

- 30 Ferrarini T, Sjöberg O. Social policy and health: transition countries in a comparative perspective. *Int J Soc Welfare* 2010; 19:S60–88.
- 31 Sjöberg O. Social insurance as a collective resource: unemployment benefits, job insecurity and subjective well-being in a comparative perspective. *Soc Forces* 2010; 88:1281–304.
- 32 Krueger AB, Mueller A. Job search, emotional well-being, and job finding in a period of mass unemployment: evidence from high-frequency longitudinal data. *Brook Papers Econ Activity* 2011; 2011:1–81.
- 33 McLeod CB, Hall PA, Siddiqi A, Hertzman C. How society shapes the health gradient: work-related health inequalities in a comparative perspective. *Ann Rev Pub Health* 2012; 33:59–73.
- 34 Virtanen P, Liukkonen V, Vahtera J, et al. Health inequalities in the workforce: the labour market core-periphery structure. *Int J Epidemiol* 2003; 32:1015–21.
- 35 Puig-Barrachina V, Malmusi D, Martínez JM, Benach J. Monitoring social determinants of health inequalities: the impact of unemployment among vulnerable groups. *Int J Health Services* 2011; 41:459–82.
- 36 Malmberg-Heimonen I. Unemployment benefits, job search activity and mental health—discouraging or buffering effects? *Nordisk Socialt Arbeid* 2005; 25:2–16.
- 37 Lundberg O, Yngwe MÅ, Stjärne MK, et al. The role of welfare state principles and generosity in social policy programmes for public health: an international comparative study. *Lancet* 2008; 372:1633–40.
- 38 Moller S, Bradley D, Huber E, et al. Determinants of relative poverty in advanced capitalist democracies. *Am Soc Rev* 2003; 68:22.
- 39 Chetty R. Moral hazard versus liquidity and optimal unemployment insurance. *J Political Economy* 2008; 116:173–234.
- 40 Keynes JM. The general theory of employment. *Quart J Econ* 1937; 51:209–23.

.....
The European Journal of Public Health, Vol. 28, No. 2, 275–283

© The Author 2017. Published by Oxford University Press on behalf of the European Public Health Association. All rights reserved.
doi:10.1093/eurpub/ckx199 Advance Access published on 18 December 2017
.....

Effectiveness of nutritional interventions addressed to elderly persons: umbrella systematic review with meta-analysis

Andrea Poscia¹, Sonja Milovanovic¹, Daniele Ignazio La Milia¹, Mariusz Duplaga², Marcin Grysztar², Francesco Landi³, Umberto Moscato¹, Nicola Magnavita¹, Agnese Collamati¹, Walter Ricciardi^{1,4}

1 Department of Hygiene, Institute of Public Health, Università Cattolica del Sacro Cuore, Rome, Italy

2 Department of Health Promotion, Institute of Public Health, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland

3 Department of Internal Medicine and Geriatrics, Università Cattolica del Sacro Cuore, Rome, Italy

4 National Institute of Health, Rome, Italy

*Correspondence: Agnese Collamati, Section of Hygiene, Institute of Public Health, Università Cattolica del Sacro Cuore, Largo Francesco Vito 1, 00168 Rome, Italy, Tel: 0630154396, e-mail: agnese.collamati@gmail.com

Background: The number of Europeans aged over 65 will double between 2010 and 2060, reaching 30% of the European population. Nutrition is emerging as a key element of healthy life since both obesity and malnutrition are established risk factors for morbidity and disability. The aim of this umbrella review (UR) is to summarize the findings of all current systematic reviews (SRs) and meta-analyses (MAs) on the effectiveness of nutritional intervention designed to promote healthy aging in older individuals. **Methods:** Eligible articles published in English or Italian between January 2000 and May 2016 were identified in six databases. Only studies that analyzed nutritional interventions in the population of 65 years and over, or papers specifically targeting older adults were deemed eligible. **Results:** Twenty-eight papers, out of which twenty-five SRs and three MAs, met the inclusion criteria and were included in this umbrella SR. Supplementation with vitamin D and other kind of products was highly effective in preventing falls and fractures. Furthermore, several interventions, ranging from the prescription of supplements to environmental and organizational programs, resulted in an improvement in energy and protein intake, as well as positive weight outcomes. Positive findings were also found for the elderly at risk of malnutrition and for older patients with dementia. **Conclusions:** The findings of this UR indicate that the use of a wide range of supplements and environmental and organizational intervention improve a number of anthropometric, nutritional and functional indices in the elderly.

.....

Introduction

The elderly constitute a growing proportion of the global population. It is projected that between 2010 and 2060, the number of Europeans aged over 65 will double, reaching 30% of the European population.¹ This trend inevitably produces a greater burden of chronic diseases, disabilities and frailty in the last years of life, with subsequent higher health care costs.²

Within a context of deteriorating social support and financial resources, health care systems are called upon to deal with a new type of patient affected by multiple concomitant conditions that

result in different degrees of functional deficits, cognitive deterioration, nutritional problems and geriatric syndromes (delirium, falls, incontinence).¹ This ‘epidemiologic transition’ requires primary prevention intervention to target the negative effects of aging and focus on the main modifiable risk factors. It also underlies the recent emergence of health promotion as a proactive strategy addressed to elderly people.³

As reported by the World Health Organization, modifiable health risk factors, such as tobacco use, obesity, sedentary lifestyle, etc. are deeply associated with the global chronic disease burden in the elderly.⁴ Among these, nutrition has become a key element of

healthy life since both obesity and malnutrition, especially when associated with hospitalization, are established risk factors for morbidity and disability.¹

As nutritional errors may lead to the development of a number of diseases, preventive nutritional interventions should be introduced early in life in order to produce positive effects at all ages.³ Their early implementation may lead to significantly lower health care expenditure due to a lower incidence or delayed onset of conditions and improvement in the overall quality of life.^{5–7}

It is clear that older people, especially those who are hospitalized or admitted to long-term care facilities are more frequently at risk of malnutrition than of over-nutrition. It has also been shown that malnutrition may exert a negative impact on recovery from many conditions.⁸ Therefore, for older patients with specific needs, a more targeted approach is required that integrates effective treatment with appropriate health promotion strategies.

The aim of this umbrella review (UR) is to summarize the findings of all current systematic reviews (SRs) of the effectiveness of nutritional interventions designed to promote healthy aging in older individuals.

