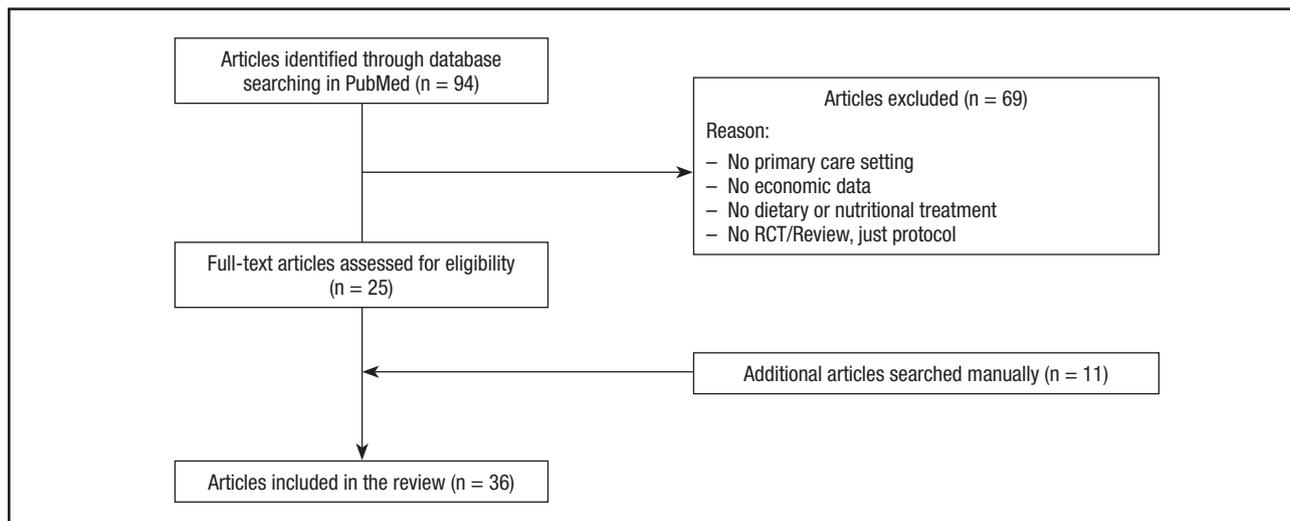


Figure 1.
Flowchart of the literature selection process.

Table I. Economic studies of nutritional treatment in weight excess

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Loveman et al, 2011 United States of America and United Kingdom	Systematic review of randomized controlled trials	Several health professionals	12 randomized controlled trials, only 2 with economic data	1. CLS vs. no treatment 2. CLS vs. UC	1. 0.056 QALY gain. Cost reduction: £ 27. Cost-effectiveness ratio (ICER): - £ 473/QALY gained (costs reduction). 2. 0.24 QALY gained. Extra costs: US \$ 3,080. Cost-effectiveness ratio (ICER): US \$ 60,390 (£ 36,000)/LYG and US \$ 12,640 (£ 7,600)/QALY gained
Lammers et al, 2012 The Netherlands	Cost-benefit analysis	Dietitian-nutritionist	-	Dietary nutritional treatment	Benefits € 0.4-1.9 billion in 5 years. For every € 1 invested, society receives € 14-63: € 56 in health improvement (QALY), € 3 in savings (medication, hospital admissions) and € 4 in labor productivity
Fuller et al, 2013 Australia, United Kingdom and Germany	Randomized controlled trial	Commercial program	N = 772 adults. 12 months follow-up	UC vs. <i>Weight Watchers</i>	Costs per kg lost per year: UC: USD 138 A, 151 UK and 133 G. <i>Weight Watchers</i> : USD 122 A, 90 UK and 180 G. ICER WW vs. UC: USD 18 266 A, 12 100 UK and 40 933 G
Hollinghurst et al, 2013 England	Randomized controlled trial	Not specified	Children with obesity (N = 143). 12 months follow-up	a) Hospital multidisciplinary team with dietitian-nutritionist (control group, 2 branches) vs. b) Nurses in primary care replicating control vs. c) Intensive program behavior modification	Cost per child: a) £ 263 and £ 209, b) £ 301, c) £ 1,749 Reduction in BMI: a) 0.15 and 0.14, b) 0.17, c) 0.40

