

SUPPLEMENTARY MATERIAL 1

Exercise contents

The American College of Sports Medicine (ACSM) categorizes exercises as aerobic, strength training, flexibility, and balance exercises. In the case of aerobic exercise, the ACSM physical activity guidelines recommend that healthy elderly individuals perform 30 minutes of moderate-intensity exercise each day (e.g., fast walking and yard work) and that frail and sedentary elderly should exercise 3–5 times per week for 20–30 minutes. Strength training exercise should be performed at least twice weekly for muscle strength and endurance. Elderly individuals should also perform balanced stretches at least 2–3 times per week to maintain flexibility and improve their sense of balance and agility. The exercise model in this study was developed based on the ACSM guidelines.

Steps of the exercise according to physical strength

The first step is for those first beginning to exercise among those who are considered to be frail based on the definitions of frailty. This step consists of two kinds of daily physical activities, three kinds of aerobic exercises that can be easily performed at home, four kinds of muscle-strengthening exercises including those performed while lying down and against a wall, five movements for flexibility of the important joints of the body, and sedentary activity that adds intentional movements.

Step 1	
Daily physical activity (every day)	1. Meet friends or acquaintances, take a walk or go out 2. Get up and move once every 20 minutes
Aerobic exercise (six times a week/Mon-Sat)	1. March in place with clapping (finger, wrist, back of the hand) (5 minutes) 2. Hold the wall and march left and right in place (5 minutes) 3. Sit on a chair and row left over right (5 minutes)
Strength training exercise (three times a week/Mon, Wed, Fri)	1. Lie down and draw up the knees with buttocks lifting (hold 5 seconds, five times/repeat three times) 2. Lie down and raise one arm and the opposite leg (five times/repeat three times) 3. Hold the wall and raise the heel (hold 5 minutes, five times/repeat three times) 4. Hold the wall and do push-up (five times/repeat three times)
Flexibility exercise (every day)	1. Lie down and do knee-to-chest (hold 5 seconds/repeat five times for each knee) 2. Stretch the legs and pull tiptoes and pushing them (five times/repeat three times) 3. Grab shoulders with the hands and circle shoulders (forward and backward five times) 4. Do an invisible hula hoop exercise (forward and backward five times) 5. Circle both wrists and ankles (forward and backward five times)
Sedentary activity	1. Clap overhead 20 times while watching television

The second step is for subjects who have improved their physical strength after performing the first step among subjects considered to be frail based on the definitions of frailty. This step consists of two kinds of daily physical activities such as housework, three kinds of aerobic exercises that can be easily performed at home, four kinds of muscle-strengthening exercises composed of lying-down and seated exercises, five movements for flexibility of the important joints of the body, and a sedentary activity consisting of word associations to improve cognitive ability.

Step 2	
Daily physical activity (every day)	1. Wash clothes (using a washing machine), meet friends or acquaintances, take a walk or go out 2. Do the dishes, get up and move once every 20 minutes
Aerobic exercise (six times a week/Mon-Sat)	1. Bounce knees and do invisible jump rope (5 minutes) 2. March in place with dementia clapping (fist, finger, fingertips, wrist, back of the hand) (5 minutes) 3. Walk with arms shaking while singing 'popular songs' (5 minutes)
Strength training exercise (three times a week/Mon, Wed, Fri)	1. Lie down and draw up the knees with buttocks lifting (hold 5 seconds, five times/repeat three times) 2. Lie down, draw up the knees with the arms stretching, and do half sit-ups (five times/repeat three times) 3. Place the hands together and maintain a prayer pose (hold 5 seconds, five times/repeat three times) 4. Sit on a chair and then stand (five times/repeat three times)
Flexibility exercise (every day)	1. Stretch the four sides of the neck (hold 5 seconds on each side) 2. Push a pillow with the knees and pull the tiptoes (hold 5 seconds/repeat five times) 3. Stretch the arms forward and backward with hands clasped (hold 5 minutes/repeat five times) 4. Stretch the four sides of the waist (hold 5 seconds on each side) 5. Circle both wrists and ankles (forward and backward five times)
Sedentary activity	1. Memorize five Senior Welfare Center members' name (friends or acquaintances) while lying or sitting down

The third step is for those first beginning to exercise among those who are considered to be pre-frail based on the definitions of frailty. This step consists of two kinds of daily physical activities such as housework, three kinds of aerobic exercises that can be easily performed at home, four kinds of muscle-strengthening exercises that can be performed in various poses, five movements for flexibility of the important joints of the body, and a sedentary activity consisting of word associations to improve cognitive ability.