Methods

Search strategy

Eligible articles were identified in six databases: MEDLINE, Scopus, The Cochrane Library, CINAHL, The Joanna Briggs Institute (JBI) Database of Systematic Reviews and Implementation Reports, and Web of Science. Only articles published in English or Italian from January 2000 to May 2016 were included.

Key words used in the search were based on the implemented PICO model which was first defined for use in MEDLINE and subsequently adapted for other databases. The combination of keywords and their synonyms was: aging AND nutrition AND 'health promotion' AND effectiveness. The entire search strategy is provided in the Supplementary material S1.

Inclusion criteria

Type of participants and type of studies

Only SRs and meta-analyses (MAs) performed in a population aged 65 and over or specifically targeting the elderly were deemed eligible.

Type of intervention(s)

This UR searched for papers that evaluated the effects of nutritional intervention in the elderly, regardless of program type, duration or study setting. Selected studies had to show improvements in nutritional indices (nutritional status or intake of foods and liquids) or any other association with outcomes related to healthy aging (body weight changes, mass outcomes, functional status).

Study selection

An initial screening of publications by titles was performed independently by two researchers (AP and SM). Assessment of the abstracts and full texts of eligible papers was conducted independently by pairs of reviewers (AP and SM; AC and DILM). Any discrepancies between reviewers were resolved through consensus and, if necessary, by consulting a third reviewer (NM). We also performed a manual review of references from the included studies.

Exclusion criteria

SRs that incorporated theoretical studies, qualitative data or text and opinion as their primary source of evidence were not included. Papers describing interventions related to medical treatment or physiotherapy, as well as combined intervention without explicit definition of the nutritional strategies were excluded. We also

excluded papers that focused on different age groups without a subgroup analysis for older adults and interventions where the effects of nutritional strategies were not clearly separated and described. Lastly, SRs/MAs that did not present study specific data (relative risks, 95% confidence intervals and numbers of cases/population) were also excluded.

Assessment of methodological quality

The methodological quality was assessed by two researchers (SM and AC) using the JBI critical appraisal instrument for Systematic Reviews and Research Syntheses.⁹

Any disagreements between the reviewers were resolved through discussion, or with the assistance of a third reviewer.

Data collection

For the purposes of this UR, a JBI Data Extraction Form for Review for Systematic Reviews and Research Syntheses was used.⁹ The following clusters of data were independently extracted in duplicate from each paper (AP and AC): Study Details (data regarding authors, study participants and setting), Search Details (databases used, number and type of studies included, as well as year range), Appraisal (quality assessment of the included studies) and Analysis (outcomes assessed, main findings and their direction).

Data summary/synthesis

Results from the individual reviews were examined, grouped into categories, tabulated for each type of intervention identified in the papers and subsequently discussed in a narrative review. Each step has been carried out independently by two researchers (AP and SM) to reach a final consensus.

In order to summarize the findings from the included papers without going into details of the individual studies included in each SRs/MAs, some criteria were defined. Each outcome for any specific intervention has been classified in the tables 1–4 as '*' (significant improvement) in the following situations: (1) A meta-analysis presented significant findings (main criteria), (2) if the meta-analysis was not performed, but the intervention's efficacy was proved and described in conclusion or discussion section, (3) if the information from the meta-analysis or conclusions/discussion was not presented clearly, then the results section was read thoroughly, and, if needed, the interpretation was confirmed by reading the discussion section. If none of the above mentioned criteria were fulfilled, the results were assigned with 'ns' (non-significant improvement/inconsistent findings). Additionally, in order to distinguish the outcomes with substantial positive findings from those that showed some improvement, but were studied less, we have specified when results were deriving from a single study included in the SR.

For each couple of outcome and intervention, the most promising or interesting results were narratively discussed: when more studies described contrasting conclusions for the same intervention, the direction of conclusions followed the findings reported in majority of the papers.

The possibility for performing a meta-analysis was also examined, when applicable. The presence of heterogeneity among studies was evaluated using the *I*² statistic for pooled study-level data and the results were pooled according the appropriate statistical model.

Results

Out of 1047 records identified through database searches, we selected 48 potentially relevant reviews and MAs. After careful full text examination, a total of 28 papers^{8,10–36} were considered eligible (Supplementary fig. S1, Supplementary material). Among these, 25 were SRs (nine studies^{8,10,13,14,18,19,21,34,35} also performed meta-analysis) and three were Mas.^{15,16,20} The main characteristics of

Table 1 Functional outcomes

Interventions	Functional outcomes			
	Functional status/ physical function	Muscle outcomes	Fall outcomes	Fractures (hip and others)
Environmental/organizational				
Food improvement interventions	ns (29)			
Services of an additional staff member		ns (18)		
Supplements				
Oral supplements (in general)	ns (22,35) ns (33) [†] ns (27) [†]	ns (18,22)	*(22) [†]	
Oral supplements				
Vit. D			*(14,20) *(23) ^a ns (16,28) ns (23) ^b	ns (16,19)
Vit. D+Ca			*(28) *(23) ^a *(20) [†] ns (23) ^b ns (16) [†]	*(19)
Multiv./multimin.			*(23) ^{a†} ns (23) ^{b†}	
energy	ns (8)	ns (8)		
Protein/amino acids		*(26) ^c ns (15,26) ns (13) ^d		
Enteral nutrition	ns (18)			
Education, counseling, workshops	*(31) [†] ns (18,27,32)			
Other				
Mixed ^e	*(31) ns (34-36) ns	ns (34)	ns (23,32) [†]	

*† = significant finding obtained in only one study included in the review

a: Rate of falls.

b: Risk for falling.

c: Leu, leucine.

d: EAA, essential amino acids.

e: Mixed intervention [i.e. mixed intervention comprising nutrition (chocolate plus homemade supplements, gratin diet for people with swallowing difficulties), exercise (individualized sessions, twice weekly) and twice weekly oral hygiene or sunlight plus calcium supplement].

the studies that met the inclusion criteria are summarized in Supplementary table S1.

The number of individual studies included per SR/MA varied from 5 to 62, making a total number of 614 articles included in this UR. Hundred and twelve of the studies included (18.2%) overlapped.

Fourteen articles included only randomized/quasi randomized controlled trials in their analysis, while the others also considered one of the following study designs: non-randomized controlled trials, cross-sectional and longitudinal studies.

Individual studies analyzed were conducted in different settings and the duration of intervention ranged widely. Thirteen papers included studies performed in a mixed setting (i.e. community dwelling and hospital/nursing homes), six focused exclusively on nursing homes or long-term care facilities and five papers considered a community setting. Three reviews did not define the setting in which the selected studies were performed. One study concerned a hospital setting.

