Determinants of the Implementation of Home Evaluations among Patients with Fall-Related Fractures at a Convalescent Rehabilitation Ward in Tokyo: A Cross-Sectional Study

Rumiko Tsuchiya-Ito, Naoki Kusumoto, Keiko Maruyama-Sakurai, Anna Tama, Haruko Yokoyama, Ayako Watanabe, Takuya Fujiwara, and Takashi Yamanaka

Introduction

Fall-related fractures are a major burden of disease worldwide (WHO, 2018). In Japan, which has the highest aging rate globally (Cabinet office, Government of Japan, 2018b), fall-related fractures are prevalent and require long-term care (Ministry of Health, Labour and Welfare, 2016). Thus, fall prevention is a cardinal strategy to promote “Aging in Place,” especially for the vulnerable people being discharged from hospitals. “Aging in Place” is defined as “individuals growing old in their own homes, with an emphasis on using environmental modification to compensate for limitations and...
disabilities” (Alley et al., 2007). However, it is unclear whether a person who is in aging in place maintains their quality of life (Vanleerbergh et al., 2017); nevertheless, more than 65% of senior and older adults hope to keep staying at home even if they need long-term care support in Japan (Cabinet Office, Government of Japan, 2015). The need to use long-term care emerged because of chronic disabilities, which are one of the life events that create an obstacle to aging in place (Litwak & Longino, 1987); therefore, we must construct a strategy to support people who are at the risk of having chronic disabilities and cannot successfully age in place.

Environmental modifications for people with functional limitations or disabilities are conducted as home adaptations by medical professionals. The relationship between people’s functional limitations and environmental modifications can be understood by Lawton & Nahemow’s (1973) person-environment fit model, which illustrates the relationship between personal competence and environmental press. In this model, it is important that the relationship between the extent of personal competence and the strength of the environmental press is appropriate to acquire adaptive behaviors. Further, medical professionals involved in home adaptations have the role of identifying personal competence appropriately and changing it to ensure an adaptive environment. Research regarding home adaptations among people in their respective communities indicates that home evaluations and modification interventions reduce the rate of falls and risk of falling (Gillespie et al., 2012); however, some review articles mentioned the insufficiency of evidence in this regard (Chang et al., 2004; Turner et al., 2011). Moreover, the activities of daily living (ADL) of patients with fall-related fractures deteriorate compared to before and after hospitalization (Orive et al., 2015). Home evaluations are conducted before home adaptations and concern the process of assessing housing environments for people with disabilities to ensure not to increase their activity limitations so that they do not get injured again. Therefore, it is crucial for by rehabilitation professionals to deliver home evaluations in an appropriately and timely manner when discharging such patients (Kalu et al., 2019).

Nevertheless, it is not systematically decided as to how rehabilitation professionals (i.e., occupational therapists (OT) and physical therapists (PT)) select patients who benefit from these home evaluations in Japan. In the hospital setting, the actual process of home evaluations is conducted by rehabilitation professionals using the following steps: 1) gathering basic information of patients and identifying their needs for home adaptations; 2) deciding whether home evaluations for each patient shall be implemented, 3) arranging home visits and assessing the home environment (home evaluation), and 4) writing a proposal for housing adaptations (Ainsworth & de Jonge, 2011; Nomura & Hashimoto, 2012). Medical or long-term care professionals in
charge of the patient then submit this proposal and apply to a local municipality that governs home adaptation grants in long-term care insurance (Ministry of Health, Labor and Welfare, n.d.). Under the long-term care insurance system in Japan, municipalities pay home adaptation grants to people who are certified as long-term care beneficiaries and are staying at home and not long-term care facilities. However, it is unclear as to how the implementation of home evaluations is decided in the second step of the home evaluation process. Since a home visit consumes resources that can be ideally spent at the hospital, hospitals with a limited number of rehabilitation professionals cannot avoid prioritizing patients who conduct home visits based on their professional experience. Therefore, it is useful to know the mindset of rehabilitation professionals and decipher how they select patients who undergo home evaluations.

