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Effects of exercise and nutrition supplementation in community-dwelling older Chinese people with sarcopenia: a randomized controlled trial

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Abstract

Background: Limited trials examining the effect of exercise and nutrition supplementation in older people with sarcopenia are available.
Objectives: to assess the impact of resistance exercise program targeting muscle strength and power with and without nutrition supplementation on gait speed, body composition, physical function and quality of life.
Methods: this trial randomized 113 community-dwelling older Chinese adults aged ≥65 and with sarcopenia defined using the Asian Criteria into one of the three groups: exercise program alone, combined-exercise program and nutrition supplement or waitlist control. The exercise program consisted of 90-min group training twice weekly and one-home session weekly for 12 weeks. Participants in the combined group were additionally asked to consume nutrition supplement twice daily for 12 weeks. Both groups were encouraged to keep home exercise after intervention period for another 12 weeks to detect sustained effect. The primary outcome was gait speed.
Results: at 12 and 24 weeks, gait speed did not differ significantly between groups. Significant improvement in leg extension, and five-chair stand test occurred in both intervention groups that persisted to 24 weeks. Physical Activity Scale for the Elderly improved in both intervention groups that persisted until 24 weeks only in the combined group. Lower limb muscle and appendicular skeletal muscle mass increased significantly in the combined group but the increase was not sustained to 24 weeks.
Conclusion: the exercise program with and without nutrition supplementation had no significant effect on the primary outcome of gait speed but improved the secondary outcomes of strength and the five-chair stand test in community-dwelling Chinese sarcopenic older adults.
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Keywords

sarcopenia, exercise, nutrition, older people

Key points

- The exercise program with and without nutrition had no significant effect on the primary outcome of gait speed.
- The exercise program with and without nutrition improved the secondary outcomes of muscle strength and the five-chair stand test.
- The beneficial effect of exercise program extended to 12 weeks after cessation of the intervention.
- Nutrition supplement had additive effect on muscle mass but not on physical function, only during the intervention period.

Introduction

Sarcopenia, the age-related decline in muscle mass and function [1] is associated with adverse functional and metabolic consequences [2]. Up to 40% of muscle mass may be lost between the age of 20 and 70 years and a decline of muscle mass at 1.4%–2.5% per year after 60 has been noted [3]. Loss of muscle strength and physical function were also common with a linear decline after 60 s [4]. Some reversibility of sarcopenia exists, highlighting the importance of intervention modalities [5]. Pharmacological interventions have been shown with limited efficacy [6], more attention has been directed towards non-pharmacological interventions [7].

There have been different intervention trials for sarcopenia and the intervention components included either nutrition or exercise, or the combination of both for sarcopenic participants diagnosed using consensus panel definitions. However, these trials were mainly conducted in Western population. While a recent review suggested that nutrition supplement enhanced the impact of exercise [8], another reported limited interactive effect of nutrition supplementation with exercise on muscle mass and function [9]. Other nutrients that are potentially beneficial for sarcopenia include high-quality protein, leucine, β-hydroxy β-methylbutyrate, vitamin D, omega-3 fatty acid and other antioxidants [10]. However, the benefits of nutrition supplement alone were largely confined to those with poor baseline nutrition status. Few studies included baseline assessment of nutritional status, nor addressed the sustained effect of the intervention after cessation of the intervention program. Moreover, most trials available in Asia were carried out predominantly in community-dwelling older adults but not specifically targeting frail or sarcopenic participants [11], thus the potential for therapeutic effects of the intervention may differ from those of the preventive interventions among healthier groups. Those clinical trials also had their own limitations regarding the study design and outcome measures [12, 13].

The present study aimed to address some of these gaps by recruiting sarcopenic participants defined using the Asian Consensus Panel Criteria [1]; by including assessments of nutritional status and a wide range of outcomes, and by assessing the sustainability of any changes 12 weeks after cessation of the intervention. We hypothesized that compared with the control group, body composition, physical functions and activities of daily living were improved in the exercise program alone group, and that nutrition supplementation would have an additive effect.

Materials and methods

Trial design

This was a prospective parallel group, single-blind randomized controlled trial. Chinese adults aged ≥65 years with sarcopenia defined using the Asian Working Group criteria and fulfilled the eligibility criteria (Appendix 1, available at *Age and Ageing* online) were recruited in the community in Hong Kong using a convenience sampling method. All participants provided written informed consent. The study was performed in compliance with the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of the Chinese University of Hong Kong.

