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Original Research

HOMEFOOD Randomised Trial – Six-Month Nutrition Therapy in Discharged Older Adults Reduces Hospital Readmissions and Length of Stay at Hospital Up to 18 Months of Follow-Up

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Abstract

BACKGROUND: Malnutrition is frequently observed in older adults and is associated with hospital readmissions, length of stay (LOS), and mortality in discharged patients.

OBJECTIVE: The aim of this study was to investigate effects of six-month nutrition therapy on hospital readmissions, LOS, mortality and need for long-term care residence 1-, 6-, 12- and 18-months post-discharge in older Icelandic adults.

DESIGN: Secondary analysis of a randomized controlled trial.

PaARTICIPANTS: Participants (>65 years) were randomised into intervention (n=53) and control (n=53) before discharge from a geriatric unit.

INTERVENTION: The intervention group received nutrition therapy based on the Nutrition Care Process, including home visits, phone calls, freely delivered energy- and protein-rich foods and supplements for six months after hospital discharge.

MEASUREMENTS: The Icelandic electronic hospital registry was accessed to gain information on emergency room visits (ER), hospital readmissions, LOS, mortality and need for long-term care residence.

RESULTS: The intervention group had a lower proportion of participants with at least one readmission compared to control (1 month: 1.9% vs 15.8%, P=0.033; 6 months: 25.0% vs 46.2%, P=0.021; 12 months: 38.5% vs 55.8%, P=0.051; and 18 months: 51.9% vs 65.4%, P=0.107). There was also a lower total number of readmissions per participant (1 month: 0.02 vs 0.19, P=0.015; 6 month: 0.33 vs 0.77, P=0.014; 0.62 vs 1.12, P=0.044) and a shorter LOS (1 month: 0.02 vs 0.92, P=0.013; 6 months: 2.44 vs 13.21; P=0.006; 12 months: 5.83 vs 19.40, P=0.034; 18 months: 10.42 vs 26.00, P=0.033) in the intervention group. However, there were no differences between groups in ER visits, mortality and need for long-term care residence.

CONCLUSION: A six-month nutrition therapy in older Icelandic adults discharged from hospital reduced hospital readmissions and shortens LOS at the hospital up to 18-months post-discharge. However, it did neither affect mortality, ER, nor need of long-term care residence in this group.

Key words: Nutrition status, oral nutrition supplements, readmission, mortality.

Introduction

Malnutrition is a frequently observed problem in older adults in hospitals and it has been reported that nutrition status often continues to decline during the stay in the hospital, resulting into a high proportion of older adults who are malnourished when discharged home (1-3). Malnutrition has many negative consequences, such as a reduction in body weight and a worsening of physical function, both associated with a loss of independence (4, 5). These unfavourable condition in older adults is also related to increased odds of hospital readmissions and mortality (6-8).

The time after hospital discharge can represent an opportunity for dietary intervention in older malnourished patients (9). It is vital to test whether a dietary intervention that increases energy- and protein intake to reduce risk of malnutrition is effective in preventing hospital readmissions, shortening the length of stay (LOS) once admitted, decreasing risk of mortality, and lessening the need for long-term care residence in discharged older adults.

A recently published meta-analysis (10) on this topic included nutrition trials which investigated personal dietary counselling with a focus on everyday food items (11, 12), oral nutritional supplements (ONS) (13, 14), or a mix of food and ONS (15, 16) to reach appropriate intake levels of energy and protein. And according to this meta-analysis, older discharged and hospitalized patients who received such intervention experienced a 16% lower risk of readmission in contrast to older adults having received standard care (10). The follow-up time in the included studies ranged from 30 to 90 days post-discharge, and hence some of the studies had quite a short duration compared to what is recommended by the European Society of Clinical Nutrition and Metabolism (ESPEN) (9). Further, this meta-analysis (10) did not consider LOS during readmissions or emergency room (ER) visits.

Another systematic review and meta-analysis that assessed nutritional therapy during and after hospital stay on mortality in adult patients reported an effect on increased survival (17). The authors, however noted that more studies are needed to confirm those findings (17). Beneficial effects of protein supplementation on mortality have also been noted in some studies (18).