Step 3	
Daily physical activity (every day)	1. Clean up (wiping, using washing machine), take a walk or go out (1 or 2 times more than usual) 2. Walk to the supermarket (going supermarket that is far away from home)
Aerobic exercise (six times a week/Mon-Sat)	3. Stand up and row (5 minutes) 4. Walk with arms shaking while singing 'popular songs' (5 minutes) 5. Bounce knees and clap on all sides (5 minutes)
Strength training exercise (three times a week/Mon, Wed, Fri)	1. Lie down, draw up the knees with arms stretching, and perform half sit-ups (five times/repeat three times) 2. Lie prone and support the body with the arms and tiptoes (five times/repeat three times) 3. Grab a water bottle and stretch the hands (forward, left & right, and backward 5 seconds, five times/repeat three times) 4. Sit on a chair and half-stand while holding the chair (five times/repeat three times)
Flexibility exercise (every day)	1. Stretch the arms forward and backward with hands clasped (hold 5 minutes/repeat five times) 2. Grab shoulders with the hands and circle shoulders (forward, backward five times) 3. Sit on the floor and spread the legs (hold 5 seconds/repeat five times) 4. Push a pillow with the knees and pull the tiptoes (hold 5 seconds/repeat five times) 5. Plate spinning (left and right five times)
Sedentary activity	1. Memorize 10 subway stations or bus stops while lying or sitting down

The fourth step is for subjects who have improved their physical strength after performing the third step among subjects considered to be pre-frail based on the definitions of frailty. This step consists of three kinds of daily physical activities such as housework, aerobic exercise including 30 minutes of outdoor walking, three kinds of muscle-strengthening exercises including complex exercises that use the upper and lower body, six movements for flexibility of the important joints of the body, balance exercise for fall prevention, and a sedentary activity consisting of word associations to improve cognitive ability. A balance exercise is included from step 4 onward.

Step 4	
Daily physical activity (every day)	1. Do housework (cleaning/shopping/cooking/using stairs instead of an elevator) 2. Walk or go out (1–3 times more often than usual, 2–3 minutes slightly faster than usual) 3. Walk with a pet
Aerobic exercise (three times a week/Mon, Wed, Fri)	1. Walk for 30 minutes (1–2 minutes faster than usual for every 10 minutes)
Strength training exercise (three times a week/ Tue, Thu, Sat)	1. Stand up and row (left and right five times/repeat three times) 2. Lie down and then raise one arm and the opposite leg at the same time (five times/repeat three times) 3. Lie down and draw a circle with each leg (left and right five times/repeat three times)
Flexibility exercise (every day): upper body/lower body/back/waist stretch	1. Pull the neck left, right, forward, and backward (stretch the four sides of the neck) (forward and backward 10 times) 2. Grab shoulders with the hands and circle shoulders (forward and backward 10 times) 3. Stand up and pull the knees (hold 5 seconds/repeat 10 times) 4. Circle both wrists and ankles (forward and backward 10 times) 5. Sit on the floor and put both feet together. sticking them to the trunk as much as possible, hold feet with hands and then slowly bend the upper body (hold 5 seconds/repeat three times) 6. Lie prone and lift the upper body toward the sky with the hands (hold 5 seconds/repeat three times)
Balance exercises (two times a week/Wed, Fri)	1. Stand straight with open arms (hold more than 5 seconds, five times/perform 3 minutes) 2. Stand up and cross the legs with open arms (hold more than 5 seconds, five times/perform 3 minutes) 3. Hold the wall and stand on one foot (hold more than 5 seconds, five times/perform 3 minutes)
Sedentary activity	1. Speak 10 words to the match word chain rules while lying or sitting down

The fifth step is for subjects first beginning to exercise among those who are not considered to be frail based on the definitions of frailty. This step consists of three kinds of daily physical activities such as housework, or aerobic exercise including 30 minutes of outdoor walking, seven kinds of muscle-strengthening exercises using chairs, six movements for flexibility of the important joints of the body, balance exercise for fall prevention, and sedentary activity consisting of word associations to improve cognitive ability.