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Table I (Cont.). Economic studies of nutritional treatment in weight excess

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Tsai et al, 2013 United States of America	Randomized controlled trial	Weight loss coach	UC (N = 130), short dietetic advice in CLS (N = 131), improved short dietetic advice in CLS (N = 129). 2 years follow-up	UC (quarterly visits in PC) vs. short dietetic advice in CLS (+ monthly dietetic advice) vs. improved short dietetic advice in CLS (+ monthly dietetic advice + drugs/meal substitutes)	Costs + \$ 292 per lost kg per year in the improved dietetic advice group vs. UC. QALY gained with no significant differences, so that the program could be profitable in the long term
Robertson et al, 2014 United Kingdom	Systematic review	Several health professionals	26 studies, only 5 with economic data; only 3 with nutritional intervention	1. CLS vs. UC 2. Dietitian /Doctor vs. UC 3. CLS vs. UC	1. Cost- effectiveness: ICER < 2000 CHF (Swiss francs) or £ 1,000/QALY. 92-98 % probability being cost-effective at a WTP of 1,000 CHF/QALY gained. 2. + 0.0002 LYG/+ 0.1210 LYG. No data QALY/WTP. 3. No data QALY/WTP
Tsai et al, 2015 United States of America	Randomized controlled trial	Not specified. Primary care team	N = 79. 18 months follow-up	6 months intensive treatment in CLS, lately randomization to standard or intensive maintenance	No change in costs of medication between groups. No other economic data
McRobbie et al, 2016 United Kingdom	Randomized controlled trial	Psychologists	N = 330. Weight loss program (N = 220) vs. nurses intervention (N = 110). 12 months follow-up	Weight loss program (1 week session/8 weeks) vs. nurses intervention (4 sessions in 8 weeks with CLS)	Weight loss program costs £ 195 vs. £ 176 nurses' intervention, per person. + 0.0104 QALY in weight loss program. No differences with UC (nurses' usual intervention £ 80). ICER £ 7,742/QALY; probability 68-77 % of weight loss program of being the most cost- effective intervention
Little et al, 2016 England	Randomized controlled trial	Nurses	Control group (N = 279), web + follow-up by nurses (N = 269) or web + remote follow-up by nurses (N = 270). 12 months follow-up	Dietetic intervention + nurse follow-up (control group); web dietetic intervention + nurses follow-up, or web dietetic intervention + remote nurse follow-up	Costs + £ 18/kg (web + nurses) and - £ 25/kg (web + remote). 88-98 % probability of being cost-effective with a threshold of £ 100/kg lost
Flodgren et al, 2017 United States of America and Australia	Review of randomized controlled trials	Several health professionals	12 randomized controlled trials, only 2 with economic data	1. a) UC vs. email b) UC vs. telephone intervention. 2. a) UC vs. dietitian-nutritionist b) UC vs. dietitian-nutritionist + doctor	1.a) Cost USD 42.18 (UC) vs. USD 50.45 (email) Cost/kg lost USD 71.50 (UC) vs. USD 72.08 (email) 1.b) Cost USD 42.18 (UC) vs. USD 39 (telephone) Cost/kg lost USD 71.50 (UC) vs. USD 132.70 (telephone) 2.a) Cost USD 23.12 (UC) vs. USD 64.21 (dietitian) 2.b) Cost USD 23.12 (UC) vs. USD 88.61 (dietitian + doctor)

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Table I (Cont.). Economic studies of nutritional treatment in weight excess

