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Hui-Chuan Hsu ^a, Chun-Hou Wang ^b, Yi-Chun Chen ^c,
Ming-Chen Chang ^a & Jean Wang ^a

^a Health Care Administration, Asia University,
Taichung, Taiwan, Republic of China

^b School of Physical Therapy, Chun Shan Medical
University, Taichung, Taiwan, Republic of China

^c School of Nutrition and Health Science, Taipei
Medical University, Taipei, Taiwan, Republic of China

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EVALUATION OF A COMMUNITY-BASED AGING INTERVENTION PROGRAM

Hui-Chuan Hsu

Health Care Administration, Asia University, Taichung, Taiwan,
Republic of China

Chun-Hou Wang

School of Physical Therapy, Chun Shan Medical University, Taichung,
Taiwan, Republic of China

Yi-Chun Chen

School of Nutrition and Health Science, Taipei Medical University,
Taipei, Taiwan, Republic of China

Ming-Chen Chang
Jean Wang

Health Care Administration, Asia University, Taichung, Taiwan,
Republic of China

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Address correspondence to Hui-Chuan Hsu, Department of Health Care Administration, Asia University, No. 500, Lioufeng Road, Wufeng Township, Taichung 41354, Taiwan, Republic of China. E-mail: gingerhsu@seed.net.tw

This study evaluated the outcome and process of a community-based aging intervention program for the elderly in Taiwan. The program included education on nutrition and dietary behavior and on physical activities. Outcome and process evaluations were conducted. The program may have had some effects on decreasing some dietary behavioral problems and increasing regular exercise, but the effect on health outcome was not proved. The strength of this program was its proper design, dosage, and implementation; the weaknesses included a low participation rate, low commitment and continuity, and selection bias for the nonparticipants who might be frailer than the actual participants.

Successful aging has been the interest of recent mainstream health studies in gerontology (Rowe & Kahn, 1997). In the past, most studies have explored the risk factors or protective factors of successful aging (Albert et al., 1995; Chang, 1997; Chou & Chi, 2002; Glass et al., 1995; Hsu, 2005, 2007a, 2007b; Strawbridge et al., 1996; von Faber et al., 2001). Until recently, some intervention programs have been developed and practiced, and their effects have been examined on various dimensions of successful aging. The intervention programs have targeted the elderly populations either in hospitals, long-term care institutions, or in the general community. However, only few studies in the past have been conducted according to the community-based approach. In fact, the public health approach embedded with health promotion activities is usually community-based. Such design is beneficial for widespread health promotion among the population, but there is also less control on the environment in such programs. Besides, earlier studies have focused on certain outcome indicators that aid in revealing the effects of the programs. However, the process evaluation that helps to explain the outcome and provide clues for further actions was examined less rigorously.

PHYSICAL ACTIVITY AND DIETARY INTERVENTION PROGRAMS

The concept of successful aging includes the physical, psychological, and societal dimensions of health (Rowe & Kahn, 1997). In the physical health domain, dietary choices, eating habits, medications, and physical activity are the potential facets, and researchers suggest that physical activity and diet be emphasized in health promotion strategies for aging people (Drewnowski & Evans, 2001).

The common physical-activity intervention program for the elderly include health education, exercise prescription, or even behavior or

cognitive strategies. The approach could be individual or group instruction, or an approach emphasizing the environmental or societal facilities or TV programs (King, 2001; Stewart et al., 2001; Hillsdon, Cavill, Nanchahal, Diamond, & White, 2001). The intervention program usually includes the exercise of the lower and upper body strength, fitness walking, aerobics, balance, flexibility, endurance, and neuromuscular strengthening (Hughes et al., 2004; LIFE Study Investigators, 2006; Miszko et al., 2003; Nelson et al., 2004; Stewart et al., 2001; Thomas & Hageman, 2003).

The proven effect or outcome of the physical activity programs includes improvement in mobility, walking speed, lower extremity functions, standing balance, leg strength, and fall risks (Gardner et al., 2001; Hughes et al., 2004; LIFE study, 2006; LaStayo et al., 2003; Morgan, Virnig, Duque, Abdel-Moty, & DeVito, 2004; Thomas & Hageman, 2003). Some programs have even improved other aspects of health such as self-efficacy resulting from exercise (Hughes et al., 2004; Rejeski, Katula, Rejeski, Rowley, & Sipe, 2005) and calorie expenditure (Stewart et al., 2001). Furthermore, preventive occupational-therapy intervention proved to be effective in maintaining the quality of life outcomes, and it was found to be particularly more effective in psychosocial outcomes than in physical dimension (Clark et al., 2001; Phelan, Williams, Penninx, LoGerfo, & Leveille, 2004; Nelson et al., 2004; Bruce, Seeman, Merrill, & Blazer, 1994; Harris et al., 2003; Ku, Liu, & Tsai, 2006; Prince, Harwood, Blizard, Thomas, & Mann, 1998; Taylor & Lynch, 2004). This indicates that the physical, psychological, or social dimensions of health are interrelated. However, it proved more difficult to adhere to the exercise regime after the intervention (Hughes et al., 2004; Thomas & Hageman, 2003). The majority of the studies with the experimental design did not apply multivariable longitudinal analysis.