Eligible participants were randomly assigned to one of the three groups: exercise program alone, combined-exercise program and nutrition supplement, or waitlist control group. Details of randomization, treatment assignments and blinding are listed in Appendix 1, available at *Age and Ageing* online. Data collection were made at baseline, 12 weeks and 24 weeks.

Outcomes

The primary outcome was the change in gait speed over 12 weeks assessed using the 6-m walk test. Secondary outcomes included the change of muscle strength, muscle power, body composition, health related quality of life (SF-12), Physical Activity Scale for the Elderly, Instrumental Activities of Daily Living and cardiorespiratory fitness from baseline to 12 weeks. Tertiary outcomes were the changes of these parameters till 24 weeks.

Questionnaires and measurements

Demographic, lifestyle and medical history data, 3-day dietary record, validated Physical Activity Scale for the Elderly, SF-12 were collected using a standardized questionnaire. Anthropometric measurements, body composition, grip strength, leg extensors strength, muscle power in the upper extremities, physical performances including five-chair stand test and usual gait speed were assessed. Renal function was monitored in the combined-exercise program and nutrition supplement group (details in Appendix 1, available at *Age and Ageing* online).

Sample size calculation

Based on previous findings [14], 26 participants per group was needed to detect a mean difference of 0.06 s in gait speed between the intervention group and the control group (SD = 0.1 and 0.04), equivalent to effect size of 0.79, with alpha = 0.05 and power = 0.8 (two-sided). A sample size of 45 per group was required based on an expected non-compliance rate of 20% and drop-out rate of 25%.

Intervention

Exercise program alone group

Two group exercise sessions and one-home exercise session were conducted on weekly basis for 12 weeks. Group exercises included 5–10 min warm-up and cool-down routine, 20–30 min chair-based resistance exercises using Thera-Bands, and 20-min aerobic exercises. The exercise intensity was closely monitored and adjusted by the qualified coach. Participants were also provided with Thera-Bands and an exercise leaflet and were asked to keep the home exercise sessions between 12 and 24 weeks (Appendix 1, available at *Age and Ageing* online).

Combined-exercise program and nutrition supplement group

This group received nutrition supplement and the above exercise program. The nutrition supplement consisted of two sachets of Ensure NutriVigor daily from baseline to 12 weeks. Each sachet (54.1 g powder) contains 231 calories, 8.61 g protein, 1.21 g β-hydroxy β-methylbutyrate, 130 IU vitamin D and 0.29 g omega-3 fatty acid.

Waitlist control group

They were asked to maintain their usual physical activities and dietary habits during the 6-month study period and were subsequently provided with the same exercise program as the intervention groups.

Statistical analysis

Data were analyzed using the intention-to-treat method including all randomized participants. ANOVA tests were used to compare continuous variables while Chi-square tests were used to compare categorical variables at baseline between groups. Differences between treatments over time were analyzed using linear mixed models, assumed random missing values driven by variables used in the analyses. Linear mixed model is a likelihood-based model, in which missing data in the follow-up could be handled, thus retained the intention-to-treat principle [15, 16]. Time, treatment and their interaction were defined as fixed factors. Subject was defined as a random factor. Mean change at 12 weeks and 24 weeks from baseline were tested between groups and effect sizes were computed using the Cohen's d. Statistical analyses were performed using SPSS version 24.0 (SPSS Inc., Illinois, USA). All statistical tests were two-tailed with significance set at $P < 0.05$. Continuous variables were presented as mean (standard deviations) for parametric data. Categorical variables were presented as number of subjects and percentages.

Results

Enrolment and baseline data

Study inclusion ran from 5 March 2015 to 5 May 2017. Last patient follow-up was completed on 25 October 2017. Due to limited resources, the trial was ended before reaching the anticipated sample size. 113 participants (40 in exercise alone group, 36 in combined-exercise program and nutrition supplement group, 37 in waitlist control group) were randomized. Twenty-five participants did not attend the 12-week assessment due to various reasons. Additional 12 participants were lost follow-up at 24-week assessment (Figure 1). During the study period, four adverse events and 12 serious adverse events were reported but none were related to the prescribed intervention.