Seven papers focused on elderly persons suffering from dementia,^{11,24,25,32,33,35,36} while subjects at risk of malnutrition or with reduced functional ability were the respective groups of interest in two studies^{8,27} and one paper.³⁴

Most of the individual studies were conducted in the USA and Canada; European studies were carried out mainly in Sweden, the UK and the Netherlands.

Methodological quality

Supplementary table S2 contains a detailed critical appraisal of the reviews included in the present study. The results obtained from the JBI appraisal checklist indicated that more than 80% (23/28) of the reviews included were of a high or moderate quality; 10 studies reached a high quality score, while 13 others were of moderate quality. Only one review¹⁹ met all the requirements of the methodological quality form. Of three MAs included in this UR two were of high quality,^{16,20} while the third had moderate quality score.¹⁵

The main quality issue among the included reviews was the absence of an analysis of the likelihood of publication bias. Furthermore, another possible point of concern might be

represented by the lack of the methods that should have been used to minimize errors in data extraction process. In four studies,^{12,22,26,28} it was unclear whether the methodological quality assessment had been performed in duplicate and independently—generally a crucial step for minimizing bias. The authors of one review¹⁸ used quality appraisal as a criterion for including the studies in their SR.

Most of the studies were SRs and therefore the use of an N/A (not applicable) answer for the question ‘Were the methods used to combine results appropriate?’ was highly justified.

Classification of interventions

For the purpose of this UR, interventions identified in the studies were classified into four groups: (1) interventions with intake of supplements, (2) environmental and organizational modifications of meals and dining aspects (3) educational interventions involving counseling or workshop and (4) other (group of interventions that contained multicomponent programs or other elements of prevention such as group conversation or behavioral techniques).

Eighteen papers, consisting of fifteen SRs^{8,12–14,18, 19,22,23,25–28,30,33,35} and three MAs^{15,16,20} analyzed programs offering a wide range of supplements. These consisted mainly of a variety of nutritional supplements, vitamin D supplements (alone or combined with calcium) and protein-based formulas. Other interventions (four reviews) provided essential energy-rich supplements accompanied by substances such as beta-hydroxy-betamethylbutyrate, vitamins and minerals.^{8,22,26,30}

Eleven studies^{10,11,17,18,21,24,25,29,32,35,36} investigated the effectiveness of environmental and organizational strategies designed to promote nutrition and healthy aging in the elderly. In the study conducted by Abbott et al., these strategies involved programs designed to improve the mealtime routine, experience or environment and usually comprised interventions for improving food by adding sauce to the dish in order to make it more visually attractive or included milk powder formulas.¹⁰ Other authors^{21,29} described interventions based on dietary enrichment with conventional foods and/or powdered modules in order to increase the energy and protein density of meals without significantly increasing its final

Table 2 Anthropometric indices

Interventions	Anthropometric indices			
	Weight outcomes	BMI ^a	Mass outcomes	Upper arm anthropometry
Environmental/organizational				
Food improvement interventions	*(18) [†] *(10) [†] ns (10,29,35)	*(36) ^{††}		ns 10 [†]
Alterations to dining environment/ changes to food service	*(32) ns (10,36)	*(32) ns (36)		ns (32) ^{†,d} ns (10)
Services of an additional staff member	ns (18) [†]	ns (18)		ns (18) ^{c,d,e}
Mealtime assistance	ns (35,36) ns (10) [†]	ns (35,36)		
Home-delivered meal programs	ns (17)			
Supplements				
Oral supplements (in general)	*(18,25,35) ns (33)	*(25,35) ns (18)	ns (18)	*(18) ^c *(35) ^f ns (18) ^{d,e} ns (33) ns (35) ^e
Oral supplements				
Energy	*(8)			*(8) ^c
Proteins/amino acids	*(13) ^g	*(13) ^g	*(13) ^g *(26) ^{†h} ns (26) ns (15) ^b	
Enteral nutrition	*(18)			*(18) ^{d,e} ns (18) ^c
Education, counselling, workshops	*(10,31) ns (18,32,36)	ns (31,32,36)		ns (36) ^{c,e} ns (10) [†]
Other				
Mixed	*(32,35) [†] *(31) ns (35) [†] ns (34,36)	*(35) [†] ns (31,36) ns (35) [†]		

ns, non-significant improvement/inconsistent finding. *Significant improvement. ns[†], Non-significant finding obtained in only one study from the review. *[†], Significant finding obtained in only one study included in the review. †, Provision of real-food snacks.

a: BMI, body mass index.

b: LBM, lean body mass.

c: AMC, arm muscle circumference.

d: MAC, middle arm circumference.

e: TSF, triceps skin fold thickness.

f: upper arm circumference.

g: Leu, leucine.

h: HMB, beta-hydroxy-beta-methylbutyrate.

Table 3 Nutritional indices

Interventions	Nutritional indices						
	Nutritional status	Protein intake	Dietary/caloric intake	Risk for malnutrition	Food security	Eating performance	Diet quality
Environmental/organizational							
Food improvement interventions	ns (29)	*(21) ns (29)	*(18,21) *(29) ^a *(10) [†]				
Alterations to dining environment/ changes to food service	*(32)		*(10,36) ^a *(32) [†] *(32) ns (25)			ns (24) [†]	ns (36) [†]
Mealtime assistance			*(10) ns (25,35) ns (36) ^a			*(24)	
Home-delivered meal programs		ns (17) [†]	*(17) ns (17) ^a	*(17)	*(17)		*(17)
Supplements							
Oral supplements (in general)	*(27) ns (33)	*(18,25,35) *(27) [†]	*(18) *(25,35) ^a *(27) [†] ns (33)	*(35) ns (18)			
Oral supplements							
Energy		*(8)	*(8)				
Enteral nutrition			*(18) [†]				
Education, counselling, workshops		*(36)	*(22,31) *(10) ^a ns (25,32,36)	*(18,36) [†]		*(24,25)	
Other							
Mixed		*(34) *(35) [†] *(36)	*(35) [†] *(31,34) ns (36) ^{†,a}	*(31) [†]			

*[†]=significant finding obtained in only one study included in the review.

a: Caloric intake.

volume, or the provision of 'real-food'.¹⁰ Liu et al. 2015²⁴ reviewed the mealtime assistance program designed to improve eating performances. Other studies also considered making alterations to the dining environment by improving lighting and table-setting,^{11,24,32,36} while one study¹⁷ described home-delivered meal programs (also known as 'meals on wheels').