In the past, dietary programs targeting the elderly in the community were limited. The effectiveness of nutrition/dietary-intervention targeted changes in dietary behavior, attitude or motivation, perceived behavioral control, compensatory behaviors (like exercise or physical activity), weight change, or biomarker change (Resnick, 2003; Pepersack, 2005; Wammes, Breedveld, Kreners, & Brug, 2006).

Process Evaluation

Intervention programs usually focus on the outcome for the evaluation of the success of the programs. However, the outcome variables are not the only achievement of the programs, and sometimes, the outcome

may not be observable during a short-term evaluation. In fact, some precious information about the programs may be lost if the process is not carefully examined. Therefore, the new trend discernable in health promotion programs is to shift the focus of evaluation from program outcomes to program processes. Process evaluation not only helps to explain the outcome of the program, but it also provides information for future implementation of similar programs (Dehar, Casswell, & Duignan, 1993). The components of process evaluation include recruitment, maintenance, context, resources, implementation of program, reach, barriers, exposure, initial use, continued use, and contamination. Both qualitative and quantitative measures of each component are suggested (Baranowski & Stables, 2000; Steckler & Linnan, 2002).

The purpose of this study was to describe a community-based aging intervention program that focused on the physical activity and diet of a Taiwanese elderly population. Both outcome and process evaluation were conducted to explain the program effectiveness and to provide suggestions for the future.

DESIGN AND METHODS

Study Design and Samples

The data were obtained from our research project Successful Ageing for the Elderly in Taiwan 2004–2006. The study design and samples are shown in Figure 1. Six contrasting communities in Miaoli County were selected to represent the different living areas and lifestyles: Miaoli City is a commercial area subdivided into East and West; Jhuolan and Gongguan townships comprising the mountain-foothill farming communities populated mainly by the Hakka ethnic group; and Tongsiao and Houlong townships comprising the coastal communities populated mainly by the Mingnan ethnic group. The selection of these six communities was also based on the geographic separation to avoid a “contamination effect” in the experiment. The sampling frames were household registers that listed people aged ≥ 65 years. Equal-probability samples were drawn in three steps; in the first step, one-third to one-fifth of the villages (or neighborhoods) in the six communities (or townships) were selected. In the second step, the clusters of settlement blocks in the selected townships were selected proportional to the population size. In the third step, four participants were selected systematically from the register in each block. A total of 120 people were chosen with constant probability from each community, and altogether 720 people were selected.

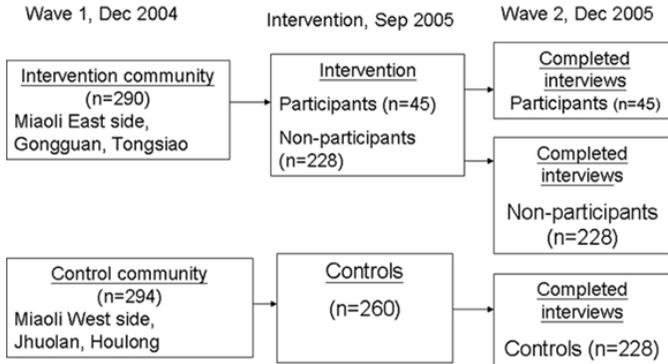


Figure 1. Proposed model.

In wave 1, the sampling frame was based on household-registered people in the six communities aged ≥ 65 years. The sampling design was a three-stage equal probability sample. There were 120 persons chosen from each township with the same sampling probability, with a total of 720 persons selected, out of which 584 completed the survey in wave 1. The sample characteristics are shown in Table 1.

All the intervention participants who had been interviewed in wave 1 ($n=290$) in the intervention communities were invited through phone by the health service-center staff to join the program. The program was conducted at the public health centers for the intervention communities, and no program was conducted for the control communities ($n=294$). However, among the invited 290 persons, there were only 45 invited participants who attended our intervention programs. After three months, the second wave survey was conducted for all the participants in the intervention communities and control communities in wave 1. In this study, we only analyzed those who attended both the wave 1 and wave 2 interviews.

Intervention Program

Protocol

The content of the program included education and practice of nutrition, dietary choice, and physical activities. The protocol was designed according to the framework of the nutrition and physical activity educational material from The Canadian Center for Activity and Aging (2001) and National Institute of Aging (2004). The contents were modified by the physical therapists and nutritionists to make the activity more simple and compatible with the Chinese

Table 1. Characteristics of the study samples at baseline

Characteristics	Intervention participants (<i>n</i> = 45)	Intervention Nonparticipants (<i>n</i> = 214)	Control (<i>n</i> = 255)	Goodness-of-fit (chi-square)
Age (2004)				12.60*
65–69	19 (42.2)	59 (27.6)	73 (28.6)	
70–74	15 (33.3)	59 (27.5)	53 (20.8)	
75–79	7 (15.6)	51 (23.8)	72 (28.2)	
80+	4 (8.9)	45 (21.0)	57 (22.4)	
Gender				1.54
Male	22 (48.9)	93 (43.5)	125 (49.0)	
Female	23 (51.1)	121 (56.5)	130 (51.0)	
Education				12.68*
Illiterate	8 (17.8)	63 (29.4)	86 (33.7)	
Elementary school or informal education	22 (48.9)	114 (53.3)	135 (52.9)	
Junior high school+	15 (33.3)	37 (17.3)	34 (13.3)	
Marital status				6.25*
No spouse	10 (22.2)	90 (42.1)	96 (37.6)	
Having spouse	35 (77.8)	124 (57.9)	159 (62.4)	
Ethnic group				2.60
Mingnan	11 (24.4)	65 (30.4)	87 (34.1)	
Hakka	31 (68.9)	136 (63.6)	149 (58.4)	
Mainlanders	3 (6.7)	13 (6.1)	19 (7.5)	
Community type				5.38
City	16 (35.6)	72 (33.6)	75 (29.4)	
Mountain	20 (4.4)	68 (31.8)	91 (35.7)	
Coastal	9 (20.0)	74 (34.6)	89 (34.9)	