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Robertson et al, 2017 United Kingdom	Randomized controlled trial	Facilitators/coaches; several health professionals	Children of 6-11 years with overweight/obesity. 15 families (N = 128 children). 12 months follow-up	UC vs. program ' <i>Families for Health</i> '	No differences in BMI z-scores at 12 months. Higher costs in the ' <i>Families for Health</i> ' program (£ 998 vs. £ 548). ICER of £ 552.175 per QALY gained
Hagberg et al, 2019 Sweden	Randomized controlled trial	Dietitian-nutritionist	Intervention women N = 54, control women N = 56. Postpartum weight loss. 2 years follow-up	Dietetic intervention vs. brochure	Cost USD 1,704–7,889/QALY gained. Probability of being cost-effective of 77-100 % with a WTP USD 50,000 per QALY

BMI: body mass index; ICER: incremental cost-effectiveness ratio; LYG: life years gained; QALY: quality-adjusted life years; UC: usual care; WTP: willingness to pay.

Two of the reviews (19,20), the cost-benefit analysis (14), and 6 of the RCTs (21-23,25,26,29) showed positive results favoring the nutritional specific treatment.

STUDIES ON DIABETES AND THE COST-BENEFIT OF DIETETIC/NUTRITIONAL TREATMENT

One review led by several health professionals (30,31) and eight studies (32-39) led by several health professionals (30,31), nurses and physiotherapists (35), primary care teams (36), trained educators (38) or coaches (39) have evaluated the cost-effectiveness of dietary advice for the prevention and treatment of diabetes in adults or of gestational diabetes in primary care (Table II). None of them was conducted by dietitians-nutritionists. Only one showed negative results for the nutritional specific treatment (35).

STUDIES ON PEOPLE AT CARDIOVASCULAR RISK AND THE COST-BENEFIT OF DIETETIC/NUTRITIONAL TREATMENT

The economic studies of nutritional treatment in people at high cardiovascular risk in primary care are described at table III. Three of them are reviews (40-42) and seven are RCTs or simulation models (43-49). Five of them were carried out by dietitians-nutritionists (40,42,44,47,48), and only one of them (47) showed negative results. Only one of the studies led by nurses (45) showed negative results.

STUDIES ON HEALTHY SUBJECTS AND THE COST-BENEFIT OF DIETETIC/NUTRITIONAL TREATMENT

Three studies evaluated the cost-benefit of nutritional treatment on healthy people (Table IV). None of the studies were led by dietitians-nutritionists (50-52). The results were inconclusive.

MALNUTRITION IN PRIMARY CARE

Only one study looked at the cost-benefit analysis of nutritional treatment in patients with malnutrition (53), showing no specific benefits of the intervention.

DISCUSSION

This review suggests that nutritional counselling and dietary treatment in primary care may be cost-effective. Data regarding the incremental cost-effectiveness ratio (ICER), quality-adjusted life years (QALY) or willingness to pay (WTP) showed that the investment is mainly cost-effective. Even so, more research is needed if clear conclusions are to be drawn.

Few studies have conducted a rigorous cost-benefit economic analysis of the dietetic treatment associated with weight excess. In 2017, the systematic review by Flodgren and coworkers (18) concluded that few studies had assessed the economic management of this treatment, and very little was known about the cost-effectiveness of the interventions evaluated.