Nine studies focused on interventions that included educational sessions or participation in professional counseling groups.^{10,18,22,24,25,27,31,32,36} Nutritional education in the study by Young et al. was based on a personalized education program that recommended a number of food portions or on the counseling of a nutritionist who gave patients a personal dietary prescription and

Table 4 Other outcomes

Interventions	Other outcomes						
	Biochemical indices ^a	QoL ^b	Infection	Mortality	Morbidity	Health services utilization	Mental health and cognitive functioning
Environmental/organizational							
Food improvement interventions			ns (29) [†]				
Alterations to dining environment/ changes to food service	ns (10) ns (32) [†]	*(10)					*(11) [†] ns (25) ^g
Services of an additional staff member				ns (18)		ns (18)	
Home-delivered meal programs		*(17) [†]					
Supplements							
Oral supplements (in general)	*(25)	ns (35) [†]		ns (18,33,35)		ns (18) ns (27) [†]	*(35) ns (25,33)
Oral supplements							
vit. D				ns (16,19)			
vit. D + Ca				ns (19) ns (16) [†]			
Multivit./multimin.tablets	*(22) [†]		ns (30) ^c	ns (30)		ns (30)	*(12) [†] *(22)
energy		ns (8)		ns (8) ^d	*(8)	ns (8)	ns (8)
Enteral nutrition				ns (18)		ns (18)	
Education, counselling, workshops	ns (31,32) ns (10) [†]	*(27)		ns (18) [†]		ns (18) ns (27) [†]	*(31) [†]
Other							
Mixed	*(36) [†] *(31)	ns (31)	ns (32) [†]	ns (34) ^h		ns (34) ^h ns (31)	*(31) ^e ns (31) ^f ns (34)
Group conversation				ns (31) ns (32,36) [†]			ns (35,36) [†]

*†=ns, non-significant improvement/inconsistent finding. *Significant improvement. ns†, Non-significant finding obtained in only one study from the review. *†, Significant finding obtained in only one study from the review. †, The authors discussed evidence on multinitruiet intervention or single components, with or without putative mechanisms.

a: biochemical indices, Hb levels, cholesterol, diabetes risk, albumin, sodium excretion, inflammatory biomarkers.

b: QoL, quality of life.

c: Significant effects of supplementation on number of infection and antibiotic use-days are outliers, as defined by the authors.

d: Statistically significant findings when the analysis was limited to older under-nourished.

e: Depression.

f: Anxiety.

g: Agitation.

h: During the intervention mortality and hospitalization were higher, at the end of follow-up authors reported the non-significant results. The main reason for this is probably that the methodology of some of the included studies was biased, resulting in groups that were imbalanced at the start.

offered a regular telephone follow-up service.³¹ Bandayrel et al. reviewed educational programs as well as group learning sessions, peer support and scheduled follow-up meetings.²² Other studies focused mainly on educational sessions organized by professionals in different settings.

While most of the educational interventions described were specifically tailored for the elderly, some were designed to help improve the knowledge and skills of staff members. Abbott et al. described the intervention that focused on mealtimes after staff had been given specific nutrition education or a feeding skills training program.¹⁰

Seven studies^{11,23,31,32,34–36} analyzed the effects of mixed interventions or interventions that were not classifiable in the aforementioned categories, e.g. group conversation promotion in the study of Whear et al.¹¹ and Bunn et al.,³⁶ or the strategy of behavioral changes described in the latter study.³⁶ With regard to mixed interventions, the same authors suggested that they should contain three components, one of which should be dining environment and food service modifications, education, behavioral strategies or exercise lessons.³⁶ Young et al. reviewed programs that included medical care, exercise lessons, dietary education and counseling sessions.³¹ Beck et al. described multicomponent intervention as a combination of personalized dietary counseling (e.g. given by a dietitian and/or oral nutritional supplements).³⁴ Other strategies comprised workshops with written instructions for each participant, or were based on nutrition and relaxation.

Summary of best evidence of nutritional interventions

Evidence from the papers included in this UR was gathered by identifying those with greater effectiveness in older individuals

as potential strategies for promoting healthy aging in this population.

Measured patient outcomes were divided into the following four categories in order to classify and summarize their effects: functional outcomes, anthropometric indices, nutritional indices and other outcomes. The SRs included in this UR contained results related to 30 outcomes. These are reported in tables 1–4.

Functional outcomes

Twenty papers^{8,13–16,18–20,22,23,26–29,31–36} reviewed the effects of nutritional interventions on outcomes that included functional status, muscle size and strength, fall outcomes and fractures (table 1). Most of the included reviews reported that these interventions yielded minor improvements or inconsistent results.

Nevertheless, supplementation with vitamin D (alone or with the addition of calcium) seemed to produce positive effects in the elderly, especially in relation to the prevention of falls and fractures.

Neyens et al. reported a reduction in falls in older adults after administration of vitamin D, both with and without calcium.²⁸ Moreover, two MAs reported a significantly reduced risk of falling.^{14,20} Bischoff-Ferrari et al. indicated that study participants had a 19% lower risk of falling when taking high doses of vitamin D (according to findings reported in 8 out of 10 studies included in the meta-analysis), while another paper reported a 14% reduction in the risk of falling in the community dwelling and institutionalized elderly.¹⁴ Furthermore, vitamin D supplements (alone and combined with calcium) led to a reduction in the rate of falls.²³

Relation between vitamin D supplementation and falls in the elderly was the only identified among the included papers that

allowed us to perform an update meta-analysis of the study by Kalyani et al., which so far represented the most comprehensive one.¹⁴ Three studies were added to the primary analysis (articles with explicit definition of falls), and an additional one to the post-hoc analysis. Our findings confirm those presented in the meta-analysis by Kalyani et al., showing 10% of fall reduction in elderly supplemented with vitamin D. Nevertheless, our pooled estimate from the primary analysis was border-line significant and with increased heterogeneity ($RR = 0.896$; 95%CI: 0.804–0.998, $I^2 = 63.2\%$) (Supplementary fig. S2), while the post-hoc analysis, which included eight articles without an explicit fall definition, was not significant ($RR = 0.959$; 95%CI: 0.912–1.008, $I^2 = 49.7\%$) (Supplementary fig. S3).