Baseline characteristics of the three groups were similar except performance of five-chair stand. Mean baseline

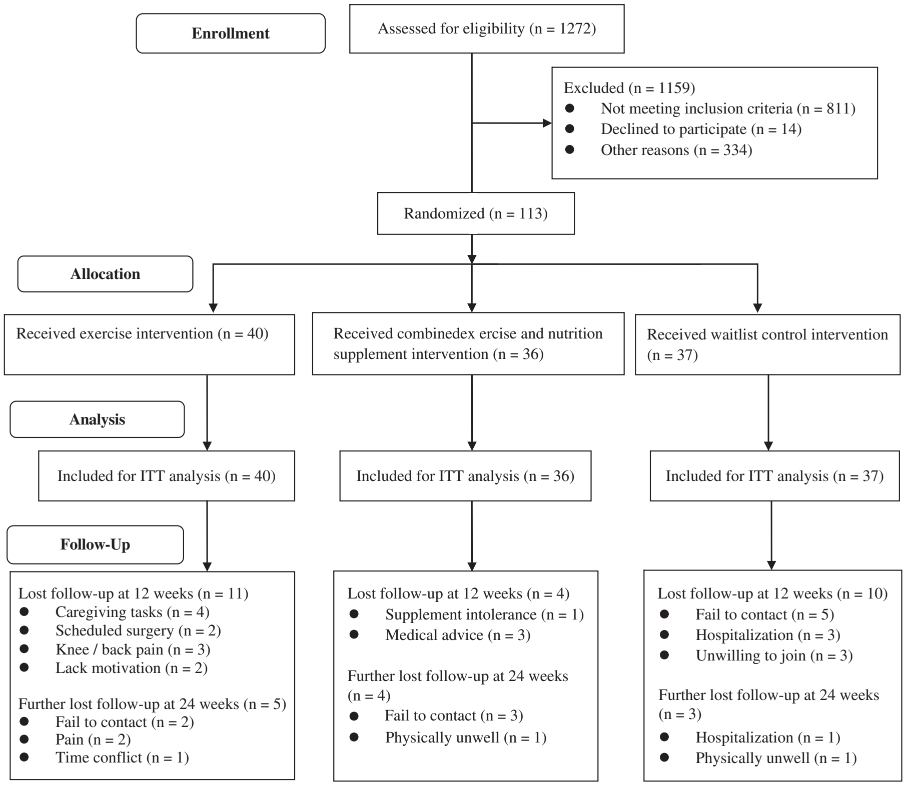

Figure 1. Study flow diagram.

Table 1. Baseline characteristics of the three-study groups. There were no significant differences among the three-study groups at any baseline characteristics except for the five-chair stand test ($P = 0.004$).

Characteristic	Waitlist control ($n = 37$)	Exercise alone ($n = 40$)	Combined-exercise program and nutrition supplement ($n = 36$)
Age, mean(SD)	72.2 (6.6)	74.5 (7.1)	74.8 (6.9)
Female, *n* (%)	29 (78.4%)	29 (72.5%)	29 (80.6%)
Weight, kg, mean(SD)	45.0 (7.8)	45.3 (6.6)	44.0 (6.6)
Height, cm, mean(SD)	153.7 (8.6)	155.1 (8.1)	152.9 (7.4)
Body mass index, kg/m^2, mean(SD)	18.9 (2.2)	18.8 (1.9)	18.8 (1.8)
CMMSE, mean(SD)	27.4 (2.7)	27.5 (3.1)	27.5 (2.5)
SARC-F, mean(SD)	1.76 (1.67)	2.80 (2.10)	2.23 (2.15)
Medical history			
Diabetes mellitus, *n*(%)	4 (10.9%)	9 (22.5%)	2 (5.6%)
Hypertension, *n*(%)	11 (29.7%)	12 (30.0%)	10 (27.8%)
Dyslipidemia, *n*(%)	9 (24.3%)	8 (20.0%)	6 (16.7%)
PRIMARY OUTCOME			
Gait speed, m/s, mean(SD)	0.94 (0.25)	0.82 (0.25)	0.88 (0.25)
SECONDARY OUTCOME			
Body composition			
Appendicular skeletal muscle mass/height^2, kg/m^2, mean(SD)	5.23 (0.68)	5.22 (0.67)	5.16 (0.59)
Upper limb fat mass, kg, mean(SD)	1.70 (0.61)	1.62 (0.48)	1.63 (0.55)
Lower limb fat mass, kg, mean(SD)	4.68 (1.18)	4.83 (1.50)	4.73 (1.36)
Upper limb muscle mass, kg, mean(SD)	3.06 (0.71)	3.11 (0.75)	2.98 (0.65)
Lower limb muscle mass, kg, mean(SD)	9.50 (2.27)	9.63 (2.03)	9.25 (1.80)
Dietary intake			
Energy intake, kcal/day, mean(SD)	1533.2 (343.1)	1517.2 (349.4)	1598.7 (406.9)
Protein intake, g/day, mean(SD)	71.9 (23.2)	67.2 (18.1)	76.3 (22.5)
Protein intake, g/kg body weight/d, mean(SD)	1.6 (0.5)	1.5 (0.4)	1.8 (0.6)
Physical function			
(1) Muscle strength			
Maximum grip strength, kg, mean(SD)	15.11 (5.63)	15.77 (5.85)	13.81 (4.89)
Maximum leg extension, kg, mean(SD)	15.4 (5.42)	14.31 (7.15)	13.09 (5.63)
(2) Physical performance			
Five-chair stand test, s, mean(SD)	10.03 (3.24)	14.06 (7.42)	14.17 (6.41)
(3) Muscle power			
Medicine ball, m, mean(SD)	2.02 (0.59)	1.86 (0.51)	1.84 (0.51)
Cardiorespiratory fitness			
6-min walk test, m, mean(SD)	373.97 (84.28)	337.22 (115.34)	354.2 (101.35)
Quality of life			
SF-12 physical, mean(SD)	41.02 (11.94)	38.90 (9.90)	41.19 (9.70)
SF-12 mental, mean(SD)	49.13 (10.18)	49.25 (10.00)	48.72 (10.62)
IADL impairment, mean(SD)	1.16 (1.44)	2.00 (1.89)	1.15 (1.52)
PASE, mean(SD)	98.26 (40.29)	78.93 (44.60)	91.28 (46.94)