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It has been shown that malnutrition increases the risk of nursing home admission (19), however, little is known about whether nutrition intervention in malnourished older adults can prevent need for long term care residence. To address this data gap in we conducted this secondary analysis of a randomised dietary intervention trial in older adults that were at nutritional risk after being discharged from hospital (20, 21). The aim of the present study was to investigate the effects of six-month nutrition therapy on hospital readmissions, LOS, risk for long-term care residence and mortality 1-, 6-, 12- and 18 months post-discharge in older Icelandic adults.

Materials and Methods

Study design

The HOMEFOOD study was a randomised controlled six-month intervention trial examining the effects of intense nutritional therapy, including free access to energy- and protein-dense foods delivered to subjects, on older adults that were at nutritional risk after being discharged to home from hospital. The trial was assessor blinded. The main outcome of this analysis was hospital readmissions (number of total readmissions, % of participants re-admitted, length of stay during readmissions) 1 months, 6 months, 12 months, and 18 months post-discharge. Additional outcomes were risk for long-term care residence and mortality. The study was conducted in Reykjavik, Iceland, starting in January 2019 and ending with the last participant receiving intervention in July 2020. This was a secondary analysis of the HOMEFOOD trial. The primary outcomes of the original study were body weight and physical function (20, 21).

Reporting, approval, and funding

The conduction and reporting of this trial followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines for Randomized Trials of Nonpharmacologic Treatments (22). The Ethics Committee for Health Research of the National University Hospital of Iceland and data protection registry (24/2018) approved the study in August 2018 and was performed in agreement with the ethical standards laid down in the 1964 Declaration of Helsinki (23). Registration of the study was done and is accessible at clinicaltrials.gov (NCT03995303).

Setting and recruitment

Screening and recruitment of the participants took place at the Icelandic National Hospital in Reykjavik, Iceland, starting in January 2019 and ending in January 2020. This was carried out by a clinical nutritionist, in cooperation with the nurses of the geriatric hospital wards, from January 2019 to January 2020. Inclusion criteria were as follows: community dwelling in the Capital area; discharge home from the hospital within a day of recruitment; age ≥ 65 years; at risk for malnutrition according to the validated Icelandic Nutrition Screening Tool (24); agreeing to participate in the trial by giving written informed consent. Exclusion criteria were: cognitive impairment (measured as Mini-Mental State Examination (MMSE) score < 20 (taken within three months of recruitment) (25); tubal feeding; known dietary allergies/being on a special diet; severe chronic kidney disease (glomerular filtration rate < 30 mL/min/1.73 m^2); active cancer treatment; and not being able to communicate with the research team.

Randomisation

The principal investigator (AR) assigned all participants randomly (allocation ratio = 1:1) to either the intervention- or the control group. The Statistical Package for the Social Sciences (SPSS, version 26.0, SPSS, Chicago, IL, USA) was used to generate the random numbers for allocation purposes, which were obscured from the clinical nutritionist enrolling and assigning the participants till the time of assignment.

Intervention

The clinical nutritionist provided the intervention group with nutrition therapy during five home visits (conducted the day after hospital discharge and at one, three, six, and twelve weeks from discharge). Additionally, the participants received three separate phone calls from the clinical nutritionist at weeks two, five, and nine after hospital discharge to encourage adherence to the nutrition therapy. The nutrition therapy followed the standards of the Nutrition Care Process (26), which entails assessing a patients nutritional status, diagnosing their nutritional problem/s, suggesting appropriate nutritional treatment, monitoring that the problem improves/resolves, and lastly, evaluating the treatment suggested. As many of the participants received support from family members, friends, relatives, or home-care staff, they were invited to be present during the home visits for added support (For more details see 20, 21).

During the first home visit, the focus was on educating the participant about the consequences of inadequate energy and protein intake and age-related changes that can affect the ability to meet their energy and protein needs sufficiently, they also were given Icelandic guidelines for frail or sick older adults (27). Other parts of the Nutrition Care Process were then followed, identifying any nutrition related problems, and a nutrition therapy suggestion was set up to resolve these problems. As the NCP is highly individualised, the nutritional needs and problems of each participant were identified and solutions were put in place, e.g., provision of ONS, or foods suggested to minimize digestive issues. This action was done to work towards a set goal, e.g., to stop weight- and muscle loss by increasing energy and protein intake, or to lessen number of times digestive pain is experienced. The participants also received, free of charge, energy- and protein-rich cooked traditional foods (at least one hot meal daily and two snacks; Supplemental table 1) and ONS. These were delivered, free of charge, once weekly for 24 weeks, by study staff that helped the participants to put the food safely in the refrigerator and

explained how to open the provided packages, how to heat up the meals safely, and how the meals should be stored.

