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Effectiveness of individual nutrition counselling for the prevention of undernutrition among elderly people living in depopulated areas: secondary analysis of a model project in Tsu city

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ABSTRACT

Objectives To examine the effectiveness of nutrition counselling (NC) in preventing undernutrition in elderly people living in depopulated areas.

Design Participants were elderly people aged at least 65 years living in a depopulated area. Participants completed self-administered questionnaires evaluating nutritional status, frailty and body composition at the start of the study, after a non-NC period (3-month control) and after an NC period (3-month intervention). During the NC period, participants attended monthly 1-hour NC sessions over 3 months. Sessions were conducted in three areas (A, B and C), and the schedule was staggered so that the NC period in one area was conducted simultaneously with the non-NC period of the next. All sessions within an area were attended by the same registered dietitian. Outcomes were assessed three times: before the non-NC period, after the non-NC period and after the NC period. The effects of NC were assessed by comparing the results between the non-NC and NC periods of all participants, using the Cochran-Mantel-Haenszel stratified test.

Outcome measures The primary outcome was undernutrition, as determined by the Mini Nutritional Assessment—Short Form. Secondary outcomes were Dietary Diversity Score (DVS), body weight and frailty. Body composition was also assessed.

Results Of 106 individuals who joined the project, 61 completed the project and were analysed. The NC in this study had no effect on the primary outcome. DVS in area A was significantly higher after the NC period than after the non-NC period (p=0.012). Frailty in area C was significantly lower after the NC period than after the non-NC period (p=0.025). NC had no significant effects on the other outcomes.

Conclusions NC improved food variety but did not improve nutritional status, frailty or body composition.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Undernutrition among elderly people is a global health problem, and those in depopulated areas are at especially high risk because of geographic difficulties. However, there are no reports on the effectiveness of nutrition interventions in preventing undernutrition among elderly people living in depopulated areas.

WHAT THIS STUDY ADDS

⇒ This is the first study to demonstrate the effectiveness of nutrition intervention in elderly people living in depopulated areas. Nutritional balance was improved by nutrition intervention, but frailty and body composition were not improved. The effectiveness of nutrition intervention in depopulated areas may be affected by geographical characteristics.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Prevention of undernutrition in elderly people is an important issue, especially in an ageing society. This study suggests that individual nutrition interventions might be effective in improving dietary diversity, although geographical factors might weaken the effectiveness of nutrition interventions on additional outcomes, including dietary status, frailty and body composition. Further studies should consider combining nutrition interventions with other interventions, such as meal delivery services, in order to prevent undernutrition in elderly people.

INTRODUCTION

Depopulation is a geographical challenge that favours the development of undernutrition.[1] For example, foods such as meat, vegetables and fruits are difficult to obtain in depopulated areas because there are no supermarkets within walking distance and transportation is scarce.[1 2] In addition, eating alone due to the declining birth rate and ageing population has been reported to be a factor in poor nutrition in depopulated areas.[3] Moreover, a food environment with limited access to food may increase the risk of chronic nutrition-related diseases.[4] As a

result, elderly people who are not self-sufficient[5] and who are unable to shop for food have poor eating habits and nutritional balance, leading to undernutrition and frailty with unintended weight loss.[6–8]

Frailty and undernutrition in elderly people are ameliorated by appropriate nutritional interventions.[9] Therefore, a programme to prevent undernutrition in community-dwelling elderly people in depopulated areas would be useful. Because nutritional interventions have little impact on bodily function in already severely undernourished individuals,[10–12] early detection and nutritional interventions are needed to prevent frailty-related undernutrition in elderly people living in depopulated areas.

Nutritional intervention methods for elderly people community dwellers include nutrition counselling (NC), meal delivery services and nutrition education, in addition to supplement distribution. NC is lifestyle-appropriate for elderly people living in the community and has been reported to be effective in improving undernutrition through self-care.[13] Meal delivery services reduce the risk of nutritional deficiencies and promote self-reliance.[14] Group nutrition education has been linked to improvements in body weight but not in activity.[15 16] In addition, interventions involving protein dietary supplements in elderly people reportedly fail to improve physical function.[17] However, these nutritional interventions have not been conducted in depopulated areas, where access to foods and social resources are limited. Because NC is lifestyle-appropriate and aims to improve health literacy in elderly people, NC seems most feasible in depopulated areas.

The purpose of the present study was to examine the effectiveness of NC in preventing undernutrition in elderly people living in depopulated areas. In this NC intervention, dieticians and public health nurses visited community centres in depopulated areas on a regular basis to provide individualised NC to elderly people.

METHODS

Study settings

The NC project 'Nutrition Patrol' was conducted by Tsu city, Mie prefecture, Japan. The study team received anonymised data from Tsu city. The first author (KO) participated in this project as a non-regular employee of Tsu city. The second author (SI), third author (HW) and last author (YTakemura) advised on the project implementation and planning. The study is a secondary analysis of data and was conducted as a project of Tsu city.

The administrative public health nurse in charge of the Tsu city project selected region M as the field of the project. Region M is a depopulated and remote area located southwest of Tsu city. The population of the target area in 2016 was 4285, and 2423 (56.5%) were aged 65 years or older. The main industries are agriculture, forestry and wood processing. Access to shops with daily necessities and groceries is limited because few restaurants or stores are within walking distance and the nearest supermarkets are about 40 km away. Access to medical care is poor, and general hospitals are at least 40 km away. Some areas have no clinics, and the clinics in other areas do not open every day.

Study procedure

The study period, comparison of target regions and study flow are shown in figure 1.

The target area was divided by public health nurses into three areas that were geographically close to region M. The three areas were designed for contrasting and overlapping the non-NC period (3-month control) and the NC period (3-month intervention). Participants took part in the measurement by selecting a desired date and venue within a month before and after the non-NC and NC periods. The time required for the measurement was 3 hours.