SD, standard deviation; CMMSE, Chinese mini-mental status examination; SARC-F, simple five-item questionnaire for sarcopenia screening; SF-12, the 12-item short form health survey; IADL, instrumental activities of daily living; PASE, physical activity scale for the elderly.

dietary protein intake ranged from 1.5 to 1.8 g/kg body weight/day across the three groups (Table 1).

Compliance of the intervention groups

Mean attendance rates during the 12-week group exercise program were 95.3% in the exercise program alone group and 92.8% in the combined-exercise program and nutrition supplement group. Mean supplement compliance rate was 86.3%.

Primary outcome

No between group differences in gait speed were observed between baseline and 12 weeks, after adjusting for baseline gait speed (Table 2).

Secondary and tertiary outcomes

Improvement in lean muscle mass especially in lower limbs was only observed in the combined-exercise program and nutrition supplement group ($P = 0.015$). Such increment was not maintained till 24th week. No change in limb fat mass were observed at any time point (Table 2).

Compared with the control group, leg extension ($P < 0.001$), five-chair stand test ($P = 0.004$) and physical activity level ($P = 0.026$) showed significant improvement in both intervention groups from baseline to 12th week (Table 2). However, no additive effect of nutrition supplement was observed. By 24 weeks, some improvements were maintained in leg extension ($P = 0.027$) and five-chair stand test ($P = 0.0003$) in both intervention groups compared to baseline and the control group. Improvement in physical

Table 2. Comparison of the change of gait speed, body composition, muscle strength, muscle power, physical performance, physical activity level, quality of life and IADLs among the combined-exercise program and nutrition supplement group (ExS) (*n* = 36), the exercise program group (Ex) (*n* = 40) and the waitlist control group (WC) (*n* = 37).