Table II. Economic studies of nutritional treatment in diabetes

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Eddy et al, 2005 Hermann et al, 2005	Simulation model	-	-	<i>Diabetes Prevention Program</i> vs placebo intervention.	Compared with no intervention, reduction of the risk of diabetes and comorbidities. \$ 1,100/QALY gained
Bertram et al, 2010 Australia	Simulation model	-	-	Analysis of the impact of 6 interventions: 3 drugs and 3 CLS (diet, exercise, diet + exercise)	Most cost-effective option is diet + exercise: cost-effectiveness ratio: AUD 22,500/DALY; followed by metformin
Kolu et al, 2013 Finland	Randomized controlled trial	Nurses + physiotherapists	N = 399 pregnant women, at least 1 risk factor of gestational diabetes	UC vs. intervention	To avoid gaining 1 g of body weight on birth, additional cost of € 7
Sagarra et al, 2014 Spain	Prospective cohort study	Primary care team	N = 2,054 subjects without diabetes. 4 years	UC vs. group CLS vs. individual CLS	Cost-utility ratio € 3,243/QALY gained
Pronk et al, 2015 Li et al, 2015	Systematic review	Several health professionals	Of the 28 studies, only 12 had information on costs and only 21 studies gave the ICER	Several	Mean ICER: \$ 13,761/QALY gained.
Neumann et al, 2017 Sweden	Simulation model	-	-	CLS in diabetes vs. UC	ICER of € 3,833- 9,215/QALY gained. Probability of 85-91 % of being cost-effective with a WTP threshold of € 50,000/QALY
Leal et al, 2017 England	Randomized controlled trial	Trained educators	N = 880 prediabetes subjects. 3 years	UC vs. <i>Let's Prevent</i>	+ 0.046 QALY; + £ 168 /3 years intervention group. ICER: £ 3,643/QALY, 86 % probability of being cost-effective with a WTP threshold of £ 20,000/QALY
Broekhuizen et al, 2018 Europe	Randomized controlled trial	Coaches	N = 435 pregnant women, high gestational diabetes risk	UC vs. healthy diet vs. physical activity vs healthy diet + physical activity	With WTP € 600/kg- € 750/kg, 90-95 % probability of healthy diet + physical activity more effective than UC

CLS: change in lifestyle; DALY: disability-adjusted life years; ICER: incremental cost-effectiveness ratio; QALY: quality-adjusted life years; UC: usual care; WTP: willingness to pay.

Table III. Economic studies of nutritional treatment in people with high cardiovascular risk

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Olsen et al, 2005 Denmark	Randomized controlled trial	Dietitian-nutritionist	N = 503 subjects. 1 year.	Dietetic counsel, primary care physician vs. dietitian	0.0919 LYG (physician) vs. 0.0274 LYG (dietitian). ICER 8,213 DKK/LYG (physician) vs. 59,987 DKK/LYG (dietitian)
Dalziel et al, 2007 Various	Review	Various	-	8 nutritional interventions	Mediterranean diet AU \$ 1,020/QALY gained. Low fat diet AU \$ 10,000/QALY gained. Intensive program CLS AU \$ 1,880/QALY gained. Nutritional counsel PC AU \$ 10,600/QALY gained. Nurses in PC AU \$ 12,600/QALY gained. 2 fruits and 5 vegetables/AU \$ 46/QALY gained. Nutritional int. at mean AU \$ 5,600/QALY gained. CLS in workplace AU \$ 19,800/QALY gained.
Erisksson et al, 2010 Sweden	Randomized controlled trial	Dietitian-nutritionist + physical therapist	N = 151 men and women (18-65 years old). Moderate-high CVR. 3 years	UC vs. UC + CLS intervention	Savings: \$ 47/subject. \$ 1,668-4,813/QALY gained (no savings discount). 89 %-100 % probability of being effective with a WTP \$ 50,000.
Smith et al, 2010 United States of America	Simulation model	-	-	<i>Diabetes Prevention Program</i>	0.01 QALY gained. \$ 3,420/ QALY gained. 78 % of the models with a lower cost than \$ 20,000/QALY gained
Mistry et al, 2012 Europe	Randomized controlled trial	Nurses	N = 2024 with no CVD. 1 year	UC vs. EUROACTION intervention	Intervention costs: £ 362-419. 0.076-0.085 QALY gained. ICER £ 5,539-4,266/QALY gained
Saha et al, 2013 Sweden	Randomized controlled trial	Dietitian-nutritionist + physical therapist	N = 145. 3 years	UC vs. intensive CLS program	-0.43 QALY (UC) vs. 0.03 QALY (CLS); total 0.46 QALY gained
Van Wier et al, 2013 The Netherlands	Randomized controlled trial	Nurses	N = 622 men and women (30-50 years old) at risk of type 2 diabetes mellitus and/or CVD. 2 years	6 face-to-face counselling sessions + three-monthly sessions by phone vs. UC	Small, statistically non-significant differences in risk scores and QALY gained were found between the intervention and UC group