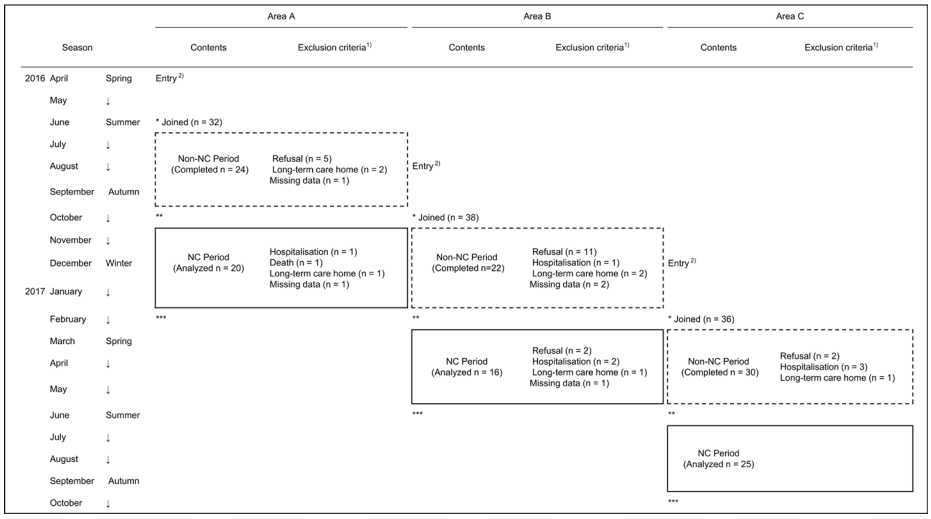

Figure 1 Outline of the study flow. 1) Exclusion criteria: haemodialysis, hospitalisation, need for nursing care and receipt of outpatient NC from a medical institution. 2) Entry: entry into the Mie Prefecture Tsu City Malnutrition Prevention Project 'Nutrition Patrol'. Assessment: *Pre, **Mid-term, ***Post-NC. NC, nutrition counselling.

Recruitment of participants

Eligible participants were community-dwelling elderly people aged 65 years or older. At an April 2016 meeting of representatives of the target areas, public health nurses and supervising dieticians explained the details of the 'Nutrition Patrol' initiative to prevent undernutrition. In addition, we distributed a guide to participant recruitment. Representatives from each region disseminated information to all households via a circular.

Applicants wishing to participate attended the NC prescreening date for their desired area. The following patients were excluded: dialysis patients, hospitalised patients, patients receiving nursing care and patients receiving outpatient NC in a medical institution.

NC details

Contents of the NC

The 'Nutrition Patrol' NC was planned by the Tsu City Administrative Health Nurse and Supervising Dietician, based on the Nutrition Care Process Framework.[18] NC was conducted individually in community centres in each area, once a month for 3 months. Participants chose the date, time and venue of their choice each month to attend a 1-hour NC session. All participants' NCs were attended by the same registered dietician (NC dietician).

Initially, the NC dietician provided participants with feedback on a survey conducted in the non-NC period and assistance in developing a self-directed nutritional care plan. Participants reported to the NC dietician on changes in activities of daily living, food intake and weight. In addition, the dieticians listened to participants talk about their diet-related lifestyles and helped the participants' goal setting of the nutrition care plan.

The content of the second and third NC sessions was the same, and support was provided to increase motivation to improve healthy eating habits. The NC dietician reviewed the participants' nutritional care plan progress, lifestyles and changes in weight and diet. If there were problems with eating habits that increased the risk of low nutrition, the NC dietician offered lifestyle-appropriate solutions. Participants judged the NC dietician's suggestions based on whether they were appropriate to solve the problem. For example, for participants who lost weight and ate less, the NC dietician provided specific education using books and pictures on how to prepare meat and other foods to increase energy and protein intake. For participants who could cook and shop for themselves, the NC dietician educated them on how to buy and use preprocessed and frozen foods that fit their lifestyles and how to shorten the time commitment. For participants with limited intake of vegetables, we educated them on how to achieve a healthy diet using familiar foods and seasonal vegetables. On the other hand, for elderly people who needed assistance with cooking and shopping, the participants' spouses, family members and helpers participated in the programme and were explained in detail, with consideration of shopping and cooking methods, the amount of food and the nutritional balance that would prevent undernutrition. In addition, participants whose risk of undernutrition was reduced were encouraged to share healthy eating tips with others.

Education of registered dieticians

The NC programme was managed by a public health nurse (NC public health nurse) and a registered dietician (supervising dietician) in charge of the target areas. Three NC dieticians were recruited to implement the NC. The requirement for recruitment was that they had at least 5 years of experience in the NC of elderly people in a hospital setting. The NC dietician attended one lecture given by an NC public health nurse and a supervising dietician. The lecture was held prior to the non-NC period in area A. The public health nurses explained the geographical characteristics of the target areas, the disease characteristics of the elderly people living in the target areas and the local food culture. On the first day of the NC in the target areas, the supervising dietician accompanied the NC dietician. The purpose was to assess and educate the NC dietician in relation to NC practices and beliefs. The survey was conducted using a self-administered questionnaire assessing basic characteristics (including activities of cooking, shopping and exercise) and the following items before and after the non-NC and NC periods.

Nutritional status

Assessment of undernutrition

Nutritional deficiencies were assessed using the Mini Nutritional Assessment—Short Form (MNA-SF),[19] which has high sensitivity and specificity for MNA[20] and has been widely used in frailty studies of community-dwelling elderly people.[21 22] The MNA-SF provides a comprehensive assessment of undernutrition in elderly people, including changes in food intake, activity range, body mass index (BMI) (kg/m^2), cognitive and mental status, and stress level on the Likert scale. The MNA-SF Score ranges between 0 and 14, and participants with an MNA-SF Score less than 11 were regarded as having undernutrition.