Variable	Group	Mean (SD)			Change after 12 weeks			Change after 24 weeks		
		Baseline	12 weeks	24 weeks	Mean change (95% CI)	Effect size[b]	*P*-value of interaction	Mean change (95% CI)	Effect size[b]	*P*-value of interaction
PRIMARY OUTCOME										
Gait speed (m/s)[a]										
	WC	0.94 (0.26)	1.05 (0.24)	1.04 (0.28)	**0.134 (0.051, 0.217)**	0.50	0.602	**0.127 (0.041, 0.213)**	0.50	0.350
	Ex	0.82 (0.25)	0.98 (0.35)	0.98 (0.30)	**0.146 (0.066, 0.225)**	0.60		**0.129 (0.044, 0.214)**	0.52	
	ExS	0.89 (0.26)	1.08 (0.23)	1.12 (0.22)	**0.173 (0.096, 0.251)**	0.65		**0.199 (0.119, 0.279)**	0.77	
SECONDARY OUTCOME										
Upper limb fat mass (kg)										
	WC	1.70 (0.61)	1.87 (0.51)	1.88 (0.58)	**0.08 (0.03, 0.14)**	0.13	0.763	**0.08 (0.02, 0.15)**	0.13	0.744
	Ex	1.62 (0.48)	1.65 (0.45)	1.62 (0.46)	**0.08 (0.02, 0.13)**	0.17		0.05 (−0.02, 0.11)	0.10	
	ExS	1.63 (0.55)	1.74 (0.53)	1.75 (0.52)	**0.10 (0.05, 0.16)**	0.18		**0.06 (0.001, 0.13)**	0.11	
Lower limb fat mass (kg)										
	WC	4.68 (1.18)	4.84 (1.01)	4.93 (1.16)	0.08 (−0.10, 0.26)	0.07	0.203	**0.19 (0.001, 0.38)**	0.16	0.298
	Ex	4.83 (1.50)	4.66 (1.50)	4.75 (1.37)	0.13 (−0.04, 0.29)	0.09		0.15 (−0.05, 0.34)	0.10	
	ExS	4.73 (1.36)	4.90 (1.21)	5.02 (1.29)	**0.29 (0.12, 0.45)**	0.21		**0.35 (0.16, 0.54)**	0.26	
Upper limb muscle mass (kg)										
	WC	3.06 (0.71)	3.06 (0.74)	3.19 (0.75)	0.04 (−0.02, 0.11)	0.06	0.852	**0.08 (0.02, 0.15)**	0.11	0.504
	Ex	3.11 (0.75)	3.24 (0.82)	3.22 (0.78)	**0.07 (0.01, 0.13)**	0.09		**0.06 (0.001, 0.13)**	0.08	
	ExS	2.98 (0.65)	3.07 (0.75)	2.94 (0.52)	**0.06 (0.001, 0.12)**	0.09		0.03 (−0.03, 0.09)	0.05	
Lower limb muscle mass (kg)										
	WC	9.50 (2.27)	9.09 (2.10)	9.60 (2.22)	−0.21 (−0.43, 0.02)	−0.09	**0.015**	−0.01 (−0.23, 0.22)	0.00	0.411
	Ex	9.63 (2.03)	9.64 (1.91)	9.59 (1.87)	−0.12 (−0.33, 0.10)	−0.06		0.03 (−0.20, 0.26)	0.01	
	ExS	9.25 (1.80)	9.44 (1.99)	9.24 (1.60)	**0.23 (0.01, 0.44)*,****	0.13		0.20 (−0.03, 0.42)	0.11	
ASM/ height^2 (kg/m^2)										
	WC	5.23 (0.69)	5.21 (0.69)	5.35 (0.69)	−0.05 (−0.14, 0.03)	−0.07	**0.025**	0.06 (−0.05, 0.16)	0.09	0.972
	Ex	5.22 (0.68)	5.33 (0.71)	5.26 (0.65)	0.02 (−0.06, 0.11)	0.03		0.04 (−0.06, 0.14)	0.06	
	ExS	5.16 (0.59)	5.26 (0.67)	5.10 (0.44)	**0.11 (0.03, 0.19)***	0.19		0.05 (−0.04, 0.15)	0.08	
Maximum grip strength (kg)										
	WC	15.11 (5.63)	16.21 (5.01)	16.88 (4.77)	1.30 (−0.61, 3.22)	0.23	0.094	1.99 (−0.17, 4.16)	0.35	0.403
	Ex	15.77 (5.86)	19.37 (7.11)	19.64 (6.61)	**3.19 (1.37, 5.01)**	0.54		**3.53 (1.41, 5.65)**	0.60	
	ExS	13.81 (4.90)	18.17 (4.56)	15.50 (5.74)	**4.19 (2.39, 5.99)**	0.86		1.60 (−0.49, 3.69)	0.33	
Leg extension (kg)										
	WC	15.41 (5.42)	14.81 (4.86)	14.65 (4.58)	−0.62 (−2.17, 0.92)	−0.11	**<0.0001**	−0.20 (−1.69, 1.29)	−0.04	**0.027**
	Ex	14.31 (7.15)	18.57 (8.56)	17.18 (6.00)	**3.47 (2.01, 4.94)***	0.49		**2.32 (0.86, 3.78)***	0.32	
	ExS	13.10 (5.64)	17.21 (5.84)	16.07 (6.63)	**3.73 (2.28, 5.18)***	0.66		**2.25 (0.86, 3.64)***	0.40	
Medicine ball (m)										
	WC	2.02 (0.60)	1.99 (0.51)	2.01 (0.49)	−0.02 (−0.13, 0.10)	−0.03	0.152	−0.01 (−0.14, 0.11)	−0.02	0.286
	Ex	1.86 (0.51)	2.03 (0.57)	1.92 (0.55)	**0.13 (0.02, 0.23)**	0.25		0.00 (−0.12, 0.12)	0.00	
	ExS	1.85 (0.51)	1.97 (0.54)	1.96 (0.47)	**0.10 (0.00, 0.21)**	0.20		0.11 (−0.01, 0.24)	0.22	