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Table III (Cont.). Economic studies of nutritional treatment in people with high cardiovascular risk

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Howatson et al, 2015 New Zealand	Systematic review	Dietitian-nutritionist	21 studies (8 RCTs, 6 non-RCTs, 3 reviews), economic data only in 3 studies and 1 review)	CLS vs. UC	Saving of NZ \$ 5.50-99 for each NZ \$ 1 invested in dietetic intervention
Lin et al, 2017 United States of America	Simulation model	-	-	Various nutritional interventions in subjects with cardiovascular risk factors	Intervention cost \$ 262; 0.019 QALY gained/person. \$ 13,900/QALY gained
Sikand et al, 2018 Various	Review	Dietitian-nutritionist	34 studies, only with economic data	Nutritional dietary intervention in patients with dyslipidemia	+ 0.75-0.78 QALY with treatment and reduction of \$ 638-1,456 per patient and year in medication

AU: Australian; CLS: change in lifestyle; CVD: cardiovascular disease; DKK: Danish currency; ICER: incremental cost-effectiveness ratio; LYG: life years gained; PC: primary care; QALY: quality-adjusted life years; RCT: randomized controlled trial; UC: usual care; WTP: willingness to pay.

Table IV. Economic studies of nutritional treatment in healthy people

Study	Type of study	Professionals responsible for the intervention program	Sample size Follow-up time	Description	Results
Speed et al, 2010 United Kingdom	Randomized controlled trial	The dietitian-nutritionist provides the physicians involved in the study with training	N = 154 subjects ≥ 55 years with chronic constipation. Months	Laxatives vs dietetic counsel and CLS ^a standard non personalised vs dietetic counselling and CLS ^a personalised.	Savings of € 13.34 in the personalized group compared with control group and less cost savings in the standard group
Emmons et al, 2014 United States of America	Randomized controlled trial	Not specified	N = 2,440 subjects ≥ 18 years with no diagnosis of dementia, blindness, neurodegenerative disease or psychiatric disease in the last 5 years, and no cancer treatment 18 months	UC vs. healthy intervention self-guided by the patient (HD2) vs. healthy intervention + 2 coach phone calls (HD2 + CC), on the score of multiple risk behaviors	The improvement of 1 unit in the score of multiple risk behaviors was of \$ 319 for HD2, and of \$ 440 for HD2 + CC. The multiple risk behavior score improved in both groups as compared to UC
Guilliford et al, 2014 United Kingdom	Cohort study	-	N = 262,704 healthy adults, no chronic disease, registered in Primary Care	Healthy diet	QALY per 1,000 participants: -0.32; probability of being cost-effective (€ 30,000 / QALY) is only 47.9 %

CLS: change in lifestyle; UC: usual care; QALY: quality-adjusted life-years.