Dietary variety score evaluation

Using the Dietary Variety Score (DVS) evaluation method of Kumagai *et al*,[23] we examined the weekly intake of 10 food groups—seafood, meat, eggs, milk, soybeans and soy products, green and yellow vegetables, seaweed, potatoes, fruits, and oils—at four levels: daily, every 2 days, every 3 days and rarely. The number of food groups rated as being consumed daily was used as the DVS, and participants whose DVS was less than 4 were regarded as problematic.[24]

Evaluation of weight loss

Weight was measured to the first decimal place using a Digital Weight Scale (TANITA HD-661). The participants took off their shoes and jackets, and 0.5 kg of clothing weight was subtracted from the measurements from May to October and 1.0 kg from November to April. Participants

with weight loss exceeding 1 kg were regarded as exhibiting weight loss.

Frailty evaluation

Frailty was assessed using the Kihon Checklist (KCL), which was validated by Satake *et al*.[25 26] The KCL comprises 25 yes/no questions on motor function, oral function, poor nutrition, depression and cognitive function. The total KCL Score ranges from 0 to 25 points and represents overall daily functioning, with higher scores indicating greater frailty. Participants with a KCL Score of 3 or more were judged to have frailty.

Body composition assessment

Body mass index

To obtain the BMI, participants' weight (kg) was divided by the square of their height (m) to the first decimal place. Height was measured to the first decimal place using a standard height metre (Sanwa Seisakusho). Measurements were taken during the baseline evaluation, and because the change in height was minimal, the same values were used for subsequent evaluations.

Body composition

The following items were measured as body composition indicators: body fat mass (BFM) (kg), lean body mass (LBM) (kg), skeletal muscle index (SMI) (kg/m^2) and basal metabolic rate (BMR) (kcal). Body composition was measured and calculated with the bioelectrical impedance method using InBody S10, a high-precision body composition analyser (In Body).

Consent to participate

Secondary data from the Tsu City Municipal Project in Mie prefecture were used for the analysis. Six months after the completion of the project, all information related to the identification of individuals, such as names, areas covered by the project, addresses, dates of birth and telephone numbers, were deleted from the existing data in accordance with the handling of personal information by Tsu city, and the data were provided in batch in a form in which personal information could not be identified.

Analysis methods

As part of their advice to the project, the members of the research team calculated the sample size, based on a statistical power of 80% and a two-sided level of significance of 5%. The required sample size for each period was calculated to be 18 persons, and 20% and 40% of participants were estimated to escape the undernutrition state in the non-NC and NC periods, respectively. With an estimated participant attrition rate of 30%, a total of 24 participants were needed.

The primary outcome was the MNA-SF, and the secondary outcomes were the DVS, weight loss, KCL and body composition. Participants with any missing values and those who deviated from the eligibility criteria during the non-NC or NC periods were omitted from the analysis listwise. Continuous and count variables are summarised with median and IQRs and were analysed with non-parametric tests. Categorical and binary variables are summarised with the number of responses and its percentage and were analysed with non-parametric tests. We analysed all participants and women alone because there were very few male participants. The Cochran-Mantel-Haenszel stratified test was conducted to analyse the MNA-SF, DVS and KCL. The strata were the presence of a problematic value in each index before the period. The χ^2 test was used to analyse weight loss. For body composition, changes within each period were calculated, and the Mann-Whitney U test was conducted. A significant probability less than 5% (two tailed) was set as statistically significant. Statistical analyses were performed using IBM SPSS V.22.0 for Windows.

RESULTS

The flow of this study is shown in figure 1. In total, 106 participants joined the project: 61 completed the project and 61 were analysed (area A, n=20; area B, n=16; area C, n=25). Participants' characteristics are shown in table 1. Many participants were older than 75 years of age. Moreover, most participants were women, and there were no men in area C. The participants did not habitually eat meat, 40% ate alone and 40% took more than 5 different medications Additionally, half of the participants did not exercise regularly and were only able to walk slowly compared with people of the same age.

Effectiveness of NC in ameliorating undernutrition

The NC in this study had no effect on the primary outcome, undernutrition, as assessed by the MNA-SF (table 2). The DVS in area A was significantly higher in the NC period than in the non-NC period (p=0.012). The number of frail elderly people in area B was significantly higher in the NC period than in the non-NC period (p=0.040). NC of women (n=51) had no effect on the primary outcome, undernutrition, as assessed by the MNA-SF (table 3). The number of frail elderly women in area B was significantly higher in the NC period than in the non-NC period (p=0.040). The number of frail elderly people in area C was significantly lower in the NC period than in the non-NC period (p=0.025). For the other items, there were no significant effects of NC.

Comparison of body composition between groups

Body composition values were significantly lower in the NC period than in the non-NC period in terms of LBM (kg) (p=0.040), SMI (kg/m^2) (p<0.001) and BMR (kcal) (p=0.035) (table 4). The body composition values of women (n=51) were significantly lower in the NC period than in the non-NC period in terms of BFM (kg) (p=0.044), LBM (kg) (p=0.008), SMI (kg/m^2) (p<0.001) and BMR (kcal) (p=0.007). SMI (kg/m^2) was significantly lower in area C in the NC period than in the non-NC period (p=0.018) (table 5).

