

Effects of Nurse and Care Worker-led Foot-Care Program on Older People's Foot Conditions: Before and After Intervention Study

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Abstract

Introduction: An increasing number of older people with frailty in Japan use geriatric day care centers. Older people who have been certified as requiring long-term care attend centers during the day and receive nursing care help with bathing, excretion, meals, and functional training services. Many older people have foot problems with need foot care by nurses and care workers (NCWs) at geriatric day care centers.

Objective: This study explored the effects of NCWs' foot-care programs on the foot conditions of older people attending daytime services.

Methods: A before-after intervention study was conducted at geriatric day care centers for older people, where the foot-care program was presented by NCWs for two months. The foot conditions of 23 clients (8 men, 15 women, mean age = 78.6 years, standard deviation = 9.2) were assessed before and after the program. Changes in foot condition and clients' perceptions after the study were analyzed through descriptive statistics, McNemar, and paired *t*-tests.

Results: Although dramatic changes in foot conditions were not observed, some conditions were improved or maintained. Changes were observed in mean dry skin scores ($p < .01$; right foot: 1.6 → 1.1, left foot: 1.6 → 1.1), skin lesions and long nails (skin lesions R: 0.2 → 0.1; long nail R: 1.4 → 1.0, L: 1.1 → 0.8), and edema (R: 43.5% → 39.1%, L: 52.2% → 47.8%). Further, clients started perceiving that foot health is important and discussed their feet with staff more often.

Conclusion: The NCWs' foot-care program was effective in maintaining and improving foot health in older people and positively affected their perception of foot care.

Keywords

Nurse and care workers, foot care program, foot problems, older people

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Introduction

Foot problems, including nail, skin, vascular, neurological, and bone changes, are a major concern among older populations. Foot problems increase due to systemic physical changes related to aging—changes include foot pain, imbalance while standing, impaired ambulation (Menz et al., 2006), falling, and depression arising from foot problems—all major concerns (Awale et al., 2016; Menz & Lord, 2001).

Miikkola et al. (2019) reported there is high demand for foot care for older people at home. Older people with frailty living in the community may experience exacerbated foot problems because of selecting inappropriate shoes, systematic physical changes, inability to self-care owing to poor vision, or lack of physical movement. Difficulty using

transportation may render them unable to access doctors, reducing daily living activities and participation in social

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activities (Eby et al., 2017) and further worsening conditions. The interpretation of “frail” here uses the definition suggested by researchers (Cesari et al., 2017; Gobbens et al., 2010), namely individuals who are physically weak or need some care assistance.

In Japan, the ongoing demographic change poses serious challenges for society. The proportion of the population aged 65 and above has changed from 5.6% to 28% from 1960 to 2018 (World Bank Group, 2018). Hospital stays are decreasing, and the focus of care is shifting from the hospital to the community. The growing number of older people in the community means the quality of their care, given the shortage of paid caregivers, is also a major concern in Japan (Ministry of Economy, Trade and Industry, 2018).

As the number of older people increases, the number of people with foot problems is also expected to increase. However, there is limited research in Japan that captures the actual prevalence of community dwelling older people with foot problems (Harada et al., 2010).

In Japan, all citizens have public medical insurance. Additionally, there is a system called long-term care insurance (LTCI). LTCI covers: (1) people aged 65 years or above (Category 1), and (2) people aged 40–64 years with at least one of 16 specified conditions (Category 2). Care service applicants are categorized into two support levels and care levels 1 to 5 after screening (Ministry of Health, Labour and Welfare, 2016). All people over 65 years are eligible to apply for long-term care services, although not all of them are certified to receive care services. This group is officially eligible to receive services after municipalities judge the level of care required via the assessment process. Currently, approximately 18.4% of individuals aged 65 or older are certified for the LTCI (Ministry of Health, Labour and Welfare, 2020). This percentage has increased over recent years, from 11.2% in 2000 to 16.9% in 2010 (Ministry of Health, Labour and Welfare, 2000; 2010).

LTCI is divided into home-based, community-based, or facility services. Geriatric day care centers (thereafter, day care centers) are included in the category of community-based services. Although services vary among facilities, they must adhere to fundamental regulations to provide daytime care services. Service costs are higher in facilities offering professional rehabilitation programs.

Foot care is one area where the quality of nursing care in the community could be enhanced. Many older people with frailty attend day care centers and may seek foot care. Ideally, foot health should be achieved by integrating care into the work of caregivers and clients. However, the provision of foot-care services is impeded by obstacles such as limited foot-care education for nurses and care workers (NCWs), no podiatry system, low public and medical awareness of foot care, and shortages of paid caregivers. Some older people have difficulties in taking care of their feet by themselves due to physical changes associated with aging, NCWs working with them can significantly aid them with

foot care. Obtaining basic knowledge and practice of foot care by NCWs would contribute to the prevention of the worsening of foot problems to maintain foot health of older people. Thus, the author (KF) introduced a foot-care program for NCWs (Fujii & Stolt, 2020) and evaluated its spill-over effects on older people. This study is part of a larger study examining the enhancement of NCW knowledge and practice skills. Here, the effects of a foot-care program on the foot health of older clients were explored.

The following were the study hypotheses:

1. The NCW foot-care program will result in some improvement in clients' foot conditions, but not dramatic changes related to older people's physical characteristics.
2. Foot-care perception of older people will be positively affected by the program.

Materials and Methods

The design of this study was a before-and-after intervention study. The study followed the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement (Fuller et al., 2012).

Study Setting

From July to October 2019, a foot-care program to enhance NCW's knowledge and practice was introduced to 21 in-home service providers, such as home-visit nursing providers, day care centers, and day care centers offering a rehabilitation program. Targeted providers were randomly selected from the Ministry of Health, Labour and Welfare's list of service providers. NCWs, who had agreed to participate in a two-month-long survey, participated in this study (Fujii & Stolt, 2020). The study focused on clients of 10 out of the 11 providers in the intervention group to ascertain how the clients' foot condition and perception of foot status were affected by the foot-care intervention for NCWs.