Note. Cases who completed interviews in 2 waves are included in the analysis. Chi-square test was used for examining goodness-of-fit. * $p < .05$.

dietary culture. The diet education focused on the recognition of six categories of food, healthy diet and cooking principles, and on how to reduce the problem of poor appetite by making eating a more fun-filled activity. A balanced-diet game was designed for practice after education. The physical activities included the introduction of physical function and activity, and demonstration and practice of endurance, strength, balance, and flexibility exercises. The whole set of physical activities was designed to focus on easy-to-perform activities that could be easily performed at home and with daily devices (such as towels and water bottle).

We also designed a brochure to remind the participants about all the educational materials, including daily record tables of food intake and physical activity for 12 weeks. All the research members

(the researchers, lecturers for the program, and the assistant trainers who helped in the participants' learning in the process) participated in our training course to be familiar with the protocol and all the educational contents.

All the educational materials (lectures, food-recognition game, physical-activity demonstration, and protocols) were recorded in video compact disc (VCD). The physical-activity demonstration video was also recorded in three dialects (Mandarin, Taiwanese, and Hakka) to suit the needs of different ethnics. The educational VCDs were provided to the health centers after the intervention program.

Implementation

The half-day intervention program was conducted in each intervention community. All the elder participants in the intervention communities were invited by the staff of the local public health centers to participate in the program. Considering the concentration, endurance, and learning effectiveness of the elderly participants, we designed an easy lecture, practice games, and physical exercise with appropriate breaks in the 3-hour duration.

At the beginning of the program, the purpose and the content of the program was introduced. Subsequently, the health education about dietary knowledge and food selection was given; this was followed by the balanced-diet game in small groups under the supervision of assistant trainers. The physical-function lecture and physical-activity practice was demonstrated and taught by a physical therapist in our team, and the assistant trainers helped the participants to practice these activities during the session. After these two sessions, the participants were asked to fill out the questionnaire with their evaluation of the program. This was a part of the results of process evaluation of the program. Finally, the brochure was provided for the participants for review at home, and the contacts of the assistant trainers were also provided to the participants.

During the 12 weeks after the program, we actively made phone calls to the participants twice. The purpose of the calls was to check (and remind them) if the participants continued with their healthy diet and physical activity, and provide assistance. If they were not committed to the physical exercise or healthy diet, then the trainers encouraged them to continue with the activity during the phone calls. The telephone calls were also employed to investigate if there had been any adverse events owing to the intervention.

Data Collection

The baseline data (wave 1) and the outcome evaluation (wave 2) were conducted by face-to-face interview surveys. The interviewers were

local residents with extensive survey experience; they received standardized interview training and signed an agreement to protect the data obtained from the interviewees and the questionnaires. All the participants signed an agreement to participate before the interview, while retaining their right to stop the interview at any time. After three months of the intervention, the data on program evaluation by the participants were collected in experimental and control communities.

The process evaluation data were collected during the intervention program. These data included the questionnaires for the participants, the questionnaires reported by the trainers, the observed diary by the trainers, and the discussion meeting of the research team.

Measures

Outcome Indicators

Several outcomes were observed to prove the effectiveness of this program, including the change in the healthy behaviors including regular exercise and dietary behaviors, and the change in the health outcome including physical function performance and depressive symptoms.

Behavior: Regular exercise and dietary behavior. We measured the regular exercise behavior. Regular exercise was defined as doing exercise for at least 30 minutes, thrice a week, which was coded as yes/no.

Diet behavior was measured based on some daily dietary habits and six categories of food intake. The items including skipping any meals in a day, insufficient food intake, poor appetite, routinely eating alone, reduced food intake because of poor digestion, reduced food intake because of oral problems, weight fluctuation >3 kg in the past year, and lack of any one of the six food categories (defined as lacking any one of the following foods in daily life: milk products, grain products, fruits, vegetables, meats and alternatives, or fats and oil). All the variables were defined as dichotomous (yes/no), and their percentages were calculated. Furthermore, the above-mentioned problematic dietary behaviors were summed up, and the log transform of cumulative number of problematic dietary behaviors was put in the general linear model.

Health outcomes. Three indicators were used to measure the effects of intervention in the physical and mental dimensions of successful aging: activities of daily living (ADL), Elderly Functional Index

(EFI), and depressive symptoms. The ADL included the following six items: eating, dressing, transferring from a bed or chair, walking in the house, going to the toilet, and taking a bath. Each item was rated based on a performing difficulty scale from 1 to 4, indicating from no difficulty to unable to perform at all. The concept of normal physical function was determined as the absence of difficulty or if impairment was for less than three months. The total score ranged 4–24, and the higher score indicated greater difficulties in ADL.