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Five-chair stand (s)[a]										
	WC	10.03 (3.24)	10.10 (2.73)	11.15 (2.97)	**−1.49 (−2.55, −0.43)**	−0.46	**0.004**	−0.40 (−1.59, 0.78)	−0.12	**0.0003**
	Ex	14.07 (7.43)	9.56 (4.67)	10.13 (4.59)	**−3.21 (−4.21, −2.22)***	−0.43		**−2.57 (−3.71, −1.44)**[*]	−0.35	
	ExS	14.17 (6.41)	9.57 (3.26)	9.72 (3.99)	**−3.77 (−4.76, −2.77)***	−0.59		**−3.58 (−4.66, −2.49)**[*]	−0.56	
Six-min walk test (m)										
	WC	374.0 (84.3)	392.6 (69.6)	379.3 (83.8)	17.12 (−1.04, 35.28)	0.20	0.796	9.22 (−9.96, 28.40)	0.11	0.839
	Ex	337.2 (115.3)	349.7 (109.0)	354.9 (97.9)	12.09 (−5.18, 29.35)	0.10		16.00 (−2.74, 34.75)	0.14	
	ExS	354.2 (101.4)	378.7 (79.5)	385.9 (70.3)	8.63 (−8.53, 25.78)	0.09		16.26 (−1.78, 34.29)	0.16	
SF12-Physical										
	WC	41.02 (11.94)	46.81 (6.82)	44.59 (8.13)	**5.73 (2.55, 8.91)**	0.48	0.705	3.11 (−0.17, 6.39)	0.26	0.395
	Ex	38.90 (9.90)	44.16 (9.14)	42.34 (8.85)	**5.06 (2.03, 8.10)**	0.51		**3.23 (0.04, 6.41)**	0.33	
	ExS	41.20 (9.70)	48.97 (5.97)	47.86 (6.42)	**6.90 (3.73, 10.07)**	0.71		**5.89 (2.68, 9.10)**	0.61	
SF12-Mental										
	WC	49.14 (10.18)	53.30 (6.61)	55.37 (7.40)	**4.06 (0.43, 7.68)**	0.40	0.815	**6.11 (2.39, 9.83)**	0.60	0.643
	Ex	49.25 (10.00)	54.81 (6.29)	55.13 (6.68)	**5.30 (1.83, 8.76)**	0.53		**5.50 (1.89, 9.11)**	0.55	
	ExS	48.72 (10.62)	54.20 (6.92)	56.27 (6.71)	**5.62 (1.99, 9.26)**	0.53		**7.87 (4.19, 11.55)**	0.74	
PASE										
	WC	98.27 (40.29)	101.98 (33.38)	92.49 (37.94)	1.60 (−13.07, 16.26)	0.04	**0.026**	−7.80 (−20.27, 4.67)	−0.19	**0.023**
	Ex	78.93 (44.60)	108.46 (54.89)	94.70 (37.97)	**28.24 (14.28, 42.19)***	0.63		11.68 (−0.67, 24.02)	0.26	
	ExS	91.29 (46.94)	114.11 (36.30)	106.93 (32.45)	**22.95 (9.03, 36.88)***	0.49		**14.96 (3.10, 26.82)**[1]	0.32	
IADL impairments										
	WC	1.16 (1.44)	0.61 (0.81)	0.63 (1.41)	**−0.51 (−0.99, −0.03)**	−0.35	0.055	−0.50 (−1.09, 0.10)	−0.35	0.535
	Ex	2.00 (1.89)	0.76 (1.20)	1.04 (1.50)	**−1.30 (−1.76, −0.84)***	−0.69		**−0.97 (−1.56, −0.38)**	−0.51	
	ExS	1.15 (1.52)	0.35 (0.75)	0.39 (0.99)	**−0.74 (−1.22, −0.25)***	−0.49		**−0.74 (−1.32, −0.15)**	−0.49	

Bold: *P*-value <0.05 comparing 12 weeks or 24 weeks with baseline.