Similarly, another systematic review published by Loveman et al. (20) revealed the poor quality of cost-effectiveness analyses of weight management programs. According to Loveman et al., for every QALY gained with nutritional interventions, £ 473 were saved in one of the studies, or an extra £ 7,200 were spent on the program including a nutritional intervention as compared with routine care (20). Robertson et al. (19) concluded that the evidence available on the economics of obesity management in men is limited and heterogeneous. They found only three studies on dietary intervention that suggested that intervening in lifestyle changes can be highly cost-effective in overweight and obese men. Several RCTs have conducted economic assessments of nutritional treatment in adults with obesity in primary care settings. Hagberg et al. (29) compared the cost and the effectiveness of a post-partum dietetic treatment program with usual treatment. The cost-effectiveness analysis was based on the QALY and cost-effectiveness ratios, and demonstrated that dietary treatment as led by dietitians-nutritionists was cost-effective. Little et al. (26) proved that a dietetic intervention based on behavioural treatment via internet, with nurse support, was cost-effective, and that a significant weight loss can be achieved. McRobbie et al. (25) compared the effect of the usual nutritional treatment performed by nurses with an intensive group weight-loss program, and found that the program was cost-effective (£ 7,742 per QALY; ratios between £ 20,000-30,000 per QALY gained are considered effective). In 2012, the Dutch Association of Dietitians (14) published a document that analysed the cost-benefit of nutritional treatment as led by a dietitian-nutritionist in subjects with overweight/obesity and associated comorbidities. The results showed that a dietetic-nutritional treatment provides a benefit of € 0.4 to € 1.9 billion over a period of 5 years. So, for every € 1 invested in dietary advice in these subjects, society gets a net € 14 to € 63 in return: € 56 as health improvement (measured in QALY), € 3 as sanitary savings (medication, hospital admissions), and € 4 as productivity gains (improved productivity and less work absenteeism). On the other hand, the weight-loss program analysed by Tsai et al. (23) was not cost-effective, because the costs were higher for the intervention, and they found no significant differences in the QALY gained. Subsequently, in another study, Tsai et al. (24) analysed the medication costs associated to two weight-loss programs consisting of 6 months of intensive lifestyle changes and subsequent randomization to standard or intensive maintenance. No differences were found between groups. Further research is needed because economic parameters other than the costs associated with the medication were not measured. Fuller et al. (21) compared the usual intervention in primary care with a commercial program (*Weight Watchers*), and demonstrated that intensive nutritional treatment achieved profitable cost-effectiveness ratios. In children, the "Families for Health" program (27,28) did not achieve greater weight loss and its costs were higher, so the authors considered the program to be less cost-effective than the control group. Hollinghurst et al. (22) compared three specific childhood obesity programs. The intensive program was more effective but much more expensive.

Bertram et al. (34) demonstrated the cost-effectiveness of lifestyle changes in the treatment of prediabetes. They showed that changes in diet and physical activity provided a better cost-effectiveness ratio than pharmacological treatment. Leal et al. (38) estimated the cost-effectiveness of a structured diabetes prevention program in subjects with prediabetes (*Let's Prevent*). The intervention group gained 0.046 QALY in 3 years, with an additional cost of £ 168 per person compared to the standard group. The increase in the cost-effectiveness ratio (£ 3,643/QALY) presented an 86 % probability of being cost-effective. The lifestyle change program Diabetes Prevention Program (DPP) (32,33) also proved to be effective, and it was cost-effective (33) although not in all the analyses (32). Neumann et al. (37) studied the cost-effectiveness of a type-2 diabetes mellitus (T2DM) prevention program. The researchers demonstrated that delaying the onset of T2DM is feasible and cost-effective. In Catalonia, Sagarra et al. (36) demonstrated that it was only necessary to invest € 746 in individual treatment or € 108 in group treatment to avoid a new case of diabetes. Some studies have also assessed the cost-effectiveness of nutritional treatment in gestational diabetes. Broekhuizen et al. (39) carried out an economic analysis in nine European countries. Compared with the standard treatment, the "healthy diet + physical activity" intervention was cost-effective. Also in gestational diabetes, Kolu et al. (35) showed that an additional cost of € 7 was required to prevent an increase in baby body weight of 1 g at birth. So the authors concluded that the program was effective but not cost-effective. Pronk et al. (30) and Li et al. (31) made a systematic review of the studies that provided economic data on the benefits of nutritional treatment in adolescents or adults with a high risk of T2DM. They found a mean cost-effectiveness ratio of \$ 13,761/QALY gained, so they recommend using lifestyle-change programs because the economic evidence shows that they are cost-effective.