As ADLs are not sensitive to the physical function of the independent elderly people, the Elderly Functional Index (EFI) was used to detect the improvement in physical function. The EFI consists of 15 items, which is a modified version of the 15-item RMI (Collen, Wade, Robb, & Bradshaw, 1991) and Nagi scale (Nagi, 1976). Each item measures the degree of difficulty for the participant with a score between 1 and 4. The higher score indicates more difficulty in performing the actions. In our study, the Cronbach's alpha of EFI among the Miaoli county elderly was .97, and the construct validity was examined by factor analysis with a total explained variance of 86%. Three factors were extracted by factor analysis: control of upper limbs and trunk (six items, including turning over in bed, sitting by the bed for 10 seconds, picking up small things with fingers or buttoning, standing up from a chair and standing still for 15 seconds, raising hands over head, and standing alone for 10 seconds); strength and balance of lower limbs (six items, including standing for 15 minutes, walking 5 meters to pick up something and go back, crouching and standing up, walking 10 meters indoors alone without assistance, walking outdoors on uneven surfaces, walking 10 meters outdoors on plain surfaces); and cardiopulmonary endurance (three items, including running or fast walking for 10 meters in 4 seconds, walking up and down two–three floors, walking up one floor alone [grabbing handrail acceptable]).

Depressive symptoms were assessed with the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977), which is a 20-item scale. In this study, the 10-item version was applied (Kohout, Berkan, Evans, & Cornohi-Huntleu, 1993). Each item was scored from 1 to 4, and the total score ranged 10–40. The higher score indicated more symptoms of depression.

Demographic Variables

The sample demographic characteristics were described by age; gender; educational level (illiterate, elementary school, or literate by informal education, junior high school, senior high school, or over);

marital status (having spouse and without spouse); and ethnic group (Taiwanese, Hakka, and Mainlanders).

PROCESS EVALUATION

The process evaluation included the researchers' evaluation and the participants' evaluation. The research members evaluated whether the participants could understand the two parts of the educational program, the telephone follow-up on the continuity of the program practice after the intervention, and the strengths and barriers in the process of conducting the intervention program. The participants were asked about their understanding of and satisfaction with the educational program, and if they were willing to continue the health promotion and participate in such kinds of program in the future. The process evaluation was carried out according to the framework suggested by Steckler and Linnan (2002).

Analysis

While the intervention was assigned at the community level instead of the individual level, residents in the intervention communities could decide to participate the program or not. Accordingly, there were three groups in the sample: participants in the intervention communities, nonparticipants in the intervention communities, and residents in the control communities. The chi-square test was used to examine differences in characteristics of residents across the three groups, and McNemar test and paired *t* test were applied to examine changes in outcome indicators before and after intervention within each group.

The generalized estimating equation (GEE) (Liang & Zeger, 1986) was performed to take into account differences across the three groups at baseline while examining the intervention effect. The GEE avoids the assumption for multivariate normal distribution by only assuming a variance functional form for the marginal distribution. The link functions were set as log (for Poisson and Gamma distribution) and logit (for Bernoulli distribution). The GELIN procedure in SPSS 15.0 (SPSS, 2006) was applied for the analysis. In the GEE models, individual characteristics (including age, gender, education and marriage status) were regarded as control variables, and the group and time effects were treated as overall differences in group (regardless of time) and time (regardless of group), respectively. It was our main interest to test the hypothesis of the significance of the interaction of group and time in the model. If the

intervention effect presents, the changes (before vs. after intervention) should show different across the three groups. Power calculation was also conducted to see whether the sample size was acceptable.

RESULTS

Table 1 shows the demographic characteristics of the participants who completed the wave 1 and 2 interviews. There were 45 intervention participants, 214 nonparticipants in the intervention communities, and 255 persons in the control communities. There were differences observed among the intervention groups after examining the test of goodness-of-fit (see Table 1). On examining the test of goodness-of-fit, no difference of gender or age distribution was found between those who completed the study and those who did not in the two waves of surveys.

There were significant differences at baseline among the intervention participants, nonparticipants, and the controls (see Table 2). The differences included weight change, lack of any category of food, and total number of problematic dietary behaviors; strength and balance of lower limbs, cardiopulmonary endurance, and total EFI score; ADL difficulty, and CES-D score. The changes between the two waves were compared within the groups using the paired *t*-test or McNemar test (see Table 2). With respect to the dietary behaviors, all the three groups showed a substantial increase in the lack of any category of food, but the control group was even worse in other dietary problems, including insufficient food intake, change in diet owing to digestive or oral problems, and weight fluctuation of >3 kg. The total number of dietary behavior problems increased significantly in all the three groups, and in the control group, it increased even more. Furthermore, regular exercise habit did not change among the intervention participants and nonparticipants, but it was significantly reduced in the control group (from 33.3% to 17.6%). This suggests that the control group showed a worsened trend between two waves in their dietary behavior or regular exercise, while the other two groups were less significant. The intervention participants had increased difficulty in cardiopulmonary endurance. The nonparticipants also had increased difficulty in the balance of lower limbs and strength as well as cardiopulmonary function, while the control group did not show any significant difference. However, the ADL difficulty and depressive symptoms did not change within any group.