**P*-value <0.05, comparing Ex or ExS with WC.

***P*-value <0.05, comparing ExS with Ex.

[a] Analysis was adjusted for baseline value of gait speed or five-chair stand.

ExS, combined-exercise program and nutrition supplement group; Ex, exercise program group; WC, waitlist control group; ASM, appendicular skeletal muscle mass; SF-12, the 12-Item Short Form Health Survey; IADL, instrumental activities of daily living; PASE, physical activity scale for the elderly.

[b] The between group effect size and the 95% CI are given in Appendix 2, available at *Age and Ageing* online.

was also maintained in the combined group till 24 weeks (Table 2).

Reduction in impairments of daily activity tended to be greater in the combined group than the other two groups at 12-week assessment ($P = 0.055$). However, the reduction was not sustained at 24-week assessment (Table 2).

Health status (SF-12) increased in all groups during the study period but no significant group difference was observed (Table 2). There was no significant change in the renal function among participants in the combined-exercise program and nutrition supplement group (data not shown).

Discussion

This study demonstrated that the exercise program with and without nutrition supplementation had no significant effect on the primary outcome of gait speed in community-dwelling Chinese sarcopenic older adults. However, the secondary outcomes of muscle strength and the five-chair stand test improved with the combination of exercise and nutrition supplement, as well as with exercise alone, this finding being consistent with previous studies [17]. Nutrition supplement had added benefit in increasing lower limb muscle mass after 12 weeks. An important point to note is the improvement in muscle strength and physical performance in both intervention groups was still observed after cessation of group sessions for 12 weeks, even though gain in muscle mass was lost in the combined-exercise program and nutrition supplement group. This suggest that some behavioural change was achieved, in that participants either continued to carry out these exercises at home, or generally increased their physical activity level, resulting in maintained strength and physical performance measures. However, with the cessation of nutrition supplement, protein anabolism likely declined, resulting in the loss of muscle mass gained during the initial 12 weeks.

Protein intake especially leucine rich mixtures contribute to the muscle protein anabolism in older adults [18]. Daily amount of β-hydroxy β-methylbutyrate contributed by the nutrition supplement was 2.42 g. This level was within the proposed threshold of 2–3 g/day for enhancing muscle protein synthesis in older adults [19]. The nutrition supplement also increased the protein intake of the combined group from 1.7 to 2.1 g/kg body weight/day, a level higher than the recommended level of 1.2–1.5 g/kg body weight/day for older people [20]. We observed an increase from 5.22 ± 0.68 to 5.33 ± 0.71 $\mathrm{kg/m^2}$ of skeletal muscle mass after nutrition intervention. This was not accompanied by any renal function decline nor increase in fat mass in the combined group. Furthermore, the supplement was well tolerated. Past findings have shown that combining resistance training with the ingestion of high quality, rapidly digested protein sources could produce additive benefits on post-exercise skeletal muscle protein synthesis in older adults beyond the effects of exercise only [21]. However, current evidence regarding such additive effect on muscle mass, muscle strength or physical performance in older people have largely produced negative findings [9, 22]. Consistent with the literature, this study showed that nutrition supplementation increased muscle mass, but had no additional effect on the exercise induced improvement of muscle strength and physical performance measures. The study also showed that the increase in muscle mass was dependent on continuation of nutrition supplementation, since the effect was lost 12 weeks after trial cessation, in contrast to the persisting effect of exercise likely resulting from participants continuing their exercise habit. However, the direct effect of the supplement on protein anabolism needs to be further explored with protein kinetics studies. Moreover, recent evidence shows that healthier diets generally characterized by optimal energy and protein intake, greater intake of vegetable and fruit, vitamin D and omega-3 fatty acid were associated with better muscle health [10, 23], the potential effect of the multiple dietary components in the nutrition supplement and the synergy of these components with exercise on the measured outcomes warrant further investigation.

Substantial evidence showed that resistance training 2–3 times/week could improve physical function and reduce muscle weakness in older people [24], but such improvements varied with exercise intensities and volumes [25]. Compared with previous studies (9%–15% increase in strength) [26], we observed over 20% increase in leg extension in both intervention groups. Such gains and the significant improvement of performance in five-chair stand test indicate that the exercise regime and the exercise intensity were adequate. Moreover, compliance to this group activity was good and appeared to have resulted in sustained improvement.