Table 1 Basic characteristics of the target population

	Total (n=61)	Area A (n=20) June†	Area B (n=16) October†	Area C (n=25) February†	P value*	
	n (%)	n (%)	n (%)	n (%)	By area	By sex
Male sex	10 (16.4)	8 (40.0)	2 (12.5)	0 (0.0)	0.001	—
Older than 75 years old	49 (80.3)	15 (75.0)	11 (68.8)	23 (92.0)	0.144	0.400
Eating alone at every meal	25 (41.0)	8 (40.0)	7 (43.8)	10 (40.0)	0.966	0.140
Habitual smoking	2 (3.3)	2 (10.0)	0 (0.0)	0 (0.0)	0.120	0.001
Drinks alcohol daily	7 (11.5)	4 (20.0)	2 (12.5)	1 (4.0)	0.244	<0.001
Dietary Variety Score (DVS)						
Seafood	31 (50.8)	10 (50.0)	7 (43.8)	14 (56.0)	0.947	0.069
Meat	9 (14.8)	1 (5.0)	2 (12.5)	6 (24.0)	0.064	0.503
Eggs	28 (45.9)	12 (60.0)	6 (37.5)	10 (40.0)	0.471	0.084
Milk and dairy products	32 (52.5)	9 (45.0)	10 (62.5)	13 (52.0)	0.227	0.463
Soybeans and soy products	40 (65.69	14 (70.0)	8 (50.0)	18 (72.0)	0.460	0.061
Green and yellow vegetables	41 (67.2)	13 (65.0)	10 (62.5)	18 (72.0)	0.240	0.572
Seaweed	34 (55.7)	11 (55.0)	7 (43.8)	16 (64.0)	0.323	0.355
Potatoes	22 (36.1)	5 (25.0)	7 (43.8)	10 (40.0)	0.921	0.658
Fruits	33 (54.1)	10 (50.0)	9 (56.3)	14 (56.0)	0.554	0.491
Fats and oils	19 (31.1)	8 (40.0)	3 (18.8)	8 (32.0)	0.355	0.737
State of health						
Decreased appetite	19 (31.1)	5 (25.0)	5 (31.3)	9 (36.0)	0.731	0.485
Weight loss of 2 or 3 kg in 6 months	13 (21.3)	3 (15.0)	5 (31.3)	5 (20.0)	0.486	0.463
Less than one bowel movement daily	27 (44.3)	10 (50.0)	5 (31.3)	12 (48.0)	0.471	0.273
Pain in three or more places	9 (14.8)	4 (20.0)	2 (12.5)	3 (12.0)	0.721	0.643
Has regular medical checkups	54 (88.5)	19 (95.0)	13 (81.3)	22 (88.0)	0.435	0.355
Taking more than five medications	26 (42.6)	8 (40.0)	7 (43.8)	11 (44.0)	0.959	0.854
Diabetes mellitus	6 (9.8)	2 (10.0)	1 (6.3)	3 (12.0)	0.833	0.985
Hypertensive disease	43 (70.5)	13 (65.0)	10 (62.5)	20 (80.0)	0.383	0.120
Dyslipidaemia	12 (19.7)	2 (10.0)	2 (12.5)	8 (32.0)	0.128	0.400
Heart disease	7 (11.5)	4 (20.0)	1 (6.3)	2 (8.0)	0.340	0.355
Kidney disease	1 (1.6)	0 (0.0)	0 (0.0)	1 (4.0)	0.481	0.655
Anaemia	13 (21.3)	4 (20.0)	4 (25.0)	5 (20.0)	0.916	0.912
Do not feel healthy	10 (16.4)	1 (5.0)	3 (18.8)	6 (24.0)	0.222	0.126
Subjective fatigue	25 (41.0)	8 (40.0)	6 (37.5)	11 (44.0)	0.913	0.945
Activities of daily living and exercise status						
Do not cook for themselves	11 (18.0)	6 (30.0)	3 (18.8)	2 (8.0)	0.162	<0.001
Do not shop for daily necessities by themselves	1 (1.6)	1 (5.0)	0 (0.0)	0 (0.0)	0.353	0.023
No going out once a week	8 (13.1)	4 (20.0)	2 (12.5)	2 (8.0)	0.494	0.179
No activity for more than 1 hour a day	18 (29.5)	7 (35.0)	4 (25.0)	7 (28.0)	0.789	0.970
More than 1 fall in 6 months	11 (18.0)	3 (15.0)	1 (6.3)	7 (28.0)	0.191	0.105
Walking speed is slower than the same age group	29 (47.5)	9 (45.0)	6 (37.5)	14 (56.0)	0.493	0.056
Not in the habit of exercising	29 (47.5)	14 (70.0)	4 (25.0)	11 (44.0)	0.024	0.865

*P value: χ^2 test, but Fisher test for expected values≤5, p value<0.05.
†Pre-evaluation month.

Table 2 Effect of the NC intervention according to the post-NC evaluation of the area (n)

	NC (n=61)					NC by area C (n=25)					NC by area A (n=20)					NC by area B (n=16)				
	Non-NC (n=61)					Non-NC by area A (n=20)					Non-NC by area B (n=16)					Non-NC by area C (n=25)				
	Risk before	Intervention	Risk after At	Risk after Not	P value*	Risk before	Intervention	Risk after At	Risk after Not	P value*	Risk before	Intervention	Risk after At	Risk after Not	P value*	Risk before	Intervention	Risk after At	Risk after Not	P value*
Undernutrition†	At	NC	9	7	0.447	At	NC	5	1	0.972	At	NC	1	4	0.165	At	NC	3	2	0.931
		Cont	11	7			Cont	3	2			Cont	3	3			Cont	5	2	
	Not	NC	3	42		Not	NC	1	18		Not	NC	1	14		Not	NC	1	10	
		Cont	5	38			Cont	2	13			Cont	2	8			Cont	1	17	
DVS‡	At	NC	13	12	0.057	At	NC	8	2	0.863	At	NC	2	4	0.232	At	NC	3	6	0.170
		Cont	19	11			Cont	4	4			Cont	7	4			Cont	8	3	
	Not	NC	1	35		Not	NC	0	15		Not	NC	0	14	0.012	Not	NC	1	6	
		Cont	6	25			Cont	2	10			Cont	2	3			Cont	2	12	
Weight loss§		NC	14	47	0.658		NC	7	18	0.045		NC	1	19	0.871		NC	6	10	0.873
		Cont	12	49			Cont	1	19			Cont	1	15			Cont	10	15	
Frailty¶	At	NC	23	6	0.955	At	NC	14	2	0.084	At	NC	6	0	0.940	At	NC	3	4	0.040
		Cont	24	7			Cont	5	5			Cont	7	0			Cont	12	2	
	Not	NC	5	27		Not	NC	1	8		Not	NC	3	11		Not	NC	1	8	0.194
		Cont	5	25			Cont	1	9			Cont	0	9			Cont	4	7	