Table 3 shows the behavior outcome of the intervention groups with the control group used as the reference and controlling for time

Table 2. Mean outcome score at 2 waves by intervention group

Outcome	Intervention participants (<i>n</i> = 45)			Intervention nonparticipants (<i>n</i> = 214)			Control (<i>n</i> = 255)		
	Wave 1	Wave 2	Change	Wave 1	Wave 2	Change	Wave 1	Wave 2	Change
Dietary behavior and regular exercise									
Missing any meals per day (%)	2.2	2.2		0.5	1.4		2.4	2.0	
Insufficient food intake (%)	0.0	0.0		0.0	0.5		0.0	2.7	*
Poor appetite (%)	15.6	8.9		16.8	15.0		20.8	24.7	
Eating alone (%)	6.7	8.9		13.6	15.0		14.5	13.7	
Intake amount change (%)	4.4	2.2		9.3	5.1		9.0	12.2	
Diet change due to digestive problem (%)	2.2	8.9		13.1	11.7		12.5	20.0	*
Diet change due to oral problems (%)	6.7	2.2		9.3	12.1		10.6	30.6	***
Weight change more than 3 Kg (%)	0.0	4.4		13.6	15.0		5.5	12.2	**
Lack of any categories of food (%)	28.9	68.9	***	49.5	76.2	***	38.4	67.5	***
Total problematic dietary behaviors	0.67	1.07	*	1.26	1.49	*	1.14	1.84	***
Mean (<i>SD</i>)	(0.83)	(0.89)		(1.38)	(1.23)		(1.21)	(1.52)	
Regular exercise (%)	28.9	44.4		30.4	31.3		33.3	17.6	***
Health outcome									
Total EFI score	17.36	18.31		22.72	23.72	*	21.12	21.11	
Mean (<i>SD</i>)	(6.90)	(7.31)		(11.78)	(12.07)		(9.52)	(9.76)	
Control for upper limbs and trunk	6.44	6.40		7.33	7.42		6.86	6.71	
Mean (<i>SD</i>)	(2.69)	(2.68)		(3.81)	(3.59)		(2.85)	(2.72)	
Balance of lower limbs and strength	6.80	7.09		9.22	9.78	*	8.45	8.86	
Mean (<i>SD</i>)	(2.78)	(3.25)		(5.72)	(6.12)		(4.72)	(5.01)	
Cardiopulmonary endurance	4.11	4.82	*	6.18	6.52	*	5.80	5.54	
Mean (<i>SD</i>)	(1.93)	(2.36)		(3.38)	(3.30)		(3.12)	(3.15)	
ADL difficulty	6.40	6.42		7.42	7.50		6.64	6.73	
Mean (<i>SD</i>)	(2.68)	(2.68)		(3.94)	(3.84)		(2.66)	(2.86)	
Depressive symptoms	11.98	12.80		14.45	14.53		15.13	15.95	
Mean (<i>SD</i>)	(3.17)	(5.21)		(5.44)	(6.12)		(5.78)	(6.38)	

Note. Means (standardized errors) or percentage (%) are given. Significance indicates the change between 2 waves, examined by paired-t test or McNemar test. **p* < .05, ***p* < .01, ****p* < .001.

Table 3. Coefficients from GEE regression of behavior outcomes by intervention groups

	Regular exercise	Total no. problematic dietary behaviors	Poor appetite	Eating alone	Intake amount change	Dietary change due to digestive problems	Dietary change due to oral problems	Weight fluctuation	Lack of any categories of food
Groups									
Intervention Participants	-0.459	-0.400*	-0.182	-0.468	-0.706	-1.606	-0.277	-0.977	-0.215
Intervention Nonparticipants	-0.169	0.096	-0.242	-0.182	0.062	0.073	-0.112	0.976**	0.478*
Time	-0.854***	0.481***	0.021	-0.046	0.325	0.555*	1.315***	0.869**	1.305***
Time * intervention Participants	1.571***	-0.012	-0.879	0.439	-1.060	0.902	-2.500*	-0.154	0.620
Time * intervention Nonparticipants	0.914***	-0.311**	-0.379	0.226	-0.992*	-0.704	-1.050**	-0.757*	0.031
Age	-0.015	0.001	0.034*	-0.039*	0.015	0.016	0.033*	0.003	-0.029*
Gender: female	0.133	-0.190*	0.107	-0.461	0.233	-0.026	-0.139	0.192	-1.212***
Education: illiterate	-0.946***	0.490***	0.464	0.130	0.114	0.977**	0.878*	-0.416	1.769***
Education: Primary school	-0.533*	0.136	-0.147	-0.225	-0.621	0.320	0.373	-0.451	0.987***
Spouse: no	-0.130	0.280***	-0.013	2.874***	0.031	0.229	-0.146	0.295	0.255

Note. GEE: Generalized estimating equation. Intercepts are omitted in the table. *N* for intervention participants = 45, nonparticipants = 214, control = 255. Missing meals and food intake were unavailable for analysis because of no variance in the response. Total no. of problematic dietary behaviors indicates the sum of following nine problematic dietary behaviors. Reference group of the independent variables are: intervention (control group), gender (male), education (primary high school or more), spouse (yes). * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4. Coefficients from GEE regression of health outcomes by intervention groups