Avenell et al. found that vitamin D alone is unlikely to prevent hip fractures or any new fracture, but when used with calcium can slightly decrease the risk of hip fracture and significantly reduce the risk of non-vertebral and any other new fracture.¹⁹

Milne et al. reported that nutritional interventions with energy supplementation failed to improve activities of daily living in the elderly,⁸ while educational sessions and mixed intervention (nutritional strategies and counseling sessions) produced beneficial effects on physical performance and motor function.³¹

Finally, Marshall et al. found no improvement in functional status across all the included interventions, even though they pointed out that ‘non-significant’ results meant preventing further decline or disease in the elderly at risk of malnutrition.²⁷

Anthropometric indices

Sixteen papers^{8,10,13,15,17,18,25,26,29,31–36} reviewed the effects of interventions on anthropometric indices including weight change, body mass index (BMI), mass outcomes and upper arm anthropometry parameters (table 2).

Most of the studies confirmed that supplements play an important role in intervention aimed at improving body weight. In six studies,^{8,13,18,25,35} supplementation programs brought about significant improvements in the participants’ body weight. Specifically, weight gain as an outcome of interest, significantly improved in studies where different kinds of supplements were provided.

A meta-analysis performed by Vanderkroft et al. indicated that oral supplementation increased weight gain in undernourished elderly patients,¹⁸ while Liu et al. and Abdelhaimid et al. reported the same results in older patients with dementia.^{25,35}

Another group of authors described weight gain also in a sarcopenia subgroup supplemented with leucine.¹³ In a meta-analysis of 42 trials, Milne et al. reported the benefits of an energy supplementation strategy that led to an increase of 2.2% kg (95%CI: 1.8–2.5).⁸

In addition to oral supplementation, other interventions were quite successful in promoting weight gain in the elderly. Vanderkroft et al. reported that enteral nutrition therapy was effective for gaining body weight in the hospitalized elderly,¹⁸ while in another paper the provision of ‘real-food’ snacks had a beneficial role.¹⁰ Lastly, two groups of authors also described the positive effects of education and counseling on body weight related to educational sessions for the elderly³¹ or staff training intervention.¹⁰

Most of the afore-mentioned studies also evaluated BMI as an outcome, strongly confirming the findings obtained for changes in body weight;^{13,25,32,35} Liu et al. 2014 performed the intervention based on nutritional supplements,²⁵ while Komar et al. used supplementation with leucine, even though the results were no longer significant after the subgroup analysis in sarcopenic patients.¹³ A meta-analysis of eight RCTs that investigated the effects of oral supplements over 3–12 weeks, demonstrated a small, but statistically significant increase in BMI (0.91 kg/m^2 ; 95%CI: 0.56–1.25).³⁵ Jackson et al. showed how simple environmental changes in the food service or dining environment can contribute to a significant increase in BMI among residents with cognitive impairment.³²

Nutritional interventions failed to produce great improvements in mass outcomes, although Komar et al. reported that supplementation with leucine may be beneficial,¹³ while the effectiveness of HMB (beta-hydroxy-beta-methylbutyrate) was demonstrated only in one study included in the review of Malafarina et al. aimed at investigating the effectiveness of nutritional supplementation in the treatment of sarcopenia in old age.²⁶

Considerable variation was found with regard to upper arm anthropometry parameters in the results of the reviews included. Two reviews reported improvements in Arm Muscle Circumference after performing a meta-analysis of the studies that used energy supplements,^{8,35} while another paper showed an increase in middle-Arm Circumference and Triceps Skin Fold thickness after enteral therapy intervention.¹⁸

Nutritional indices

Sixteen papers^{8,10,17,18,21,22,24,25,27,29,31–36} reviewed the effects of interventions on nutrition-related outcomes (table 3). Dietary, caloric and protein intake were the most frequently investigated outcomes and also those that produced the greatest improvements.

Vanderkroft et al. described a significant dietary and protein intake improvement in an undernourished older population after using strategies of food improvement and oral supplementation.¹⁸ Similarly, oral supplementation strategies,^{8,18,25,27,35} especially energy supplements,⁸ resulted in significant amelioration in dietary and caloric intake.

A number of papers indicated the positive effects of environmental/organizational interventions on caloric intake. Abbott et al. reported that three categories of environmental-organizational interventions (food improvement, alterations in the dining environment and mealtime assistance) ensured an improvement in dietary and caloric intake.¹⁰ It should be highlighted that these results are contrasting when considering the study design. In particular, observational studies found positive effects on dietary/caloric intake across all intervention types, while MAs of the trials showed little evidence for food improvement interventions. Another group of authors reported an increase in caloric intake after performing dietary enrichment intervention.²⁹ In one paper,²¹ a strategy of food-based fortification comprising techniques of enrichment (increase of volume) and densification yielded a significant increase in dietary and caloric intake. Altering the dining environment also resulted in a significant increase in dietary intake.^{32,36}

All these results need to be interpreted with caution because of the heterogeneous nature of the studies included.

One paper reported a successful increase in dietary intake due to home-delivered meal intervention (‘meals on wheels’),¹⁷ but found no alteration in caloric intake.

Several studies^{10,18,22,24,25,31,32,36} investigated the effects of educational intervention on nutritional indices. Of these, three observed improvements in dietary intake,^{10,22,31} two in eating performance^{24,25} and one in protein intake.³⁶ The study by Abbott et al. showed a slight contrast in results obtained in RCT (little evidence on dietary/caloric intake) and observational studies (positive effects) for the education intervention in residents with dementia.¹⁰

Some articles^{17,18,31,35,36} targeted the risk of malnutrition among the elderly. All the described interventions produced positive results, but only the home-delivered meal strategy¹⁷ and oral supplementation reached a level of relevant significance,³⁵ while the findings of other groups of authors were based on only one study that produced significant results,^{18,31,36} or were inconsistent.¹⁸

Zhu et al. provided evidence of an improvement in terms of food insecurity and diet quality.¹⁷

Multicomponent interventions were successful in increasing protein intake^{34–36} and dietary intake,^{31,35,36} and also decreased the risk of malnutrition,³¹ even though some of these conclusions were based on only one study.

Other outcomes

Nineteen studies^{8,10–12,16–19,22,25,27,29–36} described a wide range of outcomes related to different aspects of the life of older adults (table 4). The outcomes focused on mortality, mental health parameters and the utilization of health services. Reviews indicated that interventions led to positive effects, but most of them yielded inconclusive findings.