Control group

At discharge from hospital, the control group was provided with information on proper nutrition for older adults (published in 2018 by the Icelandic Directorate of Health (27)) and was encouraged to order Meals on Wheels (MOW), as both recommendations reflect the current standard of care in Iceland when discharging older adults at risk of malnutrition. The control group did not receive any further nutritional care or service by the hospital, primary care sector and community. The participants in the control group did not receive dietary counselling or provision of food by the study team during the study period.

Data collection

Data on participants' diagnosis (according to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)), number of medications, and height was obtained from the Icelandic electronic hospital registry SAGA (TM software 3.1.39.9) at recruitment. Background socio-demographic variables were obtained using a background questionnaire, asking into matters regarding e.g., age, sex, whether receiving home care, smoking habits, alcohol habits, and level of education, these were taken at baseline (day of discharge in the hospital) and at endpoint in the participants' home. Outcome assessors were blinded as to the intervention status of the participant.

Nutritional risk

The Icelandic Nutrition Screening Tool (ISNST) was used to evaluate the nutritional risk of potential participants, as this is a validated screening tool recommended by the Icelandic Medical Directorate of Health (27, 28). The ISNST has seven questions, where the questions give zero, one, two, four, or five points, this results in a total score range from zero to 30 points, for our participants the total score range was from one to 30 as you get one point for being ≥ 65 years old. For older adults zero to two points represents low risk of malnutrition, three to four points some risk, and ≥ five points represents being at high risk of malnutrition.

Primary Outcomes

Hospital readmissions (1, 6, 12 and 18 months)

In the fall of 2021, the Icelandic electronic hospital registry SAGA (TM software 3.1.39.9) was accessed for each participant and information extracted on hospital readmissions (number of readmissions and LOS and visits to the emergency room (ER) (number of visits) at 1, 6 (= end of intervention), 12 and 18 months after hospital discharge.

Excluded as "readmissions" were elective admissions to part-time rehabilitation wards where participants came in one to three days a week from 10:00-15:00 to see various health-care workers for rehabilitative purposes.

Secondary Outcomes

Information on mortality and on need for long-term care residence were retrieved from the electronic hospital registry SAGA (TM software 3.1.39.9). Need for long-term care residence was estimated using the Nursing Home Pre-Admission Assessment (NHPAA) which is a professional assessment of the needs of individuals for long term care in in a nursing- or residential home. This is a standardized procedure that assesses among others health status, mental state, and skills in activities of daily living. The purpose of the NHPAA screening is to identify individuals in need for long-term care residence in a nursing- or residential home. NHPAA gives a more thorough and complete picture of the condition and needs of a patient and whether they truly need a nursing home admission. This thorough assessment is important as there is limited access to nursing homes in Iceland, with long waiting lists, making prioritisation for admissions important based on the patient's needs. The outcome of this assessment is dichotomous, i.e., positive (= need for long-term care residence) or negative (= no need for long-term care residence).

Additional measurements

Dietary intake (0 and 6 months)

Two twenty-four-hour-dietary-recalls (24HR) were used to assess the dietary intake (in particular energy and protein) of the participants, one was taken at baseline the day of discharge, and one at endpoint in the home of the participant. The 24HR is used to get an estimate of intakes of energy and energy-giving nutrients of an individual during a 24-hour period, usually from midnight to midnight, the day before the recall is taken (29). The nutrition calculation program ICEFOOD was used to enter the results from the 24HR to calculate the dietary intake of the participants (30, 31). ICEFOOD was chosen to calculate dietary intake as it based on the Icelandic database of the chemical composition of food (ISGEM) (30, 31).