All clients at facilities could be influenced by the changing NCW foot-care knowledge and practice. However, two or four clients were recruited from each facility, and their foot care was monitored during practice sessions for the two-month study period (Fujii & Stolt, 2020). The care sections varied across the facilities; however, in most cases, a separate room or space was provided.

National research on foot-care provisions in day care centers is limited. It seems that simple toenail care with a nail clipper is provided daily in many day care centers. There were no foot-care professional visits at these facilities; clients with significant foot problems visited a doctor.

The facility managers agreed to select suitable clients for the study. All facilities were comfortable with selecting clients and explaining the study's purpose because they felt responsible for their care and had built trusting relationships with them. NCW staff at each facility were aware of clients'

foot conditions by observing them when assisting with bathing or changing socks; therefore, the NCWs had high interest in foot care (Fuji & Stolt, 2020; Fuji et al., 2020b). NCWs listen to the clients daily and observe foot movement when clients walk and do simple exercises.

The study's inclusion criteria were that the client:

1. Attended a facility that has never offered any other foot-care program and agreed to participate,
2. Was identified as a candidate by the facility or the first author based on a foot assessment,
3. Understood the study's content or their family signed the agreement.
4. Received foot-care services at least twice during the study period,
5. Had one or more foot problems, such as a foot with a) slight maceration or fissures between toes owing to overlapping, b) ingrown or thickened toe nail or a toe nail with potential fungal infection, c) thick keratin on the soles of the toes, d) edema of the foot, e) skin lesions (e.g., callus, corn) that cause foot pain, or f) a risk of worsening foot conditions owing to chronic diseases. Other conditions were also considered as denoting a high risk of foot problems.

Clients with normal foot conditions were excluded since it would not be possible to observe changes. Additionally, participants who had foot infections, such as cellulitis, were excluded. Previous literature related to foot infection associated with diabetes provided guidelines on diagnosis or complications (Hurlow et al., 2018; Lipsky et al., 2020). However, there are no guidelines for identifying foot infections among older people living in the community.

The author (KF) emphasized that facility staff or managers should not pressure clients to participate. Once the facility identified potential participants, a manager or staff member explained the study and verbally asked the client whether they would be interested in participating. In certain cases, a client's cognitive state was such that agreement from a family member was necessary, or the facility manager or staff member considered agreement was necessary for participating clients. Consequently, a facility staff member—instead of the author (KF)—gave the invitation and agreement letters to the client's relevant family members. When the author (KF) visited the facility before the practice session, the details were reiterated to the client, and oral and written consent was obtained.

Ethical Considerations

This study was conducted in accordance with the 2000 Helsinki Declaration (UMIN-CTR [University Hospital Medical Information Network Center Clinical Trials Registry] UMIN 000036307, July 25, 2019). The Ethical Committee of the University of Human Environments

approved the study. Each client participant, the family members of some clients, and the NCWs attending the foot-care program provided written informed consent.

Instruments

Foot assessment sheets. A foot-assessment sheet was developed for this study and used to assess clients' feet conditions before and after the foot-care program. Items were rated as 1 for "exists" and 2 for "does not exist" or, for some items, counts were provided, such as number of toe or skin lesions. The foot-assessment sheet items, along with definitions and measurement methods for analysis, are presented in Table 1. Dry skin was initially assessed as 1 for "exists" or 2 for "does not exist." Subsequently, it was classified based on overall dry skin scores (ODS) as outlined by the European Group on Efficacy Measurement and Evaluation of Cosmetics and Other Topical Products (EEMCO) guidelines' clinical scoring systems (Kang et al., 2014; Lichterfeld et al., 2016; Serup, 1995). Foot sensitivity was assessed using the Ipswich Touch Test (Madanat et al., 2015; Sharma et al., 2014), foot edema using pitting edema measurement (O'Sullivan & Schmitz, 2007), and hallux valgus using machine-based graphic assessment. If the client could not step onto the machine for measurement, the degree of hallux valgus was measured later by observing a picture of their foot taken at the research site. This condition was divided into four categories: normal (15 degrees or less), mild (less than 20 degrees), moderate (20 to 40 degrees), or severe (40 degrees or more; Coughlin & Jones, 2007). The foot-assessment sheet was reviewed by a surgeon from an expert panel with significant knowledge of feet and foot care. Items on skin lesions were adapted from another instrument with permission from the developer, Dr. Hilton Menz, an internationally recognized researcher (Menz & Lord, 2001)

Measurement equipment. Foot Look (Foot Look, Inc, Japan) was used to measure floating toes and the degree of hallux valgus. When the subject stands and places the soles of the feet on the scanner, the machine captures an image of the sole of the foot and transfers the image to a computer. The examiner is able to capture an image of the entire sole of the foot.

Toe force measurement (T.K.K 3364 Takei Scientific Instruments, Japan) was used to measure toe grip strength. Using this instrument, the participant grips a bar using the toes with maximal force for approximately 3 s. The toe force exerted is displayed on a small screen on the machine.

The definitions of terms are based on previous studies cited or the book "Terminology of Foot & Ankle Surgery" published in Japan (Japanese Society for Surgery of the Foot, 2017). The author (KF) developed the measurement of the width of toe opening.

Table 1. Foot Measurement Items.