Additionally, we do not yet fully understand the characteristics of home adaptations being proposed by rehabilitation professionals in urban areas like Tokyo, where population aging is on the rise (Cabinet Office, Government of Japan, 2018a). Home adaptations are dependent on the existing housing characteristics. To give an example, housing in Tokyo is congested compared to other parts of Japan, and the average floor space is 63.5 m² in Tokyo, while the national average is 93.0 m² (Ministry of Internal Affairs and Communications, 2015). Many houses are small and often consist of multiple floors to compensate for the limited space and cater to the high population density (Makigami & Pynoos, 2002). The conditions in the private living spaces located on the second floor ensure a higher risk of relocation (Granbom et al., 2019), and the narrow size and layouts of dwellings are also unsuitable for people with disabilities (Makigami & Pynoos, 2002). However, current literatures lack information on what types of proposals for home adaptations are conducted in urban areas; therefore, the evidence from these areas should be explored to address urban aging.

In this study, we illustrated the present situations of home evaluations and adaptations for patients with fall-related fractures in the eastern district of Tokyo. The following research questions are focused on: What factors are associated with the decision of implementing home evaluations for patients with fall-related fractures? What kind of home adaptations are proposed in a highly populated city like Tokyo in Japan?

**Methods**

**Data source and setting**

We conducted the secondary data analysis using the data of patients admitted in one convalescent rehabilitation ward in a general hospital located in the eastern district of Tokyo. A convalescent rehabilitation ward is an
intermediate hospital to prepare patients for discharge after acute care and provides intensive rehabilitation for patients with fracture, stroke, and other emerged disabilities (Ministry of Health, Labour and Welfare, 2017). This study’s rehabilitation ward has 40 beds, and the proportion of patients discharged to home in 2015 was 80.8% (Taito City, 2016). Additionally, 85.7% of inpatients of this ward were residents in the district, therefore this hospital acts as a hub for comprehensive community care. The district where this general hospital is located is a typical downtown area. The average floor space is only 55.9 m², which is narrow even by Tokyo’s measuring standards (Ministry of Internal Affairs and Communications, 2015). Moreover, some residents are at a high risk of fall-related injuries because they manage family-run retail businesses while residing in a typical housing environment, with businesses on the first floor and private spaces on the second (Ministry of Internal Affairs and Communications, 2015).

We used a dataset containing patients’ demographic characteristics, ADL, and detailed types of home evaluations. This dataset was created based on electronic medical records and reports of home evaluations. These reports were written by rehabilitation professionals after each home evaluation to propose viable home adaptation procedures. The reports included information on the basic design of housing, layouts of furniture, and proposed home adaptations (“Rearranging furniture and equipment,” “Adapting assistive device,” and “Reconstructions”). Two doctors and three OTs reviewed medical records and home evaluation reports independently and double-checked after collecting each data. After the data collection was completed, we anonymized the identity number of patients in the medical records, and then analyzed the data secondarily.

**Participants**

The study participants comprised 86 patients aged ≥40 years who were admitted to the rehabilitation ward because of fall-related fractures and then discharged to their home between April 2013 and March 2015. One subject who was under 40 years was excluded because the housing adaptation service provided by Japanese long-term care insurance supports only people over 40 years or older (Tsutsui & Muramatsu, 2005). Therefore, the final number of study participants was 85.

**Measurements**

**Study design and the conceptual framework**

The conceptual framework is illustrated in Figure 1. The study design was a cross-sectional study based on Andersen’s behavioral health model.
Andersen’s behavioral health model is a useful framework for examining various types of long-term care service utilization. This model intended to clarify the three factors determining health service utilization: Predisposing factors (demographic, social structure, health beliefs), enabling factors (personal/family, community), and needs factors (perceived, evaluated) (Andersen, 1995). We regarded home evaluations as health services conducted by hospital rehabilitation professionals and examined the associations of determinant factors as predisposing, enabling, and needs factors with the respective evaluations (Process 1). After examining these associations, we examined what kind of home adaptation was proposed for this study’s participants, for whom housing evaluations had been implemented (Process 2). For the study procedure, we followed the STROBE statement (Vandenbroucke et al., 2014).

**Process 1: Implementation of home evaluations**

**Dependent variable**
The dependent variable was the implementation of home evaluations. This variable was defined as each patient having undergone home evaluations during their in-hospital rehabilitation period. We used the categorical variable of “home evaluation” whether it was implemented (1) or not implemented (0).