Anthropometric measurements (0 and 6 months)

Using a calibrated bodyweight scale (model no. 708, Seca, Hamburg, Germany) the weight of the participants was measured, with them wearing only light underwear or clothing, at discharge and at the endpoint measure. Body mass index (BMI) was then calculated from the height obtained at the hospital registry SAGA and from the participants measured bodyweight (kg/m^2).

Physical function (0 and 6 months)

A shortened version of the Short Physical Performance Battery (SPPB) was utilized to evaluate physical function of the participants (32). The assessment of four-meter walk time (gait speed) could not be conducted as it was not feasible to carry it out at the participants' homes. The total combined score therefore changed accordingly and ranged from zero to eight points.

Cognitive function (0 and 6 months)

Cognitive function evaluation was performed using the MMSE, an eleven-question questionnaire frequently employed to screen for cognitive impairment (25).

Depressive symptoms (0 and 6 months)

A modified version of the Centre for Epidemiologic Studies Depression (CES-D) scale, called IOWA, was used to evaluate depressive symptoms of the participants (33).

Adverse events related to foods provided to the intervention group

During the intervention period, the clinical nutritionist assessed if any adverse events were reported by the participants of the intervention group due to the foods provided, e.g., stomach pain, change in bowels, or nausea. Assessment of potential adverse events related to dietary intake is part of the NCP and standardized questions were used for this assessment.

Sample size

A priori sample size considerations in the HOMEFOOD study were based on the original aim of the study which was to investigate the effects of nutrition therapy on body weight and body composition in older adults after discharge from geriatric hospital wards. Building on our previous studies that focused on body weight change (34, 35), calculations suggested that a sample size of n = 44 in each group were sufficient for a 1.8 ± 3.0 kg difference between the groups to be statistically significant ($\alpha = 0.05$, $\beta = 0.8$). However, no sample size was calculated to detect a difference between the groups in relation to the primary outcome in the study reported in this article.

Statistical analysis

Analysing the data was done by using the statistical software (SPSS, version 26.0, SPSS, Chicago, IL, USA). Data variables were checked for normality using the Kolmogorov-Smirnov test. Data is presented as mean ± standard deviation (SD).

The calculation of differences between the groups at baseline were done by using independent samples' t-test (for normally distributed variables) or Mann-Whitney-U test (for not normally distributed variables) and for categorical variables the chi-square test was used.

A general linear model adjusted for baseline values and sex was used to investigate differences in physical variables, psychological outcomes, and dietary intake between the groups at endpoint. For continuous outcomes the results are shown as parameter estimates with 95% confidence intervals (95%CI) reflecting the mean adjusted differences in the outcome variables between groups.

A Mann-Whitney-U test was used to compare differences between the two groups in hospital readmissions, LOS, and ER visits at 1, 6, 12 and 18 months after discharge from hospital. The percentages of patients in the control- and in the intervention groups with at least one hospital admission and/or at least one ER visit during the study period were compared using gender adjusted logistic regression analysis.

Cox regression analysis adjusted for gender was used to investigate differences in mortality and NHPAA between groups. The underlying time scale was the time from the start of the intervention until event or month 18 post-discharge. Results are shown as hazard ratios.

Per-protocol analysis reflects endpoint calculations, as the dropouts were only included in baseline analysis and in the analysis on mortality. The level of significance was set at $P < 0.05$.