Item	Definition of measurement	Measurement	Scale definition for this study's analysis
Arch deformities	Abnormal arch (e.g., high arch or flat foot)	Examiner assessment based on Foot Look (machine) images	Exists/does not exist
Ingrown toe nails	Corner edges of nails growing into the skin	Examiner's assessment	Exists/does not exist
Sensitivity of toe (1st, 3rd, 5th)	Foot sensation. Usually, if the subject feels numbness in two or more of the three toes, sensation is considered abnormal	Examiner touched the client's toes and asked whether they could feel it (Ipswich Touch Test)	Clients have feeling/do not have feeling (if they did not have feeling, there was a problem of sensitivity)
Foot circulation	Palpable posterior tibial arteries	Examiner palpated the artery pulse halfway between the medial malleolus posterior border and the Achilles tendon	An examiner could palpate the pulse or could not palpate it
Edema	Pitting edema	Skin was pressed over the tibia, and the area pressed rated as +1 barely detectable indentation, +2 slight indentation (15 s to rebound), +3 deeper indentation, +4 deeper indentation (above 30 s to rebound)	Above +2 was counted as edema in this study
Skin color	Skin color (e.g., red, white, or purple)	Examiner's assessment	Normal skin color or abnormal skin color (e.g., red, purple, or white)
Toe deformities	Abnormal toes (e.g., mallet toes, hammer toes, claw toes, hallux valgus, or lesser toes)	Examiner's assessment	Number of toes involved
Hallux valgus	Degree of hallux valgus	Examiner's assessment based on Foot Look (machine) images	Degrees
Skin lesions	Hyperkeratotic skin lesions (area of thickened skin caused by repeated friction or pressure). Corn is usually hard and painful when pushed	Examiner's assessment	Number of skin lesions
Maceration between toes	Peeling and fissuring between the toes, lighter in color, sometimes white	Examiner's assessment	Number of instances
Nail color change	Lack of nail color such as white or yellow	Examiner's assessment	Number of toenails involved
Long nails	Longer than fingertip	Examiner's assessment	Number of toenails involved
Thickened nail	Nail has notable thickness	Examiner's assessment	Number of toenails thicker than 2 mm
Dryness of skin	Corneal layer water loss	Overall dry skin score (ODS) EEMCO guideline. Note: Specified symptom sum score (SRRC) excluded from this study	Exists or does not exist, then assigned a score between 0 to 4
Suspected presence of nail with fungal infection	Already diagnosed or suspected from nail color	Examiner's assessment	Number of toenails involved
Walking speed	4-meter walking speed	Measured by the examiner or a research assistant	Seconds
Width of opening toes	Width between toes (first and second toes) when examiner instructs clients to open toes	Examiners measured the width using a tape measure	cm
Toe grip strength	The toe strength displayed on the screen of the machine when a client grips the bar using maximum force	Examiners or research assistants measured the toe strength with a toe grip dynamometer (T.K.K. 3364, Takei Scientific Instruments Co. Ltd)	kg
Floating toes	Toes that are not completely in contact with the ground	Examiner's assessment based on Foot Look (machine) images (Foot Look Inc.)	Number of toes involved

Other instruments. A demographic data sheet that included a questionnaire that addressed the age, level of care under LTCI, and the Barthel Index (Sainsbury et al., 2005) were used to collect data. Although the Barthel Index cannot accurately capture the conditions of the activities of daily living, it is frequently used in Japan. Data on illness history, walking time, skin temperature, degree of hallux valgus, and width between the first and second toes (when intentionally opening) were also collected.

Initially, a short physical performance battery (consisting of gait speed, balance test, and chair stand test) was considered to assess functional performance. In a previous study by the author (KF) (Fuji et al., 2020a), it was found that balancing and standing up from chairs caused instability or shortness of breath for older people with frailty, despite no previous heart problems. Therefore, these tests were not used in this study.

Questions were developed to measure the client's perception of foot care. Previous studies have reported that foot conditions are associated with psychological aspects, such as depression (Awale et al., 2016). Therefore, the attempt in this study was to include questions with psychometric features from existing scales that address aspects such as fall efficacy (measuring a person's confidence to do certain activities without falling) or anxiety. However, some frail older people were unable to answer the questions due to their inability to recall events related to their fall or other contents. The questionnaires that asked the participants about feelings and consideration towards foot care were developed in this study. Previous studies have examined the effects of reflexology on anxiety and pain in cancer patients (Stephenson et al., 2000). Studies have also investigated the effects of foot baths or mixed interventions of foot bath and reflexology on sleep, pain, and fatigue (Liao et al., 2008; Rahmani et al., 2016; Yang et al., 2010). The foot bath, touch care, or a combination of the two activated parasympathetic nerves (Hirohashi et al., 2015). Although there is limited evidence regarding foot care itself, care related to feet may be associated with the production of saliva and good sleep by activating parasympathetic nerves. Therefore, questions related to sleep and saliva were included because of their possible associations with foot conditions.

The foot perception items answered by clients after the foot-care program were as follows:

1. I have started sleeping well;
2. I have started to produce saliva;
3. My foot concerns have decreased;
4. I have started perceiving my feet as important;
5. I feel I can walk more easily;
6. I can move my foot more easily than before;
7. I feel I can open my toes better than before;
8. I have started consulting with staff about my feet more than before;
9. My foot pain has reduced.

Outcome Measurements and Survey Content

The primary outcome was changes in clients' foot conditions after the NCW foot-care program. Foot-care assessment was conducted only by the first author (KF) before and after the intervention to avoid overburdening clients. The author (KF) is a registered nurse with an authorized foot care certificate (Japanese Society for Foot-Care and Podiatric Medicine) and a foot care-related certificate (Japan Foot Care Fusspflege School; the Fusspflege Foot Care Association). The foot-care program's sessions and data collection of secondary outcomes were also conducted by the author (KF). Opportunities to see doctors and receive a diagnosis or treatment were also evaluated.

The first author conducted cross-sectional study targeting 176 older people in 2019 which was supported by a grant-in-aid for scientific research (Grant No:19K11111). 23 among those participants participated in this study. Therefore, the demographic data (sex, nursing level, and medical condition) and baseline data of foot-related items (walking speed, skin temperature, right and left hallux valgus degree, toe grip force, and number of floating toes) were partially obtained from the study. Research assistants aided in the machine-measurement of foot morphology and obtaining demographic data. They attended training sessions conducted by the first author (KF) and an academic foot researcher, learned about foot anatomy and physiology, and acquired the skills to operate the Foot Look machine and toe grip dynamometer and to conduct the Mini-Mental State Examination and Barthel Index Evaluation. The secondary outcome involved gathering perception scores from clients on a scale of 1 to 5 points.