	ADL difficulty	Depressive symptoms	Total physical function difficulty (EFI)	Function difficulty: Control for upper limbs and trunk	Function difficulty: Balance of lower limbs and strength	Function difficulty: Cardiopulmonary
Groups						
Intervention Participants	-0.003	-0.206***	-0.122*	-0.025	-0.132*	-0.240***
Intervention Nonparticipants	0.109*	-0.053	0.074	0.067	0.086	0.065
Time	0.000	0.038	-0.027	-0.037	0.016	-0.084*
Time * intervention Participants	-0.007	0.014	0.064	0.018	0.004	0.234**
Time * intervention Nonparticipants	-0.003	-0.034	0.041	0.035	0.006	0.099*
Age	0.010**	0.009***	0.019***	0.013***	0.022***	0.024***
Gender: female	0.054	0.031	0.086*	0.059	0.108*	0.089*
Education: illiterate	0.029	0.012	0.076	0.024	0.037	0.190**
Education: Primary school	0.038	-0.055	-0.005	0.028	-0.047	0.018
Spouse: no	0.035	0.078*	0.079*	0.017	0.103*	0.113**

Note: GEE: Generalized estimating equation. Intercepts are omitted in the table. *N* for intervention participants = 45, nonparticipants = 214, control = 255. Reference group of the independent variables are: intervention (control group), gender (male), education (primary high school or more), spouse (yes). * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5. Process evaluation of the program

Components	Strength and weakness
Recruitment	We asked the public health center staff to assist in the invitation procedure to increase the credibility of the program participation. The low participation may be related to the low willingness of individuals to participate, being too frail to participate in the program, or the invitation procedure was too selective. Besides, the public health centers could not provide assistance to our programs on weekends, and some elderly who needed family company were possibly unable to participate in the program.
Maintenance	After the program, we interviewed the participants by telephone three times, and also collected face-to-face interview data after three months. A total of 536 persons (263 persons in the control communities, 45 participants and 228 nonparticipants in the intervention communities) finished the interview.
Context	The context and environment of the intervention program was supported by the three public health centers. They offered the space, and their staff and volunteers were involved in the program. However, one of the settings was inaccessible for the disabled elderly. Besides, some of the potential participants could not join the program because of transportation problems.
Resource	The resources in the intervention included research project financing, the research members, and the public health center staff and volunteers. The public health centers in the research communities helped in preparing the settings for the program, inviting the participants by telephone, and during the program process assisting the participants. Because some elderly could only speak Chinese or Taiwanese dialects (e.g., Hakka), the public health center staff and volunteers helped with language communication when necessary.
Implementation	<p>(a) Before implementation: The fidelity and extent of the intervention was considered in the protocol preparation stage and also in the implementation stage. All the educational content were also designed and modified by the professionals in our research team. Also, the researchers, lecturers and trainers in the program had been trained before the program was implemented.</p> <p>(b) During implementation: The chief or the charge nurse introduced our research team to the participants. Besides the members in the research team, the staff in the health center came to assist the participants in the program. The program included easy lecture by computer and projector, video and physical therapist demonstrations, physical exercise, team-based practice games about food recognition and choice, and appropriate breaks with snacks. The lecturer received a good response from the participants. The trainers were available to give necessary assistance or explanations during the process, and provided their contact information for the participants in case they were needed after the program.</p>

(Continued)

Table 5. Continued

Components	Strength and weakness
Reach	<p>The program was finished within three hours. All the interveners could speak Mandarin and Taiwanese fluently but not in Hakka, which is the primary dialect in Gongguan, and therefore, assistance from volunteers and staff in the health center was needed. There was interference from the grandchildren that the participants took along with them, but the program was conducted smoothly in general.</p> <p>(c) After implementation: The research members self-evaluated the learning results of the participants, and were satisfied with the design of the program. The interveners (lecturers and trainers) were asked to give comments about their performance and relate the responses from the participants in each session. They estimated that at least two thirds of the participants could totally understand the program content. Almost all of the participants were satisfied with the program design and showed a strong interest in the program process.</p> <p>The food recognition games and physical activity exercises were implemented by dividing participants into small groups, while the lecturers and trainers evaluated the participants' performance and interaction as well. Interviews with participants showed satisfactory performance in the program. After the intervention program, the lecturers and the trainers evaluated the participants' understanding of the educational course as quite good, and the participants thought the course was not too difficult so most of them were able to follow all the instructions. Most participants (73.2%) thought the dietary choices and food recognition was simple and 17.1% felt the difficulty of the lecture was just fine, and 68.3% and 22.0% of the participants thought the physical activities were simple or fair.</p>
Barriers	<p>A low participation rate was the main drawback to the program, which has been discussed in the recruitment. The possible reasons that nonparticipants did not attend the program are as follows:</p> <p>(a) Personal characteristics: including being too frail to travel.</p> <p>(b) Environmental characteristics: 1. The health centers could only provide the setting and assistance on weekdays rather than weekends, and thus some elderly who needed family companionship were unable to come. 2. Some invited elderly lived far from the health center, and public transportation for some places in the communities was inconvenient. 3. We had to rely</p>