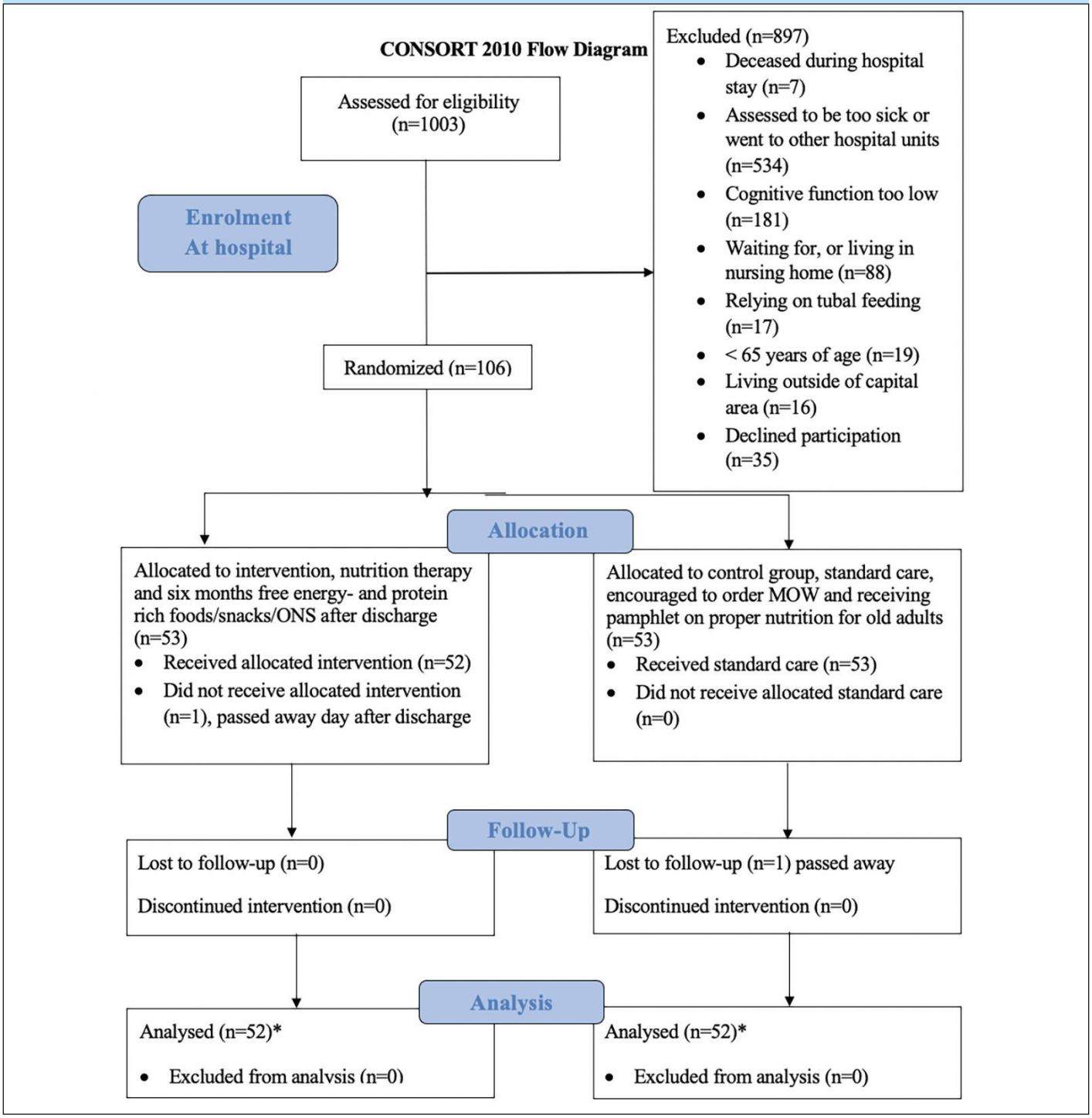
Results

The recruitment process from screening to analysis is shown in Figure 1. One thousand and three potential participants were screened and 897 were excluded as they did not meet the inclusion criteria, ending with 106 participants being randomised and participated in the study. One participant from each group dropped out during the trial (Figure 1). As the trial started, all participants of the intervention group, except for one (the drop-out), received the nutrition intervention from the clinical nutritionist, and the freely delivered energy and protein rich foods, snacks, and ONS. No adverse events related to the food provided were reported within the intervention group, i.e., nausea, a change in bowel movements, or other gastric issues.

Baseline characteristics are shown in Table 1. There was a higher percentage of women (71.7 vs 52.8%, P = 0.045) and a higher ISNST score (5.1 ± 1.7 vs 4.5 ± 1.3, P = 0.047) in the intervention group compared to the control group. No other baseline variables were significantly different between the two groups.

The intervention group experienced terms significant weight gain during the intervention period (1.7 kg ± 2.5 kg; which equals approximately 2% of body weight, only 1 out of 53 individuals lost > 1 kg body weight), while significant weight loss was observed among controls (-3.5 ± 3.9 kg; which equals approximately 5% of body weight, 42 out of 53 individuals lost > 1 kg body weight). After adjustment for sex (Table 2) this corresponded to 5.2 kg (95% CI: 3.9, 6.4) higher body weight in the intervention group at endpoint compared to controls. The intervention was also successful in increasing the participants' energy- and protein intake, improving their physical- and cognitive function, and their depressive symptoms in comparison to the control group as can be seen in Table 2.