Expected Risks When Providing Foot Care for Older Persons with Frailty

In general, the physical, emotional, and foot conditions of older people with frailty are unstable and complex. Providing foot care generally requires time and money to acquire knowledge and skills because of the complexity and difficulty of older people's foot conditions. Fragile skin, toe deformities, and various nail problems require careful attention. Therefore, the first author (KF) expected possible incidents and prepared responses for potential client risks such as pain, skin tear, stumbling which had been reported in past clinical experience and research in the field (LeBlanc et al., 2014; Malkin & Berridge, 2009; Skiveren et al., 2017). During a series of foot-care programs, the author (KF) briefly mentioned the following risks that could be occurred at low-level risk during providing foot care by considering characteristics of physiological body changes of older people:

1. Skin may be torn by washing the client's feet while assisting them in bathing even though caregiver does not scrub it.

2. When the staff recommends the client perform toe exercises, extra pain may be generated.
3. When staff gain knowledge of foot care, they may become overly confident about cutting nails and may cut the client's flesh accidentally, leading to slight bleeding.
4. When a staff member scrapes the client's nail edge, the nail file may touch the client's skin, which could result in slight bleeding.
5. When a staff member scales the sole of the foot using foot files, clients may express pain.
6. When a staff member takes care of skin close to the nail edge, clients may start feeling foot pain.
7. Clients may start to complain that have recently been told about their feet too often.
8. Clients may complain of excessive exercise when encouraged by the staff to exercise or stand, although they already engage in such activities.
9. Clients may come close to stumbling when they stand up because the staff told them to stand up sometimes to protect their health.
10. When staff and clients start cleaning toes because they realize that toe hygiene and toe exercises are important, the clients' blood pressure can sometimes rise.

Analysis Method

Each client's feet was assessed by KF independently and a foot-care professional was consulted to ...

Each client's feet were assessed by the first author independently and a foot-care professional was consulted to corroborate the rating scores for some cases based on pictures or digital foot views by providing anonymous data. Demographic data, characteristics of foot-related data, and foot perception were analyzed using descriptive statistics. The changes in clients' foot conditions, assessed before and after the foot-care program, were analyzed with McNemar or paired *t*-tests. *p*-values of <.05 were considered statistically significant in all tests. SPSS Statistics 24 (IBM Corps) was used for all analyses.

Results

Figure 1 shows the TREND flowchart for the study. Table 2 presents demographic data and the results of participants' foot-related items. Of the 28 participating clients, data from 23 clients (8 men, 15 women, mean age = 78.6 years, standard deviation = 9.2) across 10 facilities were analyzed. Four clients dropped out owing to sudden hospitalization; they were excluded from the study. Another client was excluded due to excessive missing data. The results showed that 39.1% and 21.7% of clients were assigned to nursing care levels 2 and 3, respectively. At care level 2, the person requires additional care to be able to perform essential daily life activities. At care level 3, the person's abilities to

perform essential daily life activities and tasks are significantly diminished (Shinjuku City Long-term Care Insurance Division, 2018). Of the study population, 56.5% and 43.5% were diagnosed with high blood pressure and brain-related problems, respectively. Table 3 shows the characteristics of foot-related data at the pre-intervention stage. The right and left toe grip strength were 3.3 kg and 3.5 kg, respectively. Supplemental information is provided in the tables to explain the normal value of each item.

Toe grip strength was measured with a toe grip dynamometer (T.K.K. 3364 Takei Scientific Instrument). Hallux valgus and number of floating toes were measured with Foot Look (Foot Look Inc). Width of opening toes was measured using a tape measure.

Tables 4 and 5 present participating clients' foot and ankle characteristics before and after the program. No significant difference was observed in arch deformity, ingrown toenails, edema, and skin color between the findings of the pre and post foot-care intervention for NCWs. 91.3% of the participants could feel their toes being touched. The examiner was unable to palpate the pulse on the posterior tibial arteries of most clients.

The mean dry skin scores of both right and left feet were significantly improved based on the foot assessment items (*p* < .01; Right foot: 1.6→1.1, Left foot: 1.6→1.1). After the study, the mean number of skin lesions and long nails had reduced (skin lesions R: 0.2→0.1; long nail R: 1.4→1.0, L: 1.1→0.8). The mean number of nails with an existing or suspected fungal infection remained unchanged before and after the program. However, two participants saw a dermatologist and obtained a fungal infection diagnosis during the study. The number of clients with edema also decreased (R: 43.5%→39.1%, L: 52.2%→47.8%)

Before the study, three clients had long and untidy toenails. After the program, the assessment revealed their toenails were cut correctly, and the nail edges were smooth and short.

Figure 2 illustrates the results of foot perception after the program, revealing that clients started perceiving their feet as important, and they could discuss their feet with staff more than before (means: 4.6, 3.6, SDs: 0.8, 1.0, respectively). The means of "other items" were 3.0 to 3.4 (SD 0.7~1.0).

Discussion

Although the study results indicated no dramatic changes, items such as edema, number of skin lesions, long nails, and level of skin dryness, which are directly related to foot-care practices, improved. In addition, foot conditions and foot health were either improved or maintained without deterioration. As expected, the first hypothesis was supported.

As indicated in the literature review, Wylie et al. (2019) stated that the evidence for podiatry interventions in care homes is uncertain. There is no podiatry license in Japan. Regardless of the existence of a podiatry license, the delivery of foot care for older people may not provide marked benefits