*P value: the preventive effect of undernutrition, DVS, and frailty (changes in non-NC phase and NC phase strata) was tested with the Cochran-Mantel-Haenszel test for Breslow-Day ($p>0.05$). Breslow-Day ($p<0.05$) and weight loss were evaluated with the χ^2 test.
†Undernutrition: not at risk, MNA≥12 points; at risk, MNA≤11 points.
‡Dietary Variety Score (DVS): not at risk, DVS≥5 points; at risk, DVS≤4 points.
§Weight loss: not at risk, weight<1 kg (changes between pre evaluation and post evaluation); at risk, weight≥1 kg (changes between pre evaluation and post evaluation).
¶Frailty: not at risk, KCL Score<4 points; at risk: KCL Score≥4 points.
At, at risk; Cont, control; DVS, dietary diversity score; KCL, Kihon Checklist; MNA, Mini Nutritional Assessment; NC, nutrition counselling; Not, not at risk.

Table 3 Effect of the NC intervention according to the post-NC evaluation in women by area (n)

	NC (n=51)					NC by area C (n=25)					NC by area A (n=12)					NC by area B (n=14)				
	Non-NC (n=51)					Non-NC by area A (n=12)					Non-NC by area B (n=14)					Non-NC by area C (n=25)				
	Risk before	Intervention	Risk after At	Risk after Not	P value*	Risk before	Intervention	Risk after At	Risk after Not	P value*	Risk before	Intervention	Risk after At	Risk after Not	P value*	Risk before	Intervention	Risk after At	Risk after Not	P value*
Undernutrition†	At	NC	8	5	0.579	At	NC	5	1	0.537	At	NC	0	2	0.147	At	NC	3	2	1.000
		Cont	9	6			Cont	1	2			Cont	3	2			Cont	5	2	
	Not	NC	2	36		Not	NC	1	18		Not	NC	0	10	0.115	Not	NC	1	8	
		Cont	4	32			Cont	1	8			Cont	2	7			Cont	1	17	
DVS‡	At	NC	12	8	0.318	At	NC	8	2	0.278	At	NC	1	1	0.124	At	NC	3	5	0.262
		Cont	15	11			Cont	1	4			Cont	6	4			Cont	8	3	
	Not	NC	1	30		Not	NC	0	15		Not	NC	0	10		Not	NC	1	5	
		Cont	5	20			Cont	1	6			Cont	2	2			Cont	2	12	
Weight loss§		NC	11	40	0.813		NC	7	18	0.174		NC	0	12	0.345		NC	4	10	0.475
		Cont	12	39			Cont	1	11			Cont	1	13			Cont	10	15	
Frailty¶	At	NC	20	6	0.483	At	NC	14	2	0.025	At	NC	0	3	0.391	At	NC	3	4	0.040
		Cont	22	6			Cont	3	4			Cont	0	7			Cont	12	2	
	Not	NC	2	23		Not	NC	1	8	0.439	Not	NC	1	8		Not	NC	0	7	0.070
		Cont	4	19			Cont	0	5			Cont	0	7			Cont	4	7	

*P value: the preventive effect of undernutrition, DVS and frailty (changes in non-NC phase and NC phase strata) was tested with the Cochran-Mantel-Haenszel test for Breslow-Day ($p>0.05$). Breslow-Day ($p<0.05$) and weight loss were evaluated with the χ^2 test.
†Undernutrition: not at risk, MNA≥12 points; at risk, MNA≤11 points.
‡Dietary variety score (DVS): not at risk, DVS≥5 points; at risk, DVS≤4 points.
§Weight loss: not at risk, weight<1 kg (changes between pre evaluation and post evaluation); at risk, weight≥1 kg (changes between pre evaluation and post evaluation).
¶Frailty: not at risk, Kihon Checklist (KCL) Score<4 points; at risk: KCL Score≥4 points.
At, at risk; Cont, control; DVS, dietary diversity score; KCL, Kihon Checklist; MNA, Mini Nutritional Assessment; NC, nutrition counselling; Not, not at risk.

Table 4 Group differences in the body composition changes of participants between the non-NC and NC phases