Figure 1. Flow chart



Baseline table and mortality analysis include all 106 participants

These results have been reported in more detail elsewhere (20, 21).

The number of ER visits, number of readmissions, LOS, and the proportion of subjects with at least one readmission at 1, 6, 12 and 18 months after initial hospital discharge are shown in Table 3. Overall, the intervention group had significantly fewer readmissions (significant at 1, 6 and 12 months) and shorter LOS (significant at all time points) when compared to the control group, however, the differences in ER visits were not significant. Similar results are yielded when comparing the proportion of participants with at least one hospital admission during the study period.

During the study- and follow up period, 23.1% in the control group and 13.5% in the intervention group had a positive NHPAA result which was not significant according to Cox regression analysis (intervention vs. control group: HR = 0.54

Table 1. Baseline characteristics of the participants

Variables	Control (n = 53)	Intervention (n = 53)	P-value*
	mean ± SD	mean ± SD	
Age (years)	81.8 ± 6.0	83.3 ± 6.7	0.228
Female (%)	52.8	71.7	0.045
Higher education (yes in %)	66	69.8	0.677
Lives alone (%)	66	66	0.999
Alcohol (yes in %)	45.3	37.7	0.430
Smoking (yes in %)	9.4	3.8	0.241
Height (m)	1.7 ± 0.1	1.7 ± 0.1	0.326
Weight (kg)	76.5 ± 19.1	78.3 ± 18.3	0.615
BMI (kg/m^2)	26.9 ± 5.3	28.5 ± 6.5	0.188
SPPB (score)	2.4 ± 2	2.5 ± 1.8	0.839
ISNST (score)	4.5 ± 1.3	5.1 ± 1.7	0.047
ICD10 diagnoses	10.5 ± 3.8	10.3 ± 4.9	0.877
Medications	12.4 ± 4.2	12.2 ± 5.8	0.893
MMSE (score)	25.9 ± 2.9	26.1 ± 2.8	0.702
CES - depression scale (score)	5.6 ± 4.7	5.4 ± 4.2	0.861
Energy intake (kcal)	1543 ± 299	1490 ± 363	0.410
Protein (g)	77 ± 15	74 ± 18	0.411
Protein (g/kg BW**)	1.07 ± 0.36	0.99 ± 0.31	0.228

*P-value based on chi square test for categorical variables, independent samples t-test for normally distributed continuous variables and Mann Whitney U test for not normally distributed continuous variables. SPPB = Short Physical Performance Battery Test, score range: 0-8; ISNST = Icelandic Nutrition Screening Tool sore range: 1-30, 1-2 = no nutritional risk, 3-4 = some nutritional risk, ≥ 5 = high nutritional risk; MMSE = Mini Mental State examination, score range: 0-30; ICD-10 = International Classification of Diseases, version 10; BMI = body mass index; CES-D= Centre of Epidemiological Studies depression IOWA scale, score range 0-22, > 9 = presence of depressive symptoms.
** Body weight

Table 2. Differences in outcomes between the groups at endpoint*

Outcome variable at endpoint	groups	estimate	95% CI		P-value
Body weight (kg)	control vs. intervention	-5.2	-6.5	-3.9	<0.001
Body mass index (kg/m2)	control vs. intervention	-1.8	-2.3	-1.3	<0.001
SPPB (score)	control vs. intervention	-1.0	-1.8	-0.3	0.007
MMSE (score)	control vs. intervention	-1.7	-2.6	-0.8	<0.001
CES - Depression (score)	control vs. intervention	3.1	1.6	4.5	<0.001
Energy intake (kcal)	control vs. intervention	-1696	-1834	-1557	<0.001
Protein (g)	control vs. intervention	-88	-98	-77	<0.001
Protein (g/kg BW**)	control vs. intervention	-1.1	-1.2	-1.0	<0.001

*Based on general linear model - univariate. Adjusted for baseline values and sex; SPPB = Short Physical Performance Battery Test, score range: 0-8; MMSE = Mini Mental State examination, score range 0-30; CES-D= Centre of Epidemiological Studies depression IOWA scale, score range 0-22, > 9 = presence of depressive symptoms; Control n = 52; intervention n = 52; ** Body weight

(95%CI: 0.21-1.38, P = 0.20).