In patients with cardiovascular diseases, Lin et al. (46) showed that, compared with no intervention, the ICER of the intervention would be \$ 13,900/QALY. Cost savings ranged from \$ 302 per capita for those who were obese with impaired fasting glucose, hypertension, and dyslipidemia, to a cost of \$ 103,200/QALY for overweight people without these conditions. The conclusion was that the dietary intervention, with a WTP standard cutoff of \$ 50,000/QALY, is cost-effective. Eriksson et al. (48) conducted a study in people at moderate-high cardiovascular risk. The savings were \$ 47 per participant, and the costs per QALY gained ranged from \$ 1,668 to \$ 4,813. The probability of the program being cost-effective was 89-100 %. So, the program was highly cost-effective. Also in people at high cardiovascular risk, the results of the cost-effectiveness analysis of the EUROACTION study were published by Mistry et al. (43). The intervention had higher costs and less QALY than the standard treatment, so the EUROACTION program would only be cost-effective in less than 6 % of cases. Saha et al. (44) obtained a gain of 0.46 QALY in the intervention group compared with the control group, and the authors concluded that the intervention was cost-effective. Van Wier et al. (45) regarded the gain in QALY to be non-cost effective. Smith et al. (49) compared the cost-effectiveness of a modified Diabetes Prevention Program with standard treatment in people with met-

abolic syndrome. The standard treatment reduced the relative risk of metabolic syndrome but the DPP reduced it more, and achieved a 0.01 QALY gain. In 2005, Olsen et al. (47) compared the effect of dietary advice provided by a dietitian-nutritionist or a physician, and found that treatment by physicians was the most cost-effective option. Howatson et al. in 2015 (41) published a systematic review to determine whether dietary intervention in primary care was effective and cost-effective. All the publications found with economic data showed economic advantages, and the recommendation was to incorporate dietitians-nutritionists into primary care in New Zealand, as they could save the National Health System NZ \$ 5.50 to NZ \$ 99 for each NZ \$ 1 invested in dietary intervention. Dalziel et al. (41) analyzed the cost-effectiveness of various nutritional treatments. The 8 interventions submitted to economic analysis can be considered cost-effective. Sikand et al. (42) published a systematic review that evaluated the clinical effectiveness and cost benefits of dietitian-administered nutritional therapy in people with dyslipidemia. The results showed an improvement in QALY and a reduction of costs in medication, associated with improvements in clinical objectives.

In healthy people, Emmons et al. (50) compared the effectiveness of two treatments, showing that both improved the multiple risk score behavior when compared with the usual treatment, with no significant differences between the two versions. Gulliford et al. (51) showed that a treatment with a balanced diet was associated with an increase in the number of years lived without illness, but in the cost-utility analysis the probability of being cost-effective increased only in the age range of 50-74 years. In participants with chronic constipation, Speed et al. (52) studied the clinical effectiveness and cost-effectiveness of laxatives (control group) versus standardized but not personalized dietary advice and lifestyle recommendations, and personalized and reinforced dietary advice and lifestyle recommendations. Due to the low number of participants in the process, it was not possible to draw firm conclusions about the clinical effectiveness of the interventions. The data on health care costs show that the personalized group seemed to perform best and produce the greatest cost savings.

In malnourished patients, Schilp et al. (53) found no significant differences in body weight, QALY, or total cost between groups. Therefore, more studies are necessary to evaluate the cost-effectiveness of dealing with malnutrition in unpredictable people by dietary treatment in primary care.

In summary, the results from this review showed that nutritional counselling was led by a dietitian-nutritionist in two studies conducted in an overweight or obese population, both of which showed positive, cost-effective results. We found no studies led by a dietitian-nutritionist in people with T2DM. However, a total of three RCTs and two systematic reviews assessed nutritional counselling as led by a dietitian-nutritionist in people harbouring cardiovascular risk factors in the primary care setting. Two of these RCTs showed that the nutritional intervention of a dietitian-nutritionist in primary care was positive in terms of cost-effectiveness and economic results. The only study led by dietitians-nutritionists in older people with malnutrition showed that dietary treatment was not cost-effective as compared to usual care in older people

with malnutrition. This lack of effect could be explained by the limited intensity (2.4 hours in the intervention group and 0.2 hours in the control group) and short duration of the treatment provided.