					Area A (July to September 2016), area C (July to September 2017)			Area B and area A (November 2016 to January 2017)			Area C and area B (March to May 2017)		
	Δ*	Non-NC (n=61)	NC (n=61)	P value†	Non-NC_Area A (n=20)	NC_Area C (n=25)	P value†	Non-NC_Area B (n=16)	NC_Area A (n=20)	P value†	Non-NC_Area C (n=25)	NC_Area B (n=16)	P value†
Height (cm)	Pre	147.0 (143.0, 152.0)	147.0 (143.0, 152.0)	1.000	152.1 (145.9, 159.0)	144.0 (140.2, 148.7)	0.003	150.7 (147.5, 153.7)	152.1 (145.8, 159.0)	0.750	144.0 (140.2, 148.7)	150.7 (147.5, 153.7)	0.001
BW (kg)	Pre	48.0 (43.0, 56.0)	48.9 (43.2, 56.5)		48.7 (45.7, 57.3)	47.7 (40.7, 55.3)		52.6 (43.0, 61.2)	49.9 (45.5, 57.3)		48.5 (41.8, 54.8)	54.3 (44.6, 62.5)	
	Post	48.9 (43.2, 56.5)	47.8 (42.8, 56.5)		49.9 (45.5, 57.3)	46.8 (40.0, 54.5)		54.3 (44.6, 62.5)	50.5 (46.2, 57.4)		47.7 (40.7, 55.3)	54.3 (43.2, 61.6)	
	Δ	0.0 (–0.7, 0.55)	–0.2 (–0.9, 0.7)	0.634	–0.2 (–0.5, 0.3)	–0.4 (–1.25, 0.0)	0.112	0.5 (0.0, 1.9)	0.8 (–0.4, 1.7)	0.937	–0.2 (–1.3, 0.3)	–0.4 (–1.6, 0.4)	0.947
BMI (kg/m^2)	Pre	22.5 (20.1, 25.2)	22.6 (20.0, 25.2)		22.3 (20.2, 23.5)	23.1 (20.3, 25.4)		23.2 (19.1, 24.8)	22.2 (20.2, 23.5)		23.1 (20.3, 25.6)	24.2 (19.7, 25.2)	
	Post	22.6 (20.0, 25.2)	22.7 (20.1, 25.1)		22.2 (20.2, 23.5)	22.8 (19.9, 25.3)		24.2 (19.7, 25.2)	22.5 (20.2, 24.0)		23.1 (20.3, 25.4)	23.6 (19.3, 25.0)	
	Δ	0.0 (–0.03, 0.3)	–0.1 (–0.5, 0.3)	0.607	–0.1 (–0.2, 0.1)	–0.2 (–0.7, 0.0)	0.120	0.2 (0.0, 0.8)	0.3 (–0.2, 0.9)	0.949	–0.1 (–0.6, 0.1)	–0.2 (–0.7, 0.2)	0.989
BFM (kg)	Pre	15.1 (11.6, 20.1)	14.6 (10.9, 18.7)		12.9 (9.4, 15.1)	16.4 (11.0, 18.8)		16.0 (10.8, 20.0)	13.5 (10.2, 15.3)		17.3 (12.3, 20.6)	17.1 (11.4, 19.6)	
	Post	14.6 (10.9, 18.7)	15.4 (10.9, 18.6)		13.5 (10.2, 15.3)	15.8 (11.1, 18.7)		17.1 (11.4, 19.6)	14.2 (11.1, 16.4)		16.4 (11.0, 18.8)	15.2 (9.4, 19.1)	
	Δ	–0.6 (–1.4, 0.7)	0.0 (–1.1, 1.1)	0.141	–0.5 (–0.8, 1.0)	–0.2 (–0.9, 0.9)	0.918	0.9 (–0.2, 1.8)	0.6 (0.2, 2.1)	0.836	–1.2 (–1.6,–0.6)	–1.3 (–1.7, 1.0)	0.669
LBM (kg)	Pre	33.7 (29.6, 36.6)	34.4 (29.8, 37.3)		37.2 (33.8, 42.9)	32.2 (28.9, 36.0)		36.3 (31.7, 39.3)	37.3 (33.8, 42.1)		31.5 (28.9, 35.6)	36.5 (33.0, 40.0)	
	Post	34.4 (29.8, 37.3)	33.5 (29.8, 37.2)		37.3 (33.8, 42.1)	31.8 (29.0, 36.0)		36.5 (33.0, 40.0)	37.3 (33.6, 42.9)		32.2 (28.9, 36.0)	36.3 (32.9, 40.5)	
	Δ	0.4 (–0.4, 1.2)	–0.2 (–1.1, 0.7)	0.040	0.4 (–1.0, 0.8)	–0.5 (–1.1, 0.3)	0.150	0.4 (–1.1, 1.4)	0.1 (–1.3, 1.0)	0.417	0.6 (–0.1, 1.5)	0.4 (–0.4, 1.1)	0.495
SMI (kg/m^2)	Pre	5.8 (5.2, 6.3)	5.8 (5.5, 6.4)		6.1 (5.8, 7.1)	5.8 (5.4, 6.1)		6.3 (5.2, 7.1)	6.3 (5.8, 7.1)		5.6 (5.2, 6.0)	6.4 (5.3, 7.0)	
	Post	5.8 (5.5, 6.4)	5.8 (5.3, 6.5)		6.3 (5.8, 7.1)	5.7 (5.2, 6.2)		6.4 (5.3, 7.0)	6.0 (5.7, 7.0)		5.8 (5.4, 6.1)	6.4 (5.6, 7.2)	
	Δ	0.1 (0.0, 0.3)	–0.1 (–0.2, 0.1)	<0.001	0.1 (0.0, 0.3)	–0.1 (–0.2, 0.1)	0.018	0.1 (–0.1, 0.3)	–0.1 (–0.4, 0.0)	0.048	0.2 (0.0, 0.3)	0.0 (–0.1, 0.2)	0.128
BMR (kcal)	Pre	1099 (1009, 1162)	1113 (1013, 1175)		1174 (1100, 1295)	1067 (993, 1148)		1154 (1056, 1219)	1175 (1100, 1279)		1050 (993, 1139)	1158 (1082, 1234)	
	Post	1113 (1013, 1175)	1094 (1015, 1174)		1175 (1100, 1279)	1057 (997, 1148)		1158 (1082, 1234)	1175 (1095, 1298)		1067 (993, 1148)	1154 (1081, 1245)	
	Δ	10 (–10, 26)	–3 (–23, 17)	0.035	10 (–22.75, 17)	–12 (–23.5, 4.5)	0.140	8 (–24, 31)	2 (–27, 21)	0.440	13 (0, 32)	9 (–9, 23)	0.479

Median (25th to 75th percentile).
*Changes between pre evaluation and post evaluation.
†P value was calculated using the Mann-Whitney's U test. P<0.05.
BFW, body fat mass; BMI, body mass index; BMR, basal metabolic rate; BW, body weight; LBM, lean body mass; NC, nutrition counselling; SMI, skeletal muscle index.