In both groups, 9.4% of the participants deceased during the study and follow-up period. Also, for this outcome, gender adjusted Cox regression analysis did not show any differences (intervention vs. control group: HR = 0.97 (95%CI: 0.28-3.34, P = 0.96).

Discussion

The present study was a secondary analysis of a six-month randomised controlled trial (20, 21) investigating the effects of nutrition therapy on hospital readmissions, LOS, mortality and need for long-term care residence 1-, 6-, 12- and 18 months post-discharge. Considering that the intervention had significant effects on energy intake, BMI, physical- and cognitive function as well as on depressive symptoms (20, 21), we also found that it reduced the number of readmissions, the proportion of subjects with at least one readmission, as well as LOS up to 18 months after discharge. However, the intervention did not affect ER visits, NHPAA results, or mortality.

Table 3. Hospital readmissions, ER room visits and LOS in the control- and in the intervention group during the study period

	control (n = 52)				intervention (n = 52)				
	mean	25th per.	median	75th per.	mean	25th per.	median	75th per.	P-value
No. of emergency room visits 1 month	0.21	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.370
No. of emergency room visits 6 months	0.98	0.00	0.00	2.00	0.79	0.00	0.00	1.00	0.750
No. of emergency room visits 12 months	1.69	0.00	1.00	2.00	1.4	0.00	1.00	2.00	0.911
No. of emergency room visits 18 months	2.31	0.00	2.00	2.75	1.96	0.00	1.00	3.00	0.928
No. of re-admissions 1 month	0.19	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.015
No. of re-admissions 6 month	0.77	0.00	0.00	1.00	0.33	0.00	0.00	0.75	0.014
No. of re-admissions 12 month	1.12	0.00	1.00	2.00	0.62	0.00	0.00	1.00	0.044
No. of re-admissions 18 month	1.52	0.00	1.00	2.00	0.92	0.00	1.00	1.75	0.072
Length of stay 1 month	0.92	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.013
Length of stay 6 months	13.21	0.00	0.00	13.75	2.44	0.00	0.00	1.50	0.006
Length of stay 12 months	19.40	0.00	3.00	21.00	5.83	0.00	0.00	7.75	0.034
Length of stay 18 months	26.00	0.00	9.00	39.25	10.42	0.00	2.00	10.75	0.033
Proportion of participants readmitted 1 months	15.8				1.9				0.033
Proportion of participants readmitted 6 months	46.2				25.0				0.021
Proportion of participants readmitted 12 months	55.8				38.5				0.051
Proportion of participants readmitted 18 months	65.4				51.9				0.107

*P-values for the differences between groups in emergency room visits, no. of readmission and length of stay are based on Mann-Whitney U test. P-values for the differences between groups in proportion of participants readmitted are based on gender adjusted logistic regression; 25th per. = 25% percentile, 75th per. = 75% percentile. LOS = length of stay.

Hospital readmissions

Hospital readmissions are an important outcome in health sciences as they can negatively impact both an individual and the society (36). For an older adult, hospital readmissions in older persons are related to poor nutrition status, reduced health, physical dependence, decreased quality of life (37, 38), and increase in healthcare costs (39). It is of importance to test potential interventions which can reduce hospital readmissions (40). According to a recent systematic review by Lærum-Onsager et al. (2021), nutrition therapy in discharged patients resulted into a 16% lower risk of readmissions (10). Depending on the time point, our intervention resulted in a risk reduction (relative risk) of readmission between 21-88%, and its effects partly faded at later time points of the 18 months study period. This is not entirely unexpected considering the intervention period was six months, but the study period was 18 months. Lærum-Onsager et al. (2021) did not include LOS and not ER visits in their meta-analysis (10). We found significant effects of the nutrition intervention on LOS at all investigated time points, but the intervention did not affect ER visits.

Our intervention was intense and long and improved the participants' diet as well as their physical and mental health (20, 21), all of which can possibly explain the reduced readmissions in our study.