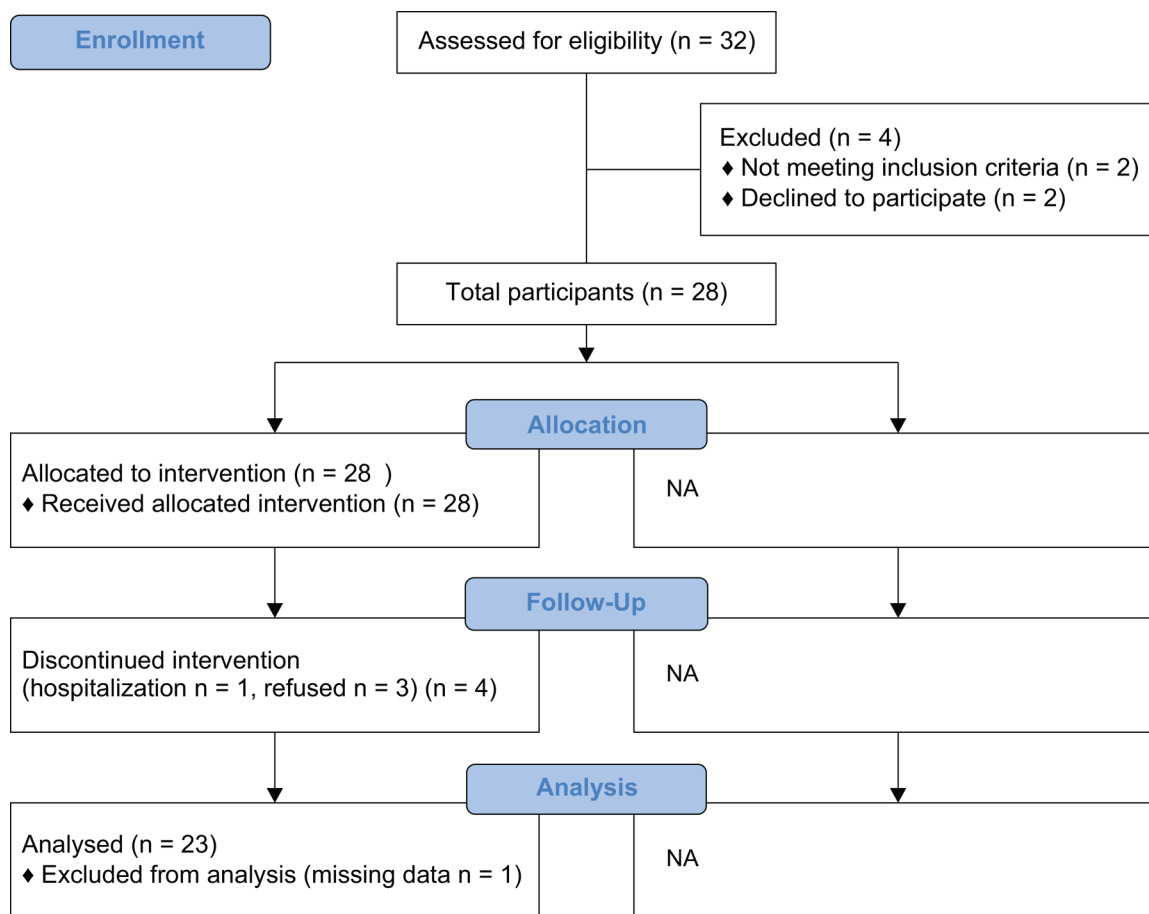


Figure 1. Consort flow diagram.

due to the complexity of foot conditions with aging. The effect of foot care on the population with frailty and foot disorders needs to be explored in greater depth in future studies. Additionally, similar to a previous study that explored the link between frailty syndrome and foot pain (Navarro-Flores et al., 2021), the association between frailty and various foot disorders should be studied in Japan in the future. Further, nail length and skin dryness may improve over a short period; however, toe and arch deformities, and circulation need to be examined over a longer period.

The second hypothesis was also supported. The mean values of perception items revealed that an NCW foot-care program did not result in immediate improvements in foot movement. However, the higher means for consultation with others and the perception that one's feet are important indicate this study positively affected perceptions by reducing older people's tendency to ignore foot care or their difficulties in discussing the issue (Miikkola et al., 2019).

Foot skin dryness was found in all clients. Stolt et al. (2012) reported that 44%–45% of older people receiving home care services had dry skin. Furthermore, prior research has reported that 89.5%–100% of older people with frailty

using home-visit services had dry skin on their feet (Fuji, 2018). The foot-care program in this study included recommendations that clients see a dermatologist and use moisturizing cream/ointments. The mean dry skin score showed significant improvement, indicating the program's effectiveness in changing behaviors to reduce instances of dry skin experienced by older people. Dry skin can be prevented through the efforts of both the client and caregiver. Older clients may be able to reach their lower limbs but may struggle to reach their toes. Clients and caregivers must be aware of the importance of regular moisturizing to protect the skin barrier.

In the program, the author (KF) demonstrated how to scale corns and calluses using a foot file. After the study, the mean number of skin lesions on the right foot was reduced. Clients who received skin lesion care stated their walking improved after their corns were reduced with the foot file. Although corns or calluses are common foot problems, disparities in correlations between clinical and histopathological findings have previously been reported (Mohan et al., 2008). Even in a country where podiatry services exist, evidence of the long-term effect of the treatment is limited. Randomized controlled trials have reported scalpel debridement leading to pain reduction in older people (Farndon et al., 2013;

Table 2. Demographic Characteristics, Foot-Related Data (*N* = 23).

Item	Category	<i>N</i>	Proportion	Supplemental information
Sex	Men	8	34.8%	
	Women	15	65.2%	
Nursing level	Support-level 1	0	0.0%	Support-level 1: The person can excrete, eat, rise, walk, and perform most other essential daily life activities by himself/herself. Some assistance is needed for basic activity. Of LTCI certified persons, 14% are classified as support-level 1
	Support-level 2	5	21.7%	Support-level 2: The person's ability is slightly lower than support-level 1 (14%)
	Care-level 1	3	13.0%	Care-level 1: Some kind of assistance is required for performing essential daily life activity and personal care (20%)
	Care-level 2	9	39.1%	Care-level 2: More assistance is required compared with care-level 1 (17%)
	Care-level 3	5	21.7%	Care-level 3: The person is not able to perform complicated movement and requires almost constant care (13%)
	Care-level 4	1	4.3%	Care-level 4: The person is hardly aware of their surroundings. He/she needs assistance to perform activities of daily living and requires constant care (12%)
	Care-level 5	0	0.0%	Care-level 5: The person is not able to walk or remain standing, eat, or excrete without assistance (9%)
Medical condition (Already diagnosed)	Diabetes	6	26.1%	
	High blood pressure	13	56.5%	
	Kidney disease	2	8.7%	
	Arteriosclerosis	0	0.0%	
	Heart-related disease	6	26.1%	
	Brain-related disease	10	43.5%	
	Rheumatoid Arthritis	1	4.3%	
	High lipid condition	8	34.8%	
	Lung-related disease	0	0.0%	
Current condition	Incontinent	3	13.0%	

Medical condition: multiple answers.