Mental health was studied in 10 papers,^{8,11,12,22,25,31,33–36} 6 of which reported considerable improvements.^{11,12,22,31,35,36} One group of authors used the multi-nutrient supplement strategy to enhance cognitive functioning,²² while another study showed the effectiveness of mixed intervention.³¹ Group conversation intervention produced significant results in two reviews,^{11,36} while supplementation with L-carnitine and vitamins in the study by Manders et al. led to improvements in the cognitive functioning.¹²

Ten papers that investigated mortality failed to indicate a significant decline in the mortality rate.^{8,16,18,19,31–36}

A significant improvement in the quality of life was reported in three reviews^{10,17,27}; one group of authors referred to alterations in the dining environment,¹⁰ another to educational sessions,²⁷ while Zhu et al. investigated 'home-delivered meal programs', even though this result was based on only one study.¹⁷

Discussion

To the best of our knowledge, this is the first UR devoted specifically to exploring and assessing evidence of the effectiveness of nutritional interventions designed to promote healthy aging in the elderly. The main challenge in this study was to classify the interventions analyzed in the selected reviews in such a way as to provide a better understanding of their effectiveness and utility. Other aims were to identify significantly improved outcomes, and gaps in research that could become the subject of further investigation. Although nutritional interventions are widely studied in scientific literature, little is known of their real effectiveness.

The authors of the included reviews ascertained that interventions involving vitamin D supplements or other kind of products in the doses and formulations tested so far in older people are highly effective in preventing falls and fractures. Bischoff-Ferrari et al. stated that fall prevention begins with a daily dose of 700 IU supplemental vitamin D and is warranted in all individuals over 65-years of age.²⁰ Moreover, they emphasized that 25(OH) D in a concentration of 60 nmol/l is also required for fall prevention. Evidence from Cameron et al. and Kalyani et al. also suggests that vitamin D supplementation may be an effective strategy for reducing falls in older adults and should be incorporated into the clinical practice of elderly care providers, especially for those at greater risk of falling (i.e. sarcopenic patients).^{14,23}

Some authors suggested that environmental and organizational nutritional interventions could have a favorable effect on nutritional indices (dietary, protein intake)^{10,25,29,35} and functional status²⁹ as a result of mealtime assistance and dietary enrichment programs. Nevertheless, evidence was derived from studies of moderate and low quality or from papers of a considerably heterogeneous nature, and therefore needs to be interpreted with caution.

Even though a great effort was made to standardize the data provided in the SRs/MAs included, several issues such as the different methods used to measure outcomes, the short term studies with small sample sizes, the diversity in the populations of older people and the quality of the studies included in the papers prevented us from drawing firm conclusions.

Nevertheless, oral supplementation (i.e. vitamins, protein-based products) appeared to be the most effective intervention for producing significant outcomes. More than 50% of the included studies with a focus on provision of various supplements^{8,14,18–20,26–28,30} reported significant improvements in the outcomes investigated. With regard to the quality of evidence provided in these papers, six were of high quality; vitamin D supplementation

intervention was made in four of these papers,^{14,19,20,23} while commercial oral supplements were used in the other two.^{8,18}

Other intervention that resulted in noteworthy effects focused on changing dining conditions and the organizational aspects of eating habits in the elderly. The effects of this intervention were particularly outstanding in the domain of nutritional indices, especially in improving dietary and caloric intake, even though some of the findings were not consistent.^{10,25,32,36}

In the 30 different outcomes assessed in all the studies, a definite association was found between nutritional interventions and the following five outcomes: dietary intake and caloric intake,^{8,10,17,18,21,22,25,29,31,32,35,36} risk of malnutrition,^{17,35} weight outcomes,^{8,10,13,18,25,31,32,35} and prevention of falls and fractures.^{14,19,20,23,28}

Conversely, outcomes related to muscle function (muscle size, muscle strength and hand grip strength) and functional status, which were often either limited or non-significant in the various reviews, failed to provide consistent conclusions regarding the effectiveness of nutritional interventions.^{8,13,15,18,22,26,27,29,32–36}

In the current literature on nutritional interventions, healthy aging programs combine strategies for improving environmental management, supplementation and lifestyle interventions in order to enhance the well-being of older adults.³⁷ The method of administering fortified foods or supplements is one of the issues that nutritional intervention researchers usually address in an attempt to improve the nutritional condition of elderly people. Very often older people are unwilling or unable to consume supplements of any kind. Efforts need to be made to provide them with regular meals and snacks that stimulate their appetite, or to give them assistance with feeding when required.⁸

Participation in home-delivered meal programs may contribute to the health and independence of older adults living in the community, especially if they are food insecure or are making the transition from hospital care to their home setting.³⁸

This UR has a number of strong points. It was conducted taking into account all the SRs/MAs published from 2000 to 2016. The time span could have been shorter as the issue of active aging has been in the forefront since 2012 thanks to the 'European Year for Active Ageing and Solidarity between Generations'. Nevertheless, the question of active aging has been present in the scientific literature since the early 2000 s, so this wider timeframe was chosen in order not to overlook papers that might have been of interest for the present study. A further valuable strong point of this UR was the identification of indices that require more attention in the promotion of healthy aging.

However, some limitations should be taken into consideration when interpreting our findings. Included reviews contain individual studies characterized by small sample sizes and follow-up periods that were often insufficient to determine the real long-term effects of the interventions. Furthermore, the reviews included different populations ranging from subjects dwelling in the community to older residents in long-term care facilities, and it might have influenced the consistency of our interpretations. In addition, most of the included studies did not consider the multi-dimensionality of the relation between nutrition and health. Even if several conclusions arise from RCTs, in which the randomization process should balance known and unknown confounding factors, the socio-economic factors and the clinical and social frailty might partially explain the inconclusive results of studies dealing with the prevention in older people.

Some papers might have been subjected to selection bias since the quality assessment process was used as an inclusion criterion for individual studies. Moreover, as in most reviews, publication bias might have been an issue. Lastly, different methods were used in the outcome categories for measuring and reporting results.

In conclusion, the aging population is of increased interest for the policy makers, public health professionals and clinicians, who should be more aware of the importance of nutritional interventions in older

adults. Policy makers should encourage greater adoption of prevention-oriented approach in this population, since it plays a crucial role in maintaining a good health status and a better quality of life in advanced age. Additionally, health care professionals should implement tailored nutritional interventions with evidence of efficacy, such as supplementation with vitamin D for preventing falls and fractures, or oral supplements and protein-based formulas for improving the weight and reducing the risk for malnutrition in the older adults, according to the their functional and cognitive status.