Step 5	
Daily physical activity (every day)	1. Perform housework (cleaning/shopping/cooking/using stairs instead of an elevator) 2. Take a walk or go out (1–3 times more often than usual, 2–3 minutes slightly faster than usual) 3. Take a walk with a pet
Aerobic exercise (three times a week/Mon, Wed, Fri)	1. Walk fast while shaking arms (30 minutes)
Strength-training exercise (three times a week/Tue, Thu, Sat)	1. Sit on a chair and push and pull the tiptoes (left and right five times/repeat three times). Sit on a chair and raise the knees alternately (five times/repeat three times) 2. Sit on a chair and perform invisible bike exercise (hold 10 minutes/repeat three times) 3. Sit on a chair and stand up without support (five times/repeat three times) 4. Sit on a chair and sit up (five times/repeat three times) 5. Keep arms crossed and hold them overhead (hold 30 minutes/repeat three times) 6. Grab the water bottle and bend your arms behind the head (5 times/repeat three times).
Flexibility exercise (every day): upper body/lower body/back/waist stretch	1. Pull the neck left, right, forward, and backward (stretch the four sides of the neck) (forward and backward 10 times) 2. Grab shoulders with the hands and circle shoulders (forward, backward 10 times) 3. Stand and pull the knees (hold 5 seconds/repeat 10 times) 4. Circle both wrists and ankles (forward and backward 10 times) Sit on the floor and put both feet together. stick them to the trunk as much as possible and hold the feet with the hands and slowly bend the upper body (hold 5 seconds/repeat three times) 5. Lie prone and lift the upper body toward the sky with the hands (hold 5 seconds/repeat three times)
Balance exercises (Two times a week/Wed, Fri)	1. Walk backward 3 m with hands clapping back and forth (perform 3 minutes)
Sedentary activity	1. Speak 15 city or fruit names while lying or sitting down

The sixth step is for subjects who have improved physical strength after performing the fifth step among subjects considered to not be frail based on definitions of frailty. This step consists of three kinds of daily physical activities such as housework, aerobic exercises consisting of sports such as badminton, and dance for the elderly, five kinds of muscle-strengthening exercises using a theraband, six movements for flexibility of the important joints of the body, balance exercises for fall prevention, and a sedentary activity consisting of word associations to improve cognitive ability.

Step 6	
Daily physical activity (every day)	1. Do the housework (clean-up/shopping/cooking/using stairs instead of elevator) 2. Take a walk or go out (1–3 times more often than usual, 2–3 minutes slightly faster than usual) 3. Take a walk with a pet
Aerobic exercise (three times a week/Mon, Wed, Fri)	1. 30 minutes of badminton/30 minutes of dance for the elderly/50 minutes of swimming/5 games of table tennis/50 minutes of gate ball
Strength training exercise (3 times a week/Tue, Thu, Sat): strength exercise using a theraband	1. Hold the theraband overhead and spread it to both sides (five times/repeat three times) 2. Step on the theraband, hold it in an X shape, and pull it diagonally (five times/repeat three times) 3. Lie on the side, tie two legs together, and alternately raise one leg (five times/repeat three times) 4. Sit down and put the theraband on the sole of one foot and pull it, raising the legs alternately (five times/repeat three times) 5. Sit on a chair, press the thigh with the theraband, and raise one leg alternately (five times/repeat three times)
Flexibility exercise (every day): upper- body/lower body/back/waist stretch	1. Pull the neck left, right, forward, and backward (stretch the four sides of the neck) (forward and backward 10 times) 2. Grab the shoulders with the hands and circle the shoulders (forward and backward 10 times) 3. Stand and pull the knees (hold 5 seconds/repeat 10 times) 4. Circle both wrists and ankles (forward and backward 10 times) 5. Sit on the floor and put both feet together. stick them to the trunk as much as possible and hold the feet with the hands, and then slowly bend the upper body (hold 5 seconds/repeat three times) 6. Lie prone and lift the upper body toward the sky with the hands (hold 5 seconds/repeat three times)
Balance exercises (2 times a week/Wed, Fri)	1. Do Jegichagi (10 times, repeat three times/perform three minutes) 2. Maintain the pose (superman pose with one leg raised, scarecrow pose) (hold more than 5 seconds, five times/perform 3 minutes)
Sedentary activity	1. Lie down and mentally organize the happenings of that day