Table 5 Group differences in the body composition changes of women between the non-NC and NC phases

					Area A (July to September 2016), area C (July to September 2017)			Area B and area A (November 2016 to January 2017)			Area C and area B (March to May 2017)		
	Δ*	Non-NC (n=51)	NC (n=51)	P value†	Non-NC_Area A (n=12)	NC_Area C (n=25)	P value†	Non-NC_Area B (n=14)	NC_Area A (n=12)	P value†	Non-NC_Area C (n=25)	NC_Area B (n=14)	P value†
Height (cm)	Pre	147.0 (143.0, 152.0)	147.0 (143.0, 152.0)	1.000	147.3 (144.0, 155.5)	144.0 (140.2, 148.7)	0.095	150.3 (146.8, 152.7)	147.3 (144.0, 155.5)	0.777	144.0 (140.2, 148.7)	150.3 (146.8, 152.7)	0.003
BW (kg)	Pre	48.0 (43.0, 56.0)	48.9 (43.2, 56.5)		47.9 (45.1, 51.1)	47.7 (40.7, 55.3)		52.0 (40.8, 60.9)	48.3 (45.1, 53.4)		48.5 (41.8, 54.8)	51.9 (42.3, 62.5)	
	Post	48.9 (43.2, 56.5)	47.8 (42.8, 56.5)		48.3 (45.1, 53.4)	46.8 (40.0, 54.5)		51.9 (42.3, 62.5)	47.7 (46.2, 55.7)		47.7 (40.7, 55.3)	52.0 (41.1, 60.7)	
	Δ	0.0 (−0.9, 0.5)	−0.2 (−0.8, 0.7)	0.807	−0.1 (−0.7, 0.6)	−0.4 (−1.3, 0.0)	0.177	0.4 (−0.1, 1.4)	0.9 (0.2, 1.5)	0.471	−0.2 (−1.3, 0.3)	−0.3 (−1.1, 0.7)	0.528
BMI (kg/m^2)	Pre	22.5 (20.1, 25.2)	22.6 (20.0, 25.2)		21.9 (19.7, 23.6)	23.1 (20.3, 25.4)		23.2 (18.3, 25.3)	22.0 (20.0, 23.3)		23.1 (20.3, 25.6)	23.4 (19.0, 25.6)	
	Post	22.6 (20.0, 25.2)	22.7 (20.1, 25.1)		22.0 (20.0, 23.3)	22.8 (19.9, 25.3)		23.4 (19.0, 25.6)	22.2 (20.2, 23.8)		23.1 (20.3, 25.4)	23.3 (18.5, 25.6)	
	Δ	0.0 (−0.4, 0.2)	−0.1 (−0.4, 0.3)	0.730	−0.1 (−0.3, 0.3)	−0.2 (−0.7, 0.0)	0.188	0.2 (0.0, 0.6)	0.4 (0.1, 0.8)	0.410	−0.1 (−0.6, 0.1)	−0.1 (−0.5, 0.3)	0.568
BFM (kg)	Pre	15.1 (11.6, 20.1)	14.6 (10.9, 18.7)		13.6 (10.2, 15.2)	16.4 (11.0, 18.8)		16.7 (10.4, 20.8)	13.5 (11.0, 15.7)		17.3 (12.3, 20.6)	16.6 (10.8, 20.9)	
	Post	14.6 (10.9, 18.7)	15.4 (10.9, 18.6)		13.5 (11.0, 15.7)	15.8 (11.1, 18.7)		16.6 (10.8, 20.9)	14.9 (11.3, 16.7)		16.4 (11.0, 18.8)	15.2 (9.3, 20.0)	
	Δ	−0.7 (−1.5, 0.5)	−0.1 (−1.0, 1.1)	0.044	−0.5 (−0.8, 0.8)	−0.2 (−0.9, 0.9)	0.820	0.6 (−0.7, 1.4)	0.8 (0.2, 2.3)	0.303	−1.2 (−1.6,−0.6)	−1.1 (−1.6, 1.5)	0.326
LBM (kg)	Pre	33.7 (29.6, 36.6)	34.4 (29.8, 37.3)		34.3 (31.7, 37.7)	32.2 (28.9, 36.0)		35.9 (30.4, 38.9)	35.1 (32.6, 38.0)		31.5 (28.9, 35.6)	35.7 (31.6, 39.6)	
	Post	34.4 (29.8, 37.3)	33.5 (29.8, 37.2)		35.1 (32.6, 38.0)	31.8 (29.0, 36.0)		35.7 (31.6, 39.6)	34.2 (31.1, 38.2)		32.2 (28.9, 36.0)	35.4 (31.9, 40.0)	
	Δ	0.5 (−0.3, 1.2)	−0.3 (−1.1, 0.6)	0.008	0.5 (−0.4, 1.0)	−0.5 (−1.1, 0.3)	0.038	0.4 (−1.0, 0.8)	−0.3 (−1.3, 0.9)	0.410	0.6 (−0.1, 1.5)	0.4 (−0.7, 1.0)	0.404
SMI (kg/m^2)	Pre	5.77 (5.2, 6.3)	5.85 (5.5, 6.4)		5.9 (5.5, 6.2)	5.8 (5.4, 6.1)		6.3 (5.0, 6.9)	5.9 (5.7, 6.4)		5.6 (5.2, 6.0)	6.3 (5.1, 7.0)	
	Post	5.85 (5.5, 6.4)	5.84 (5.3, 6.5)		5.9 (5.7, 6.4)	5.7 (5.2, 6.2)		6.3 (5.1, 7.0)	5.8 (5.3, 6.4)		5.8 (5.4, 6.1)	6.3 (5.4, 7.0)	
	Δ	0.1 (0.0, 0.3)	−0.1 (−0.2, 0.1)	0.000	0.2 (0.0, 0.3)	−0.1 (−0.2, 0.1)	0.005	0.0 (−0.1, 0.3)	−0.2 (−0.4, 0.0)	0.090	0.2 (0.0, 0.3)	0.0 (−0.1, 0.2)	0.095
BMR (kcal)	Pre	1099 (1009, 1162)	1113 (1013, 1175)		1111 (1053, 1186)	1067 (993, 1148)		1145 (1028, 1210)	1129 (1074, 1191)		1050 (993, 1139)	1140 (1053, 1226)	
	Post	1113 (1013, 1175)	1094 (1015, 1174)		1129 (1074, 1191)	1057 (997, 1148)		1140 (1053, 1226)	1109 (1042, 1194)		1067 (993, 1148)	1135 (1058, 1235)	
	Δ	10 (−5, 27)	−7 (−24, 13)	0.007	10 (−10, 23)	−12 (−24, 5)	0.038	8 (−27, 28)	−7 (−27, 20)	0.456	13 (0, 32)	9 (−14, 23)	0.388

Median (25th to 75th percentile).
*Changes between pre evaluation and post evaluation.
†P value was calculated using the Mann-Whitney U test. P<0.05.
BFM, body fat mass; BMI, body mass index; BMR, basal metabolic rate; BW, body weight; LBW, lean body mass; NC, nutrition counselling; SMI, skeletal muscle index.