**Independent variables**

*Predisposing factors.* Age and sex (male/female) were used to adjust the basic characteristics of patients as predisposing factors. Age was measured at the year of admission and used as a continuous value.
Enabling factors. We used living arrangements, working years of experience of the OT in charge, and working years of experience of the PT in charge as enabling factors. Living arrangements were selected because they affect healthcare utilization (Alkema et al., 2006; Blomgren et al., 2008; Feng et al., 2017). It was thus assessed whether the patients had been living with someone or not just before hospitalization. Living arrangements were categorized into “living with someone” or “living alone.” The working years of experience by an OT or PT assessed the difference of years between the year each patient was admitted to the hospital and the year the OT or PT received national certification. Andersen and Newman (1973) showed “family” and “community” as a category of enabling factors, but we considered that the OT or PT, who has a role in deciding home evaluations, is an enabling factor. We categorized the working years into “over 5 years” or “under 5 years” because OT or PT with over 5 years of experience can be a preceptor of OT or PT students in a clinical internship (Ministry of Health, Labour and Welfare, 2019b) and have enough experience to be regarded as an OT or PT.

Needs factors. All 18 items constituting the Functional Independence Measure (FIM) were used as needs factors by measuring ADL (Naoichi Chino, Tsubahara, Sonoda, Doumen, & Takahashi, 2012; Data management service of the uniform data system medical rehabilitation and the center for functional assessment research, 1990). The structure of FIM comprised two subcategories: FIM motor items and FIM cognition items. The motor items encompassed 13 elements concerned with daily physical activities: self-care (eating, grooming, bathing, dressing-upper body, dressing-lower body, toileting), sphincter control (bladder management, bowel management), transfer (bed/chair/wheelchair, toilet, tub/shower), and locomotion (walk/wheelchair, stairs). The cognition items comprise 5 elements regarding cognitive components: communication (comprehension, expression) and social cognition (social interaction, problem-solving, memory). The scale ranged from 1 (total assistance) to 7 (complete independence) with a higher score indicating a better ADL. Care need levels could be regarded as a needs factor; however, it had a risk of multicollinearity with FIM items, and we only selected FIM items that could measure ADL more comprehensively than care need levels.

Other factors
To show the basic characteristics of patients, we illustrated care need levels, the types of fracture, whether they underwent surgery, the types of surgery, and length of stays. Based on care need levels, patients are certified to use long-term care services. It ranged between seven levels: Preventive care
need level 1 or 2 and Care need level 1 to 5, with higher levels indicating a greater need. In this study, we used care need levels just before admission, and categorized them into four levels: No certification to be applicable, preventive care need level 1 or 2, care need level 1 or 2, and care need level 3 or 4. The types of fractures were categorized into femoral neck fracture, femoral trochanteric fracture, or spine/pelvis/other parts of lower limbs. The undergoing of surgery was categorized dichotomously (undergoing surgery or not undergoing surgery). The type of surgery was counted only among patients who underwent surgery and was categorized as: a bipolar hip arthroplasty, a short femoral nail (gamma nail type), an open reduction and internal fixation (ORIF), a Hansson pin, a sliding hip screw (compression hip screw type), or others. The length of stay was calculated by the difference between the date of admission to discharge (days).

**Statistical analysis**

In the first step of the analysis, we conducted the $\chi^2$ test and $t$-test to examine the association of basic characteristics and functional status of participants with the implementation of home evaluations. In the second step, we used univariate regression analysis to examine the associations of predisposing, enabling, and needs factors with the implementation of home evaluations. Subsequently, multivariable logistic regression analyses were conducted by using only predisposing factors (Model 1), enabling factors with adjustments for predisposing factors (Model 2), and needs factors with adjustments for predisposing and enabling factors (Model 3). Care need levels in Japanese long-term care insurance is decided by assessments of individual’s physical and cognitive function (Tsutsui & Muramatsu, 2005); therefore, care need levels were excluded due to the multicollinearity between care need levels and FIM items. In addition, due to the small number of data in this study, it was necessary to reduce the number of independent variables as much as possible (Peduzzi et al., 1996). Therefore, care level was not included as an adjustment variable in this study. When constructing model 3, we only selected FIM items, which were significantly different from the implementation of housing evaluations in the $t$-test because of the limited number of participants. The results of logistic regression were exemplified by the odds ratio (OR), 95% confidence interval, and $p$-value. All analyses were conducted using SPSS version 25.0 (SPSS Inc., Chicago, IL), and the significance threshold was set at $p = 0.05$ (two-tailed).