The strengths of this study include the selection of sarcopenic participants defined using the Asian Consensus Panel, the inclusion of outcomes not just confined to muscle health, but also outcomes relevant to older people, and the observation of 12 weeks post-intervention to monitor changes in these outcomes. It is possible that if participants without sarcopenia were included, no increase in strength may have been observed. Furthermore, the study included a period of observation after the cessation of the intervention, when beneficial effects persisted, showing that the intervention program may have been able to change exercise behaviour, an important finding that may be applied to community health promotion activities. Another strength is the inclusion of habitual dietary intake, showing that even in a protein replete population, nutrition supplementation may still achieve increase in muscle mass. Supplementation may be more important in the management of sarcopenia among communities where habitual protein intake may be much lower. However, the small number of participants with low baseline protein intake precluded further analysis to differentiate the effect of supplementation among participants with various protein intake levels.

There are limitations in this study. The current sample size and the attrition of 22% at 12 weeks and 32% at 24 weeks warrant concern regarding the internal validity of this study, and may explain the null difference in gait speed improvement among the study groups. Only participants from the community without mobility impairment were recruited. The results may not be generalized to those living in the residential care or hospital settings. However, it may be argued that such programs may show even more benefits to people who are frail, malnourished or predominantly inactive. The nutrition supplement contained vitamin D and omega-3 fatty acid. However, the quantities were small, and may or may not have contributed to the primary outcome. Limited data regarding vitamin D and omega-3 fatty acid contents of Chinese foods also precluded comparison of vitamin D and omega-3 fatty acid intakes across study groups. The use of self-report on home exercise session compliance was subject to reporting bias. We did not include cognitive function measures which may be benefited from the exercise program [27]. Although strength and physical performance measures may be affected by inter-muscular adipose tissue and intra-myocellular lipid content, we only measured total limb fat content using dual-energy X-ray absorptiometry but not with more accurate methods, such as magnetic resonance imaging. However, the participants had a low mean BMI and fat muscle infiltration is likely to be low.

To conclude, the exercise program with and without nutrition supplementation had no significant effect on the primary outcome of gait speed in community-dwelling Chinese sarcopenic older adults. However, improvements were seen in the secondary outcomes of strength and the five-chair stand test, and these beneficial effects extended to 12 weeks after cessation of intervention. Nutrition supplement had additive effect on lower limb muscle mass only during the period of intervention.

Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

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Antibiotic prophylaxis and clinical outcomes among older adults with recurrent urinary tract infection: cohort study

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Abstract

Background: clinical guidelines recommend antibiotic prophylaxis for preventing recurrent urinary tract infections (UTIs), but there is little evidence for their effectiveness in older adults.
Methods: this was a retrospective cohort study of health records from 19,696 adults aged ≥65 with recurrent UTIs. We used prescription records to ascertain ≥3 months' prophylaxis with trimethoprim, cefalexin or nitrofurantoin. We used random effects Cox recurrent event models to estimate hazard ratios (HR) and 95% confidence intervals (CI) for risks of clinical recurrence (primary outcome), acute antibiotic prescribing and hospitalisation.
Results: of 4,043 men and 15,653 women aged ≥65 with recurrent UTIs, 508 men (12.6%) and 2,229 women (14.2%) were prescribed antibiotic prophylaxis. In men, prophylaxis was associated with a reduced risk of clinical recurrence (HR, 0.49; 95% CI, 0.45–0.54), acute antibiotic prescribing (HR, 0.54; 95% CI, 0.51–0.57) and UTI-related hospitalisation (HR, 0.78; 95% CI, 0.64–0.94). In women, prophylaxis was also associated with a reduced risk of clinical recurrence (HR, 0.57; 95% CI, 0.55–0.59) and acute antibiotic prescribing (HR, 0.61; 95% CI, 0.59–0.62), but estimates of the risk of UTI-related hospitalisation were inconsistent between our main analysis (HR, 1.16; 95% CI, 1.05–1.28) and sensitivity analysis (HR, 0.82; 95% CI, 0.72–0.94).
Conclusions: antibiotic prophylaxis was associated with lower rates of UTI recurrence and acute antibiotic prescribing in older adults. To fully understand the benefits and harms of prophylaxis, further research should determine the frequency of antibiotic-related adverse events and the impact on antimicrobial resistance and quality of life.

Keywords

urinary tract infection, antibiotic prophylaxis, recurrence, older people