DISCUSSION

This is the first study to clarify the effectiveness of NC interventions in a project to prevent undernutrition in elderly people living in depopulated areas in Japan. Our results showed that NC was not effective in improving undernutrition and body weight. On the other hand, NC did somewhat improve DVS and frailty. However, some body composition values were worse after the NC.

Effects on undernutrition risks

In this study of elderly people living in depopulated areas, NC was not effective in ameliorating the risk of undernutrition. As detailed below, our NC intervention improved DVS but not body composition or frailty, in line with the reports by Kawabata *et al*.[15 16] In frail elderly people, the effects of nutritional interventions are more limited. Therefore, the addition of some other related interventions might be effective, such as exercise[27] or a home delivery service for meals.[14 28] However, there are no social resources in this study area for food delivery service projects.

Furthermore, the MNA-SF, used to assess low nutrition and weight in this study, is a comprehensive assessment of diet and activity, dementia, BMI and weight.[19] Based on our results, the risk of undernutrition among community-dwelling elderly people assessed by the MNA-SF may not have been improved. MNA-SF-based studies comprehensively evaluate the process of improving frailty. Therefore, it can be inferred that, unless all frailty processes are improved, undernutrition will not improve.

Effects on DVS

In this study, only area A showed a significant improvement in DVS. On the other hand, the trends for participants in all areas and area B appear to be consistent with those of area A, although not significantly so. This finding supports previous reports that lifestyle nutrition education improved DVS in urban areas.[15 29]

The trend in area C was the opposite of this, but this may be due to the geographical characteristics of area C. Area C is the furthest region from urban areas, is mountainous and has poor transportation accessibility. In addition, although most of the participants in areas A and B were engaged in agriculture, none of the participants in area C had a self-sufficient environment and they were experiencing increased food insecurity.[30] Therefore, even if the participants in area C wanted to follow the advice given by the NC, they might not have been able to change their dietary behaviour due to the geographical environment of area C. These results suggest that NC may effectively improve the dietary habits of residents in depopulated areas.

Effects on frailty

In this study, only area B showed a significant improvement in frailty. Meanwhile, areas A and C exhibited disimprovements. Frailty is associated with undernutrition, and increased energy and protein content improve body composition when combined with exercise.[31 32] However, few participants in this study ate meat daily. Moreover, fewer participants in areas A and C had exercise habits compared with those in area B. The NC intervention in this study did not involve any exercise intervention. These results show that the effects of NC on frailty varied from area to area.

Moreover, in terms of weight and skeletal weight, the participants worsened overall, with area B remaining unchanged and areas A and C worsening. Thus, it is difficult to say that NC improves frailty and physique in elderly people in depopulated areas. Accordingly, the results supported previous findings[31 32] that a nutritional intervention alone in elderly people in depopulated areas is insufficient to improve frailty and body composition. The nutrition intervention in this study improved DVS after 3 months of NC intervention by a dietitian, but it did not improve body composition or frailty, nor did it reduce the risk of undernutrition as assessed by the MNA-SF. Neither studies involving nutrition intervention alone for 12 weeks nor those involving 2 years of supplemental nutrition intervention alone showed any improvement.[33] However, a nutrition intervention involving three delivered meals and one snack per day for 6 months was found to improve the MNA-SF Score of participants.[14]

A combined programme of nutritional intervention involving exercise, oral care education, nutritional supplements and nutrition education for 3 or 6 months[34 35] was found to improve frailty, DVS and body weight. This study's target area was a village in a mountainous region,[5] with no supermarkets nearby and few local stores, making it difficult to obtain protein-rich foods. Thus, people living in this area are likely at high risk of undernutrition.[6–8]

Therefore, to realise nutritional improvement in this study, a combined programme of NC and exercise for more than 3 months or a nutrition intervention involving a food delivery service for more than 6 months may be needed, considering the limited access to food. In addition, there were 45 dropouts (43%) in this study, and the main reason for which was the busy farming season. The target area is rural, and the intervention period coincided with the farming season. Therefore, the NC intervention in this study should be changed to a combined programme that includes an exercise intervention lasting longer than 3 months, takes place outside the busy farming season and takes into account access to food.

Few men participated in this study. This is consistent with previous studies on nutritional interventions in community-dwelling elderly people.[32 36 37] Elderly men in the community may be reluctant to participate in community-based nutrition programmes such as the one in this study. However, some of the male participants voluntarily organised and conducted a cooking class for men after the NC in this project. This suggests that some elderly men in the community might be able to promote social resources for undernutrition prevention by participating in nutrition activities conducted in the community.

Limitations of the study

This research has some limitations. First, the representability of this study might be limited. The study was limited

to those who could travel independently and on foot. Also, many residents were unable to participate during the busy farming season. Finally, interprofessional collaboration with general practitioners might be needed because some of participants were medically dependent.

CONCLUSIONS

NC improved food variety but did not improve nutritional status, frailty or body composition. Further studies may be needed with the following technical improvements: a reduction in participant bias, improved methods for undernutrition assessment and a longer NC duration.

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