- on the staff in the health centers to assist in the invitation procedure, because the people only trusted the local health center but not our research team. We offered the name-list and phone numbers for the health center staff, but how they contacted the invited elderly was not under our supervision. Some staff invited some other people who were not on our sampling name-list because they thought that sufficient numbers were more important than *who* were coming. 4. One of the intervention settings was on the 4th floor of a building which didn't have an elevator.
- (a) Program characteristics: 1. Because of the low participation rate and necessity to separate the programs into intervention communities, we were unable to do a randomized assignment so there was a comparison problem. 2. The once-intervention design is less reinforcing than a repetitive design. The low compliance of the participants after the intervention program, was possibly related to a lack of commitment to the research team or the health center staff, or being unaware of the necessity for behavior change, according to their responses in the follow-up phone calls.
- Exposure Most of the participants (63.4%) were satisfied with the intervention program, 31.7% thought it was fair, and only 4.9% were unsatisfied. The time control was very good (within the three hours) considering the ages of the participating elderly. The participants showed their interest in the program from their responses to the lecturers and trainers.
- Continued use Only 43.5% of the participants still continued with the physical activity and healthy diet. Even though they promised to continue the health promotion activity at home, they did not record their exercise or diet on the brochure. During the wave 2 interviews, the participants' willingness to continue the physical activity or participate in a similar, follow-up course was only 34.2% and 53.6%. And 41.4% of them felt the brochure would remind them of health promotion activities. No adverse events were reported in the subsequent telephone follow-up or the survey.
- Contamination The selection of research communities took into account the possibility of 'contamination'. Each comparable community was geographically separated from its counterpart by another community to reduce the chance of contamination. However, the participants and the nonparticipants in the same intervention community could possibly have influenced each other. There were also some programs conducted by other research groups being implemented in one of our research communities.
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change within the individuals and their demographics. The results indicated that intervention participants demonstrate more regular exercise ($\beta = 1.571$) and less dietary change due to oral problem ($\beta = -2.500$) than the control group. The intervention nonparticipants were found to perform more regular exercise and had less problematic dietary behaviors than the control group, although they did not participate in the program. The intervention nonparticipants showed more regular exercise, less intake amount change, less dietary change due to oral problems, and less weight fluctuation than the control group. In addition, the significance of time effects also indicated the reduction of regular exercise and the increase of problematic dietary behaviors across time.

Table 4 shows the health outcomes by comparing the groups. The intervention participants were not different from the control group in most health outcome indicators, and the intervention participants showed more difficulties in cardiopulmonary function than the control group after intervention ($\beta = 0.234$). The non-participants also showed similar results. Therefore, the discussion of the intervention effect must be done through the process evaluation.

The results of process evaluation are shown in Table 5. In general, the process of implementation and reach were conducted according to our design, and the satisfaction of the participants was high. The main barriers of the program were the low participation and difficulty in compliance or adherence. The personal, environmental, and program characteristics of the barriers are described in Table 5. The intervention process involved the participation of the community (healthcare centers, community setting, transportation, etc.), combined with strength and weakness, such as recruitment, context, resource, and contamination. These barriers were less controllable in a community-based experimental design.

DISCUSSION

This successful aging intervention focused on physical function and dietary behavior through a community-based, group education-approach program for the elderly people in the communities described earlier. The intervention participants demonstrate more regular exercise behavior and less dietary change than the control group due to oral problems. Nevertheless, the intervention program did not prove its effect in improving physical function or depressive symptoms significantly. The process evaluation showed that the

strengths of this program were proper design, dosage, and implementation, while the weaknesses included low participation rate, low commitment and continuity, and selection bias for the nonparticipants who might be frailer and subjected to contamination.

Effects on Healthy Behaviors

This means that the intervention program may have the effect of regular exercise and reduce problematic dietary behavior, particularly a diet change due to an oral problem. Hence, such intervention programs may be partially useful to change some dietary behavior, as demonstrated in previous studies (Resnick, 2003). However, not all the dietary behaviors were proved to be changed after the intervention, and the choice of the six categories of food did not significantly change either. Some possible explanations are as follows. First, the meals of the elderly people in the research communities were usually cooked by their family or they dined out; therefore, they did not make individual decisions on what to eat in everyday meals. Second, the diet was not only a health behavior, but also a culture. To improve the nutrition knowledge may be easier, but to change the dietary habits that had already been established throughout an elder's whole life is relatively difficult. In addition, dietary habits are usually related to the coresident family member who is in charge of cooking. Thus, the effect may not be very efficient when the intervention is implemented only on the elderly people and not on the family member who cooks the meals. Third, the the nonparticipants compared to the control groups also showed an increase in their regular exercise and a reduction in problematic dietary behaviors. It is possibly the result of a "contamination effect" of the intervention, since the nonparticipants also lived in the intervention communities.

Effects on Health Outcome

The intervention effect on physical function was not proved as previous studies (Hughes et al., 2004; LIFE study, 2006; LaStayo, Ewy, Pierotti, Johns, & Lindstedt, 2003; Thomas and Hageman, 2003; Gardner et al., 2001). Although the time effect in a year may offset the effect of improving cardiopulmonary function, the total effect was still positive. This means the intervention program is effective to slow the deterioration of physical function or even to improve it. Furthermore, our program did not show its effect in improving

depressive symptoms through regular exercise or balanced diet as previous studies (Paluska & Schwenk, 2000; Taylor, Sallis, & Needle, 1985; Woo et al., 2006). The possible reasons include that the dose of the intervention was limited and that the outcome evaluation of the effect was only short-term.