The description of each care and support level is based on information in the Guidebook for long-term care insurance (Shinjuku City Long-term Care Insurance Division, 2018).

Landorf et al., 2013). However, studies of corns and calluses are limited in general.

Among various foot problems, the suspicion or presence of nails with fungal infection was a concern for clients; this has also been observed in other studies (Gupta, 2000; Suzuki et al., 2017). A large study that was conducted in Japan reported the highest number of people who had skin and nail fungal infections were those over 60 years (Furue et al., 2011). Yellowish and crumbling nails suggest the possible existence of a fungal infection. During this study, two clients saw a doctor and were diagnosed and treated for nail and skin fungal infections. Nails with fungal infection are often overlooked or ignored; however, this may cause cellulitis (Bristow & Spruce, 2009), or the nail may fall off. The ability to identify fungal infection symptoms could contribute to protecting not only foot health but also systemic

health. Defining what constitutes a fungal nail infection, identifying factors that trigger these infections, and then intervening are important (Abdullah & Abbas, 2011).

In previous research and field experience, the author (KF) heard from many older people that tissue was cut when caregivers cut the client's nails. Older persons may therefore fear receiving nail care from others. Complaints also included the clients' nail edges getting caught in their socks, which could be resolved by receiving foot care or tidying nails. NCWs were taught how to use a nail and foot file in this study, although this study did not include training staff to use a grinder machine that podiatrists worldwide regularly use.

The introduction of foot and nail files into daily practice seems to be cost-effective, and the necessary skills require less training compared to learning how to use a machine such as a grinder. As a starter kit, delivering these methods

Table 3. Characteristics of Pre-intervention Foot-Related Data (N=23).

Items	N	Mean	SD	Supplemental information
4-meter walking speed	20	7.4 s (0.54 m/s)	2.1	<ul style="list-style-type: none"> ■ Bohannon and Wang (2019) reported a mean gait speed of 4 meters by age groups: 1.11 m/s (0.20) for women 18–19 (n = 179), 0.95 m/s (n = 42) for women 80–85 ■ Peters et al. (2013) reported a mean gait speed of 10 meters for persons with an average age of 84.3 (32 women and 11 men) ■ 0.96 m/s (SD 0.23)
Skin temperature	23	34.5 degrees	2.0	<ul style="list-style-type: none"> ■ Nardin et al. (2010) indicated “a mean +/-SD awake temperature of 30.6 degrees +/-2.6 degrees C and asleep temperature of 34.0 degree +/-1.8 degree C.” They found association between foot temperature and ambient temperature
R Degree of hallux valgus	23	11.6 degrees	9.6	<ul style="list-style-type: none"> ■ Coughlin and Jones (1997) stated that HVA ≤ 15° is normal, 15 < HVA ≤ 20° mild, 20° < HVA ≤ 40° moderate, and HVA > 40° severe
L Degree of hallux valgus	22	9.9 degrees	7.1	<ul style="list-style-type: none"> ■ As above
R Widths of opening toes	20	0.2 cm	0.3	<ul style="list-style-type: none"> ■ Fujii (2018) reported mean of widths of opening toes among ambulatory persons as 0.47 (±0.46) for the right foot (n = 34) and 0.33 (±0.29) for left foot (n = 33)
L Widths of opening toes	22	1.1 cm	2.1	
R Toe grip strength	23	3.3 kg	2.2	<ul style="list-style-type: none"> ■ Uritani et al. (2014) reported mean toe grip strength of 10.4 (3.3) kg for men (n = 116) and 7.3 kg (3.6) for women (n = 223)
L Toe grip strength	23	3.5 kg	2.4	As above
R Number of floating toes	23	1.3	1.4	<ul style="list-style-type: none"> ■ Floating toes indicates that one or more toes fail to contact the ground (Uritani et al., 2017)
L Number of floating toes	23	1.0	1.3	As above

and awareness points to NCWs to prevent accidents at the time of practice would be beneficial in providing foot care for older clients.

The examiner could not detect the pulsation of the posterior tibial artery in most participants. In the aging population, an absent pulse may be related to the process of aging or a sign of atherosclerosis (Ludbrook et al., 1962).

Additionally, the methods used by the examiner could be a reason for the apparent absence of pulse. The palpation depends on the strength of the person who presses on the skin, and an abundant experience of foot examination is required to palpate the pulse of the older population. In this study, pulse palpation was used instead of doppler examination, although doppler ultrasonography is accepted as it has

Table 4. Foot and Ankle Characteristics Pre- and Post-Intervention (N=23).

Items	Pre-intervention		Post-intervention		p-value	
	n	Proportion	n	Proportion		
Right	Arch deformity	22	95.7% (78.1–99.9)	22	95.7% (78.1–99.9)	>.99
	Ingrown toe nail	5	21.7% (7.5–43.7)	5	21.7% (7.5–43.7)	>.99
	Edema	10	43.5% (23.2–65.5)	9	39.1% (23.2–65.5)	>.99
	Skin color	15	65.2% (42.7–83.6)	15	65.2% (42.7–83.6)	>.99
Left	Arch deformity	18	78.3% (56.3–92.5)	18	78.3% (56.3–92.5)	>.99
	Ingrown toe nail	4	17.4% (5–38.8)	4	17.4% (5–38.8)	>.99
	Edema	12	52.2% (30.6–73.2)	11	47.8% (30.6–73.2)	>.99
	Skin color	9	39.1% (19.7–61.5)	9	39.1% (19.7–61.5)	>.99
Right	Sensitivity of the first toe	21	91.3% (72–99)	21	91.3% (72–99)	>.99
	Sensitivity of the second toe	21	91.3% (72–99)	21	91.3% (72–99)	>.99
	Sensitivity of the third toe	21	91.3% (72–99)	21	91.3% (72–99)	>.99
	Circulation	2	8.7% (1.1–28)	2	8.7% (1.1–28)	>.99
Left	Sensitivity of the first toe	21	91.3% (72–99)	21	91.3% (72–99)	>.99
	Sensitivity of the second toe	21	91.3% (72–99)	21	91.3% (72–99)	>.99
	Sensitivity of the third toe	21	91.3% (72–99)	21	91.3% (72–99)	>.99
	Circulation	4	17.4% (5–38.8)	4	17.4% (5–38.8)	>.99

Circulation: The proportion represents the clients for whom an examiner could palpate the pulse; Sensitivity of toes: The proportion represents clients who felt the examiner's touch on their toes (1st, 3rd, and 5th toes).