The studies we have reviewed have several methodological limitations that should be taken into account in future research. The size of many of the samples does not provide sufficient statistical power to draw clear conclusions. This is a common problem of economic evaluations (54). Likewise, the main objective of some studies was not to assess the cost of nutritional intervention, and the differences seen in the populations studied (heterogeneous populations, not always in the primary care setting, or with different baseline pathologies, etc.) also make it difficult to draw appropriate conclusions. The different methodologies used (cost-minimization analysis, cost-benefit analysis, cost-utility analysis, or cost-effectiveness) may also introduce an additional factor of variability.

The person responsible for dietary treatment in primary care may be another factor of confusion when assessing cost-effectiveness. Several studies have demonstrated the cost-effectiveness of dietary treatment when led by a dietitian-nutritionist, the expert healthcare professional in dietary counselling (14). The medical and nursing professionals in primary care have limited time to attend to patients, and this often makes it difficult to allocate a specific time in each visit to dietetic and nutritional treatment, as well as changes in physical activity. Giving dietitians-nutritionists a greater role to play in primary care will make it possible to assess the personal situation of each patient with a chronic illness, establish individual goals, and motivate a change in lifestyle.

The Mediterranean diet has been reported to be one of the most cost-effective interventions, together with an intensive lifestyle change program (55). The PREDIMED multicenter study also proved the efficacy of nutritional intervention to reduce the incidence of diabetes (55), metabolic syndrome (56), and cardiovascular disease, as well as mortality for all causes in individuals at high cardiovascular risk (57). However, such nutritional intervention has not been analysed in terms of cost-effectiveness.

It should also be noted that there are many limiting factors in dietetic and nutritional treatment that require intervention by a dietitian-nutritionist: for example, compliance with treatment, sociocultural factors, channel used for the intervention (email, telephone, individual or group visit, information leaflet), intensity (weekly, monthly, quarterly, etc.), and duration of treatment. All these factors can vary the effectiveness on clinical objectives and, therefore, influence the economic analysis of effectiveness. A professional dietitian-nutritionist can discern the most recommended therapeutic option in each specific case. In fact, in the UK, the British Dietetic Association considers that dietitians-nutritionists play a key role in primary care, and recently proposed to extend their role by creating the specialisation of "expert generalist" (58). The UK also has specialist dietitians-nutritionists who work predominantly in general practices and medical management teams in clinical commissioning groups to help prescribe nutritional products effectively and appropriately. Data from audits carried out in primary care indicate that up to 75 % of adult prescriptions for oral nutritional supplements were not appropriate according to the criteria and dietetic judgement of the Advisory Committee for

Borderline Substances (59). Therefore, evidence shows that optimal nutrition—including medical nutrition—as part of a patient's total care also has functional and clinical benefits, resulting in a reduction of health care costs (60).

Therefore, incorporating or increasing the presence of dietitians-nutritionists in primary care would improve quality of life, reduce the demand for specialized medical care, enable people to self-control their chronic diseases, reduce the demand for medical visits, reduce the need for hospitalization, reduce the prescription of drugs, and reduce absenteeism.

Finally, it should be noted that the European Commission has recently published *A New Management for the Primary Care in Europe: Reconsidering the Evaluation of Tools and Methodologies*, drawn up by the Group of Experts on the Evaluation of the Performance of Health Systems (2), which shows that primary care must be enhanced by evaluating the performance of all the health professions that work in multidisciplinary teams, including dietitians-nutritionists.

CONCLUSION

Dietitians-nutritionists are registered health professionals who apply robust scientific knowledge on food and nutrition. Most of the dietary treatments led by dietitians-nutritionists in primary care have proven cost-effective. Therefore, incorporating or increasing the presence of dietitians-nutritionists in primary-care multidisciplinary teams will allow the population access to the best qualified healthcare professionals to carry out dietetic and nutritional treatment for various pathological states, and to promote health and prevent disease in both individuals and the community. The primary care team including dietitians-nutritionists may also increase life expectancy and quality of life, reduce the risk of such chronic diseases as obesity, diabetes, hypertension, malnutrition, etc., and at the same time be cost-effective in terms of health expenditure. Even so, more research is required to confirm these conclusions.

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