Acknowledgement

The authors thank Ms. Elisabeth Ann Wright for assistance with the English version of this manuscript.

Supplementary data

Supplementary data are available at *EURPUB* online.

Funding

This publication arises from the project Pro-Health 65+ which has received funding from the European Union, in the framework of the Health Programme (2008–13).

The content of this publication represents the views of the author and it is his sole responsibility; it can in no way be taken to reflect the views of the European Commission and/or the Executive Agency for Health and Consumers or any other body of the European Union. The European Commission and/or the Executive Agency do(es) not accept responsibility for any use that may be made of the information it contains.

Publication financed from funds for science in the years 2015–17 allocated for implementation of an international co-financed project’.

Preliminary results from this work have been presented as pitch presentation at the 9th European Public Health Conference ‘All for Health, Health for All’ at the ACV—Austria Center Vienna, Vienna, 9–12 November 2016.

Conflicts of interest: None declared.

Key points

- The findings of this UR indicate the benefits of using supplements, especially vitamin D, in elderly persons suffering from sarcopenia.
- The results also confirm the effectiveness of other oral supplements and protein-based formulas in promoting weight gain and minimizing the risk of undernutrition.
- More educational strategies, mealtime interventions and home-delivered programs should be implemented for the aging population, since there is evidence of potential improvements in the health of the elderly.
- Gaps identified in this UR suggest opportunities for further investigation.
- Larger studies with longer follow-up periods could help to obtain greater insight into the long-term effects of health promotion programs.

References

- Poscia A, Landi F, Collamati A. Public health gerontology and active aging. In: *A Systematic Review of Key Issues in Public Health*. Cham: Springer International Publishing, 2015: 129–51.
- The World Health Organization. Global status report on noncommunicable diseases 2010 [Internet]. World Health. 2010 [cited 2017 Feb 1]. p. 176. Available at: http://whqlibdoc.who.int/publications/2011/9789240686458_eng.pdf.
- Chernoff R. Nutrition and health promotion in older adults. *J Gerontol A Biol Sci Med Sci* 2001;56:47–53.
- The World Health Organization (WHO). Reducing risks, promoting healthy life [Internet]. 2002 [cited 2017 Feb 3]. Available at: http://www.who.int/whr/2002/en/whr02_en.pdf?ua=1.
- Denny A. An overview of the role of diet during the ageing process. *Br J Community Nurs* 2008;13:58–67.
- Dwyer J. Starting down the right path: nutrition connections with chronic diseases of later life. *Am J Clin Nutr* 2006;83:415–21.
- Haveman-Nies A, de Groot LCPGM, van Staveren WA. Dietary quality, lifestyle factors and healthy ageing in Europe: the SENECA study. *Age Ageing* 2003;32:427–34.
- Milne AC, Potter J, Vivanti A, Avenell A. Protein and energy supplementation in older people at risk from malnutrition. *Australas J Ageing* 2010;29:144.
- JBI. The Joanna Briggs Institute, 2014 Reviewers’ manual [Internet]. 2014 [cited 2016 Jan 15]. Available at: <http://joannabriggs.org/assets/docs/sumari/reviewersmanual-2014.pdf>.
- Abbott RA, Whear R, Thompson-Coon J, et al. Effectiveness of mealtime interventions on nutritional outcomes for the elderly living in residential care: a systematic review and meta-analysis. *Ageing Res Rev Elsevier B V* 2013;12:967–81.
- Whear R, Abbott R, Thompson-Coon J, et al. Effectiveness of mealtime interventions on behavior symptoms of people with dementia living in care homes: a systematic review. *J Am Med Dir Assoc Elsevier Ltd* 2014;15:185–93.
- Manders M, de Groot LCPGM, van Staveren WA, et al. Effectiveness of nutritional supplements on cognitive functioning in elderly persons: a systematic review. *J Gerontol A Biol Sci Med Sci* 2004;59:1041–9.
- Komar B, Schwingshackl L, Hoffmann G. Effects of leucine-rich protein supplements on anthropometric parameter and muscle strength in the elderly: a systematic review and meta-analysis. *J Nutr Heal Aging* 2015;19:437–46.
- Kalyani RR, Stein B, Valiylil R, et al. Vitamin D treatment for the prevention of falls in older adults: systematic review and meta-analysis. *J Am Geriatr Soc* 2010;58:1299–310.
- Xu Z-R, Tan Z-J, Zhang Q, et al. Clinical effectiveness of protein and amino acid supplementation on building muscle mass in elderly people: a meta-analysis. *PLoS One* 2014;9:e109141.
- Zheng YT, Cui QQ, Hong YM, et al. A meta-analysis of high dose, intermittent vitamin D supplementation among older adults. *PLoS One* 2015;10:e0115850.
- Zhu H, An R, Number P, Agreement P. Impact of home-delivered meal programs on diet and nutrition among older adults: a review. *Nutr Health* 2013;22:89–103.
- Vanderkroft D, Collins CE, Fitzgerald M, et al. Minimising undernutrition in the older inpatient. *Int J Evid Based Healthc* 2007;5:110–81.
- Avenell A, Mak JC, O’Connell D. Vitamin D and vitamin D analogues for preventing fractures in post-menopausal women and older men. *Cochrane Database Syst Rev* 2014;2014:7.
- Bischoff-Ferrari HA, Dawson-Hughes B, Staehelin HB, et al. Fall prevention with supplemental and active forms of vitamin D: a meta-analysis of randomised controlled trials. *BMJ* 2009;339:b3692.
- Morilla-Herrera JC, Martin-Santos FJ, Caro-Bautista J, et al. Effectiveness of food-based fortification in older people. A systematic review and meta-analysis. *J Nutr Health Aging* 2016;20:178–84.
- Bandayrel K, Wong S. Systematic literature review of randomized control trials assessing the effectiveness of nutrition interventions in community-dwelling older adults. *J Nutr Educ Behav Elsevier Inc* 2011;43:251–62.
- Cameron I, Gillespie L, Robertson M, et al. Interventions for preventing falls in older people in care facilities and hospitals (Review). *Cochrane database Syst Rev* 2012;2012:4.
- Liu W, Galik E, Boltz M, et al. Optimizing eating performance for older adults with dementia living in long-term care: a systematic review. *Worldviews Evidence-Based Nurs* 2015;12:228–35.
- Liu W, Cheon J, Thomas SA. Interventions on mealtime difficulties in older adults with dementia: a systematic review. *Int J Nurs Stud Elsevier Ltd* 2014;51:14–27.
- Malafarina V, Uriz-Otano F, Iniesta R, Gil-Guerrero L. Effectiveness of nutritional supplementation on muscle mass in treatment of sarcopenia in old age: a systematic review. *J Am Med Dir Assoc Elsevier Ltd* 2013;14:10–7.