McNemar test *p<.05, **p<.01, ***p<.001.

Table 5. Foot and Ankle Characteristics pre- and Post-Intervention ($N = 23$).

	Items	Pre-intervention		Post-intervention		p -value
		Mean	SD	Mean	SD	
Right	No. of toe deformities	2.0	1.6	2.0	1.6	>.99
	No. of skin lesions (corn and callus)	0.2	0.5	0.1	0.3	.162
	Maceration between toes	0.8	1.1	0.8	1.1	>.99
	No. of nails with abnormal color	1.2	1.1	1.2	1.1	>.99
	No. of long nails	1.4	1.4	1.0	1.2	.148
	No. of thickened nails	1.5	1.6	1.5	1.6	>.99
	Level of skin dryness	1.6	0.7	1.1	0.3	.005**
	No. of nails with suspected or existing fungal infection	1.3	0.7	1.3	0.8	.162
Left	No. of toe deformities	1.2	1.7	1.2	1.7	>.99
	No. of skin lesions (corn and callus)	0.2	0.4	0.2	0.4	.328
	Maceration between toes	0.5	0.8	0.5	0.8	>.99
	No. of nails with abnormal color	1.0	1.5	1.0	1.5	>.99
	No. of long nails	1.1	1.0	0.8	1.0	.110
	No. of thickened nails	1.4	1.8	1.4	1.8	>.99
	Level of skin dryness	1.6	0.7	1.1	0.3	.005**
	No. of nails with suspected or existing fungal infection	1.0	0.8	1.0	0.8	>.99

Paired t -test * $p < .05$, ** $p < .01$, *** $p < .001$. Nail color: abnormal nail color; Thickened nail: more than 2 mm thickness.

greater accuracy than palpation (Pandey et al., 2020). However, Duarte et al. (1988) reported the reliability of palpation of the pulses for diabetic patients. Subsequently, studies related to this topic have been limited. Therefore, a study with a larger sample is needed to ensure the reliability of both methods.

Future studies may need to utilize machines such as a doppler to detect pulse for this population. The reliability of pulse examination of older people who live in the community as a tool for early detection of vascular problems will also need to be explored.

Compared to baseline, edema on both feet had decreased. Leg edema is a common problem in older people (Ciocon et al., 1993), along with dorsum edema. Foot edema is caused by various factors, including drug use (Thaler et al., 2010). During this study, a method of lymph massage, the distinction between lymph massage and connective tissue massage, and the importance of foot exercise were introduced to some staff members. Most clients with edema did not routinely engage in exercise, aside from short-term group exercise in their facility, tending to sit in chairs for extended periods except for when using the bathroom or engaging in other activities. Previous studies have reported the negative effects of overly sedentary behavior on physical health (Dunstan et al., 2012; Keevil et al., 2015). Medication, such as a diuretics, may also have an effect on foot conditions. Despite the complex ways foot edema can be generated, knowledge of edema and its prevention may contribute to preventing worsening of the condition or promote early detection and consultation with other professionals. Further research would be needed from different perspectives, such as medication use. Massage education is limited to the NCW curriculum in Japan. Knowing how to

distinguish lymph massage and connective tissue massage (Ekici et al., 2009) or the side effects of compression stockings may allow NCWs to protect foot health.

In the individual session, the author (KF) explained the risks that could be generated at the time of providing foot care for older people. While the author (KF) showed the grinder to some NCWs, it was not introduced in the intervention because it takes time to learn how to use a grinder. Instead, the author (KF) used a nail and foot file for foot care. Several older people expressed their gratitude for this study as it was the first time their feet appeared healthy. The study also provided them with an opportunity to express their feelings and concerns regarding their foot problems to others. The author (KF) informed the NCWs about the points to remember during foot care. However, a few clients became deeply interested in the procedures of foot care and started to perform them independently, such as scraping their nails. In future studies, researchers and NCWs need to ask older people about what they would like to do as part of their foot care, followed by assessing what they can do and what information the researcher should provide. International research into nurses' knowledge and practices of foot care (Stolt et al., 2015) and studies of people with frailty or dementia are limited (Lopez-Lopez et al., 2018; Muchna et al., 2018). Moreover, the foot-care instruments or methods used in previous studies of older people in the community with diabetes were not adequately suited to this population. In future studies, a different study design may be used based on resources presented in previous studies (Navarro-Flores et al., 2018, 2020a, 2020b, 2020c, 2021; Sánchez-Gómez et al., 2020; Simón-Pérez et al., 2020).

Many day care centers are introducing exercise programs for older people with frailty. However, foot and toe issues are not