The age of the participants in our and the above-mentioned studies was similar (11-16), as was the number of medications and number of diseases (16). However, in our study, the control group had readmission rates (19% at 1 months and around 77% at 6 months according to Table 3) higher than reported in other studies (11, 14-16), which might indicate that home care assistance in Iceland is limited compared to other countries thus resulting into more frequent readmissions.

Mortality and need of long-term care residency

Besides hospital readmissions, the current study also investigated other important outcomes, i.e., risk of long-term care residence (NHPAA results) and mortality. The mortality rates were not significantly different between intervention and controls. This contrasts with findings from one meta-analysis which found a 37% mortality risk reduction based on the results from 13 intervention studies, comparable to the nutrition intervention described in our study (17). The mortality rate of 9.4% in our study was well within the range of mortality rates reported in the above-mentioned meta-analysis of 0.9 – 34.2%. Another systematic review and meta-analysis from the same study group (18) showed similar risk reductions and indicated clinical potential for multifaceted, individualized, high protein nutrition therapies.

Malnutrition has been associated with an increased risk of nursing home admission (19), but it is currently not known whether nutrition therapy in malnourished older adults can prevent nursing home admission. In our study, the percentage of positive NHPAA results, a tool that assesses the need for long-term care residence, in the control group seemed to be higher than in the intervention group although not statistically significant. Malnutrition can be linked to a higher risk of need for long term care due to its associations with, e.g., low physical function (41) and poor ADLs (42), low cognitive function (43) and increased depressive symptoms (44).

Finally, it is an important question to discuss how generalizable the results from this study are because the included study population presents only a fraction of the screened population.

The two main reasons for exclusion from study participation were 1) low cognitive function according to MMSE (n=181), and 2) being too sick or being discharged to other hospital units where we did not have permission to recruit (n=534). Low cognitive function as an exclusion criterion is used in study design and is required by the ethical committee to protect the potential participant from an intervention which they cannot understand or follow. It is our opinion that in a real-life setting, our intervention would work independently from cognitive function if a care giver guided a participant with low cognitive function through the nutrition therapy. We also think that more vulnerable participants (exclusion reason 2) who were not discharged home but to another hospital ward might benefit from such intervention.

The dietary intervention in this study was conducted by the University of Iceland and demonstrated that nutrition therapy is beneficial for a wide array of outcomes in the investigated population of older adults at risk for malnutrition. The primary sector was not involved in this intervention; however, future involvement of the primary sector is considered of great importance for the aim of implementation of such intervention as standard care for older adults at risk for malnutrition.

Strengths and limitations

An apparent strength of the present study was that it was a randomised, controlled trial with a very low drop out and despite COVID-19 challenges during the end of the study a 100% delivery of the intended intervention to 52 of the 53 participants was achieved.

However, this study also has some limitations: in dietary intervention studies as this one, the participants cannot be blinded to the treatment given. The time length (six months), the intensity of the intervention (five nutrition therapy sessions delivered in the participant's home, three phone calls, and free home delivered food) and, importantly, the length of follow up made this study one of the most extensive studies in the field of nutrition therapy in older discharged older adults. It is however clear, that such intense study protocol comes at the cost of the number of participants that can be included in such intervention. Our study was designed and adequately powered for the detection of anthropometric differences between the groups (20, 21). As shown by our own study as well as by the study from Lindegaard Pedersen et al 2017 (11), large differences in incidences (considering a categorical outcome) are necessary to detect significant differences between two groups in a study with limited sample size. Thus, lack of statistical power might be an explanation why the current study failed to detect a significant difference between the groups in the NHPAA results.

Conclusion

This study shows that a six-month nutrition therapy in older Icelandic adults discharged home from hospital reduces hospital readmissions and shortens LOS at the hospital up to 18-months post-discharge but did not affect mortality, ER visits, or need of long-term care residence in this group.

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Conflict of interest: Blondal BS: no conflict of interest. Geirsdottir OG: no conflict of interest. Halldorsson TI: no conflict of interest. Beck AM: no conflict of interest. Jonsson PV: no conflict of interest. Ramel A: no conflict of interest.

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Ethical standards' declaration: This study complied with the current laws of Iceland in which it was conducted.

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