**Process 2: The classification of the types of proposed home adaptations**

To better understand the current situation of home adaptations recommended by rehabilitation professionals in the eastern district of Tokyo, as
the second part of this study’s process, we classified the types of home adaptations. The variables of home adaptations were “Rearranging furniture and equipment,” “Adapting assistive device,” and “Reconstructions” to decrease the risk of falls or improve accessibility. “Rearranging furniture and equipment” meant just changing the layout of furniture or equipment. “Adapting assistive device” are concerned with selecting assistive device, which are usually leased or bought under the long-term care insurance services, such as a walking aid, a wheelchair, or a bath board (Ministry of Health, Labor and Welfare, n.d.-b). “Reconstructions” exemplify that the housing needs to modify its basic construction or add new equipment, for which the family can request financial support up to 200,000 yen (2,118 US dollars; 1 dollar = 94.39 yen as of April/01/2013) under home adaptation grants in long-term care insurance (Ministry of Health, Labor and Welfare, n.d.-a). These three types of adaptations were selected multiple times for each location. The location was categorized into approach, entrance, living room, bedroom, bathroom, stairs, toilet, corridor, and kitchen. The number of patients for whom each housing adaptation was proposed was then illustrated by a Venn diagram. We only received the detailed housing adaptations data from 2013; therefore, the total number of participants in the classification was 32.

**Results**

*The basic characteristics of patients with fall-related fractures*

The average age of patients admitted to the ward because of fall-related fractures and for whom housing evaluation was implemented was 83 years old, and the average age of patients for whom housing evaluation was not implemented was 77 years old. Among them, 53 (62.4%) had home evaluations. The differences between demographic characteristics among for whom home evaluations were implemented is illustrated in Table 1. Older age, being a female, and having certified care needs were more likely to result in implemented home evaluations. Although the years of working experience of PT was not significantly different ($p = 0.384$), less than 5 years of working experience for an OT was significantly associated with the implementation of home evaluations ($p = 0.010$). The types of fracture were also associated with implemented home evaluations. A femoral neck fracture (77.5%) and a femoral trochanteric fracture (70.6%) were more associated than that of spine/pelvis/other parts of a lower limbs’ fracture (35.7%) in this regard. Besides, the length of hospital stay was significantly longer for patients for whom home evaluations were implemented ($p = 0.023$).

The difference in patients’ ADL with implemented home evaluations is exhibited in Table 2. The total score of FIM, the total score of FIM-motor,
and 13 items of FIM-motor were not significantly different irrespective of whether home evaluations were implemented. However, in FIM cognition, comprehension was significantly different, and patients for whom home evaluations had been implemented attained a significantly lower comprehension score than those for whom it had not ($p = 0.003$).

**The results of logistic regression models of implementation of home evaluations**

Based on Andersen’s behavioral health model (1995, 1973), we examined the association between predisposing, enabling, and needs factors of healthcare utilizations and implemented home evaluations (Table 3). As a result of examining three models, being a female (OR: 8.712; 95%CI: 2.005–37.858) as a predisposing factor and lower FIM-comprehension
(OR: 0.614; 95%CI: 0.380–0.993) were most likely to yield home evaluations. Age and less than 5 years of OT working experience were associated with the implementation of home evaluations in univariate regression analysis, but was not significantly associated in Model 3 for age (OR: 1.023; 95%CI: 0.953–1.097) and OT working experience (OR: 0.432; 95%CI: 0.139–1.345).

The characteristics of housing for patients for whom home adaptations were implemented

The characteristics of patients having home adaptations and who were living in multi-dwelling blocks was 63.3%. Almost all of the houses were owned (90.0%) and not rentals, and the patients who were residing on the second floor was 66.7%. Among them, 33.3% of patients had been living on the second floor without an elevator.