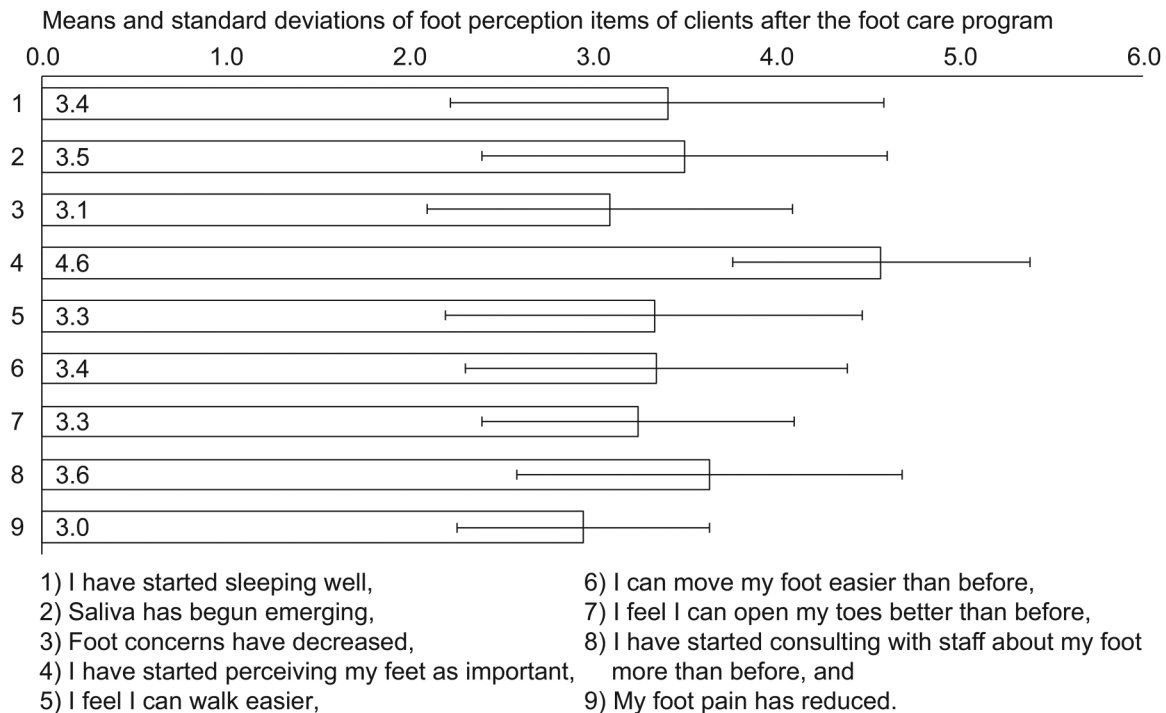


Figure 2. Means and standard deviations of foot perception items of clients after the foot-care program.

adequately incorporated in the exercise framework. Exercise programs for older people with advanced frailty have not been included sufficiently in Japan's care policy. Research regarding older people with frailty is also lacking. Given the major concern of the high number of bedridden people in Japan, the incorporation of foot care into exercise programs for a wide range of the older population may lead to stability of posture and walking and prevent clients from becoming increasingly bedridden. Therefore, foot-care education for NCWs in this area is challenging but important to address some of the problems faced by an aging society in Japan.

This study was conducted by considering NCWs' limited knowledge and practice level of foot care in different randomly selected facilities. Overall, each facility's staff operate under significant time constraints because they have to carefully watch clients when they perform movements or activities to prevent falls or injury. They know foot-care issues exist and are concerned and willing to learn, but they do not have sufficient available time for foot care. However, the foot-care program presented in this study may affect foot conditions and older people's perceptions of them. Therefore, many participating facilities expressed a willingness to participate in such a program again. Considering the growing number of older people and the decreasing number of younger people, simple and highly effective foot-care methods must be delivered and developed for the future.

Japan is facing dramatic demographic changes and tremendous shortage of caregivers. Artificial intelligence technology needs to be developed in order to supplement the shortage of personnel assisting in care tasks, such as meal

delivery. Ideally, gaining time for foot care would provide better quality of care. However, several barriers have to be overcome, such as the lack of foot-care education and poor awareness in the public and private sectors, mass media, and government members, in addition to a shortage of research and foot-care programs for people in the community. Foot-care education for the public and private sectors as well as studies with empirical analysis will provide new insights for future strategies. It is necessary to inform the public, regardless of age, about the importance of foot care. It is further necessary to promote foot-care education to deepen the public's understanding of this intervention.

Strengths and Limitations

Client medical history was obtained based on the facilities' records. A complete medical history might have been missing because some clients did not regularly visit a doctor and some medical information may have been missing because these facilities were not directly connected with hospitals. Some older people take different kinds of medication. In particular, edema-diuretics or anticoagulant medications may affect foot conditions (Chan et al., 2000; Weir et al., 2001). However, it was difficult to exclude participants based on the medication they took because the effects and side effects of medications may interact, or different factors may affect foot conditions. In every facility in the community, the introduction of a system to track diseases and medications is necessary.

Staff shortages and time constraints meant only one to three staff members from each facility could participate in

each practice session. When the staff had no time to participate, the author (KF) initiated provision of foot care and explained the assessment and care to the staff when they were available. Consistency of foot exercise was difficult to achieve because of each facility's daily schedules. Owing to schedules and limited prior foot-care knowledge, it was difficult to promote consistent foot exercise encouragement or incorporation of family involvement in foot care.

In Japan, foot-care education in the curricula in NCW schools is limited. Providing foot-care education to acquire foot-care awareness, knowledge, and practice may lead to making time for foot care in each facility to increase efficiency of caregivers.

Several problems were observed in this study. However, the presentation of particular foot problems across the whole population was limited. The small sample size for each foot problem meant that quantitative data were difficult to collect. It was challenging to insist that clients conduct foot self-care at home, owing to their frailty. Aggressive interventions, such as telephone follow-ups (Jayakody et al., 2016) and home visits (Estey et al., 1990) were not conducted.

Implications for Practice

The results of this study provide significant reference material for the incorporation of foot care education for NCWs into regular care practice. Aging accelerates foot discomfort and various foot problems as well as reduces the ability of people to care for their feet. Although there is complexity of foot problems associated with aging, foot care provision by NCWs contributes to the improvement of foot conditions to some extent.

Conclusions

Conducting foot-care research with clients with mild-to-severe frailty and NCWs who oversee the foot health of this population in the community was challenging. To supplement the self-care ability of older people, the NCW's foot-care program is meaningful to prevent worsening foot conditions among older people. The NCW's foot-care program had a ripple effect on maintaining and improving foot health in older people to some degree and positively affected their perception of foot care. However, the research team needs to overcome several limitations to provide consistent and effective care. Changes in the working environment are needed so that staff can spend more time on foot care.

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Declaration of Conflicting Interests

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Ethical Approval

The Ethical Committee of the University of Human Environments approved the study (2019N-002).

Blinded Statements

This study was conducted in accordance with the 2000 Declaration of Helsinki (UMIN-CTR [University Hospital Medical Information Network Center Clinical Trials Registry] UMIN 000036307, July 25, 2019).

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