COMMUNITY-BASED INTERVENTION AND INTERVENTION DESIGN

Many of the barriers and limitations of this study were from the design of the public health approach, i.e., community-based and group education. The community-based intervention design may confront uncontrollable situations such as low participation rate, recruitment selection-bias, lack of commitment or compliance among the participants, inappropriate setting in the community, or unavailability of transportation in rural areas. The acceptance of the intervention program by a public health approach may be lower than for those programs that are clinical- or medical-oriented (King, 2001). However, the public health approach applied in health promotion programs is common, especially in Taiwan. In fact, the randomized controlled trial or medical-oriented design is difficult and not suitable for health center nurses or community volunteers to implement in the programs. These community workers, nevertheless, are one of the important resources of health promotion in the community. Therefore, the barriers of such programs should be considered and reduced in advance. One of the key factors to the success of a community-based program is the collaboration of community resources and good communication with the health center nurses or the community workers. However, partnership between the researchers and community workers is not easy to establish. The collaboration needs a long-term and trusting relationship, necessary empowerment or education of the community workers before the implementation, and assistance from the community to offset the unavailability of infrastructure or public transportation. In addition, adequate research funding for compensating the community workers appropriately may be necessary, because being a part of a research program needs extra effort in addition to the workers' usual heavy workload. The presence or lack of such compensation may influence the recruitment and participation of community workers.

The compliance and adherence of the participants in our study was not very good, which was also observed in other research (Hughes et al., 2004). The low involvement required in our program (attending

the program just for one of three hours) may also affect the adherence to the program. However, we tried to offer visual cues using brochures and design of simplified exercises to compensate the low involvement design. Besides, the lack of encouragement and social support, unpleasant sensations, constraints to exercise, and the fading of the effect may decrease the willingness of the participants (Resnick et al., 2005). In this study, we assigned a trainer to several participants to keep contact and make follow-up calls to encourage their adherence, but the effect of these calls may be lesser than a more repetitive or multiple-time program. We presume that a small group design with appropriate educational content and multiple-time or repetitive approach may be more effective. In the repetitive or follow-up contact, encouragement and social support to the participants is embedded in the program. This includes such things as the assignment of a specific trainer, enforcing positive behavioral change by rewards, or inviting the family of the participants to also attend the intervention program.

Researchers have reported that either individual or group education is an effective approach in the intervention, and a combination of class-based and home-based models may increase the efficacy of the program (King, 2001; Marcus et al., 2006). However, the group approach is the most popular and economic approach to implement health promotion programs in public health. A combination of written prescription and verbal advice is considered to enhance the effectiveness under such situation (Marcus et al., 2006). In our program, we combined the educator's input, media education, group practice, and a brochure with recording tables to help in improving the effectiveness of the program. The participants showed a satisfactory evaluation toward the program, and the process was also assessed to be well conducted by the trainers and lecturers. We also found an additional benefit of our program—we offered the intervention educational materials to the health centers in the research communities and some volunteer groups as feedback and as an empowerment instrument for their future work.

LIMITATIONS

There are some aspects of this study that may be improved. First, the research communities were purposely selected to be the intervention or control groups to assure the sampling variability of different lifestyles and ethnic constituency in the communities. However, the samples (participants/nonparticipants/control) were not randomized assigned, so we have to control the sample characteristics by

statistical methods to examine the intervention effects. And the power of the statistics can be improved if the sample size of the participants could increase. Second, the amount of the intervention may not be enough to produce the desired effect. Additionally, the duration of the observation may not be enough to show whatever effects there were. In fact, we initially designed the intervention program to be longer and repetitive in the intervention communities. However, the elderly people in the community did not show much willingness to participate in the program, according to the health center staff used in the recruiting process. Thus, the program was only conducted once in each community. At the same time, the participants of the intervention program were few. Third, the duration between two waves was long, and there may have been a time lag showing achievement of successful aging for all the elderly participants. Fourth, the intervention participants may be the healthier elderly people in the community, and those frail elderly who might have been improved through the intervention were not included. Therefore, the effect of the intervention might be underestimated. Fifth, the questions about intake of the six categories of food were possibly not validated by self-report. However, this is the limitation of the survey method when applied to elderly people. Other methods for recording nutrition intake are not suitable for elderly people. In view of all this, one could conclude that conducting research about dietary problems of the elderly people is difficult.

CONCLUSION

Our successful aging intervention showed partial improvement in regular exercise and dietary behaviors, but did not prove its effect on the health outcome of successful aging. The change of health outcome may need a long-term effect of the program to detect the difference. In addition, physical health of the disabled or frail elderly people may not be easily improved, particularly their health may deteriorate across time rapidly. However, the effects of engaging in health promotion earlier may possibly postpone the decline of health. We suggest application of random assignments or matched pairs in similar research—if the participation rate is higher and the participation in the program is adequate. We also suggest that further studies should assess the long-term successful aging effect by health promotion interventions in public health programs, and the process of the programs should be examined to improve the effectiveness.

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