- 27 Marshall S, Bauer J, Capra S, Isenring E. Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence. *J Nutr Heal Aging* 2013;17:645–51.
- 28 Neyens JC, van Haastregt JC, Dijcks BP, et al. Effectiveness and implementation aspects of interventions for preventing falls in elderly people in long-term care facilities: a systematic review of RCTs. *J Am Med Dir Assoc* 2011;12:410–25.
- 29 Trabal J, Farran-Codina A. Effects of dietary enrichment with conventional foods on energy and protein intake in older adults: a systematic review. *Nutr Rev* 2015;73:624–33.
- 30 Stephen AI, Avenell A. A systematic review of multivitamin and multiminer supplementation for infection. *J Hum Nutr Diet* 2006;19:179–90.
- 31 Young K, Bunn F, Trivedi D, Dickinson A. Nutritional education for community dwelling older people: a systematic review of randomised controlled trials. *Int J Nurs Stud Elsevier Ltd* 2011;48:751–80.
- 32 Jackson J, Currie K, Graham C, Robb Y. The effectiveness of interventions to reduce undernutrition and promote eating in older adults with dementia: a systematic review. *JBI Database Syst Rev Implement Rep* 2011;9:1509–49.
- 33 Hines S, Wilson J, McCrow J, et al. Oral liquid nutritional supplements for people with dementia in residential aged care facilities. *Int J Evid Based Healthc* 2010;8:248–51.
- 34 Beck AM, Dent E, Baldwin C. Nutritional intervention as part of functional rehabilitation in older people with reduced functional ability: a systematic review and meta-analysis of randomised controlled studies. *J Hum Nutr Diet* 2016;29:1–13.
- 35 Abdelhamid A, Bunn D, Copley M, et al. Effectiveness of interventions to directly support food and drink intake in people with dementia: systematic review and meta-analysis. *BMC Geriatr BMC Geriatr* 2016;16:26.
- 36 Bunn D, Abdelhamid A, Copley M, et al. Effectiveness of interventions to indirectly support food and drink intake in people with dementia: Eating and Drinking Well IN dementia (EDWINA) systematic review. *BMC Geriatr* 2016;16:89–21.
- 37 Scult M, Haime V, Jacquot J, et al. A healthy aging program for older adults: effects on self-efficacy and morale. *Adv Mind Body Med* 2015;29:26–33.
- 38 Campbell AD, Godfryd A, Buys D, Locher JL. Does participation in home-delivered meals programs improve outcomes for older adults? Results of a systematic review. *J Nutr Gerontol Geriatr* 2015;6:356–72.

.....
The European Journal of Public Health, Vol. 28, No. 2, 283–288

© The Author 2017. Published by Oxford University Press on behalf of the European Public Health Association. All rights reserved.
doi:10.1093/eurpub/ckx121 Advance Access published on 3 September 2017
.....

Food insecurity in Denmark—socio-demographic determinants and associations with eating- and health-related variables

Thomas B. Lund,¹ Lotte Holm,¹ Inge Tetens,² Sinne Smed,¹ Annemette L. Nielsen³

1 Department of Food and Resource Economics, University of Copenhagen, Copenhagen, Denmark

2 Department of Nutrition, Exercise and Sports, University of Copenhagen, Copenhagen, Denmark

3 Strategic Research Consultant, City of Copenhagen, Health and Care Administration Copenhagen, Denmark

Correspondence: Thomas B. Lund, IFRO, Rolighedsvej 25, DK-1958 Frederiksberg C, Denmark, Tel: +45 35336861, e-mail: tblu@ifro.ku.dk

Background: Food insecurity and its consequences have not received much attention in the Nordic, social-democratic welfare states. This study reports the prevalence of low and very low food security in Denmark, identifies its socio-demographic determinants and examines its associations with eating-related and health-related outcomes. **Methods:** A cross-sectional survey with a mixed-mode response format (telephone interviewing or Internet). A disproportional stratified random sampling design was employed ($N = 1877$). Main measure was the 6-item gradient food security construct adapted from the US. **Results:** Prevalence of low and very low food security was 6.0% (95% CI: 5.4–8.5%) and 2.4% (95% CI: 1.3–3.3%), respectively. Prevalence was highest in households with disposable income below OECD's poverty threshold, households receiving benefits or disability pensions, and single-parent households. After socio-demographic adjustment, adults from low/very low food secure households had a higher probability of eating an unhealthy diet (women: adj.RR 2.82 $P < 0.001$; men: adj.RR 2.15 $P < 0.01$). Adults from low/very low food secure households had lower life satisfaction (women: adj.RR 0.49, $P < 0.05$; men: adj.RR 0.09 $P < 0.001$) and higher risk of psychological distress (women: adj.RR 2.42 $P < 0.05$; men: adj.RR 8.95 $P < 0.001$). Obesity was more prevalent in low/very low food secure women (RR 2.44 $P < 0.05$), but not after socio-demographic adjustment. **Conclusion:** Food insecurity in Denmark is associated with adverse factors such as unhealthy diet, obesity, life satisfaction, and psychological distress. It is important to widen food insecurity research to non-liberal welfare states since low/very low food security is negatively associated with unhealthy eating and other health indicators, even in a social-democratic welfare state.

Introduction

More than two decades ago, it was recognized that, even in high-income countries, income inequality may imply that parts of the population face difficulties procuring the most basic necessities.^{1,2} In the US, research showed that one or several members of low-income households experienced problems obtaining adequate and sufficient food in socially acceptable ways. This condition was referred to as

food insecurity (FI).^{2,3} Subsequently, FI has been shown to also exist in other high-income countries.^{4–9}

Concurrent research has shown that FI is negatively correlated with the nutritional quality of foods consumed in high-income countries such as the US,^{2–10} Canada¹¹ and the UK.⁶ Further studies have shown that FI increases the risk of depression,⁴ anxiety¹² and distress^{13–14} as well as the risk of obesity in women.¹⁵

In response to the high prevalence of FI and its negative association with eating behavior and health outcomes, some countries