The proportion of recommendations for home evaluations and classification results of the types of home adaptations are shown in Figure 2. The entrance was signified by the highest percentage of patients as having a

**Table 2. The differences in patients’ activities of daily living based on implemented home evaluations.**

|                             | Implemented home evaluations (n = 53) | Not implemented home evaluations (n = 32) | p Value |
|-----------------------------|--------------------------------------|------------------------------------------|---------|
| FIM total                   | 94.0 21.8                            | 98.1 22.9                                | 0.415   |
| FIM Motor total             | 67.1 15.6                            | 68.5 17.8                                | 0.709   |
| **Self-care**               |                                      |                                          |         |
| Eating                      | 6.5 0.8                              | 6.4 1.1                                  | 0.733   |
| Grooming                    | 5.9 1.3                              | 6.0 1.4                                  | 0.765   |
| Bathing                     | 4.5 1.4                              | 4.6 1.7                                  | 0.751   |
| Dressing-Upper body         | 5.8 1.4                              | 5.6 1.8                                  | 0.694   |
| Dressing-Lower body         | 4.9 2.0                              | 5.0 1.9                                  | 0.898   |
| Toileting                   | 5.4 1.6                              | 5.6 1.9                                  | 0.522   |
| **Sphincter control**       |                                      |                                          |         |
| Bladder management          | 5.8 1.9                              | 6.0 1.7                                  | 0.527   |
| Bowel management            | 5.8 1.7                              | 6.3 1.4                                  | 0.180   |
| **Transfers**               |                                      |                                          |         |
| Bed/Chair/Wheelchair        | 5.6 1.3                              | 5.6 1.6                                  | 0.995   |
| Toilet                      | 5.5 1.4                              | 5.5 1.7                                  | 0.940   |
| Tub/Shower                  | 4.3 1.5                              | 4.6 1.4                                  | 0.359   |
| **Locomotion**              |                                      |                                          |         |
| Walk/Wheelchair             | 4.7 1.5                              | 4.5 2.0                                  | 0.639   |
| Stairs                      | 2.5 1.9                              | 2.6 2.0                                  | 0.667   |
| **FIM cognition total**     | 26.9 7.4                              | 29.6 6.3                                  | 0.089   |
| **Communication**           |                                      |                                          |         |
| Comprehension               | 5.4 1.5                              | 6.3 1.1                                  | 0.003   |
| Expression                  | 6.0 1.2                              | 6.5 0.9                                  | 0.089   |
| **Social Cognition**        |                                      |                                          |         |
| Social Interaction          | 5.7 1.7                              | 6.0 1.3                                  | 0.384   |
| Problem Solving             | 4.9 2.0                              | 5.3 1.8                                  | 0.399   |
| Memory                      | 4.9 1.9                              | 5.6 1.7                                  | 0.065   |

t-test (p < 0.05). Abbreviation: FIM: Functional Independence measure.
Table 3. Logistic regression models of implementation for home evaluations.

|                      | Univariate regression analysis | Model 1: Predisposing factors\(^a\) | Model 2: Enabling factors\(^a\) | Model 3: Needs factors\(^a\) |
|----------------------|-------------------------------|-----------------------------------|-------------------------------|-------------------------------|
|                      | OR 95% CI                      | AOR 95% CI                        | AOR 95% CI                    | AOR 95% CI                    |
| Predisposing factors |                               |                                   |                               |                               |
| Age                  |                               |                                   |                               |                               |
| 1 years increase     | 1.090 1.031 1.153 0.003       | 1.060 0.997 1.127 0.062           | 1.048 0.984 1.116 0.142       | 1.023 0.953 1.097 0.533       |
| Sex                  |                               |                                   |                               |                               |
| Male                 | 1.000 1.000 1.000             | 1.000 1.000 1.000                | 1.000 1.000 1.000            | 1.000 1.000 1.000            |
| Female               | 8.471 2.673 26.844 0.001      | 5.659 1.665 19.236 0.005          | 6.596 1.740 24.881 0.005      | 8.712 2.005 37.858 0.004      |
| Enabling factors     |                               |                                   |                               |                               |
| Living arrangement   |                               |                                   |                               |                               |
| Living with someone  | 1.000 1.000 1.000             | 1.000 1.000 1.000                | 1.000 1.000 1.000            | 1.000 1.000 1.000            |
| Living alone         | 1.543 0.578 4.117 0.387        | 1.144 0.342 3.830 0.827          | 1.806 0.473 6.892 0.387       |                               |
| Working experience of OT in charge | | | | |
| < 5 years            | 1.000                         | 1.000                            | 1.000                         |                               |
| ≥ 5 years            | 0.307 0.122 0.770 0.012        | 0.379 0.130 1.104 0.075          | 0.432 0.139 1.345 0.147       |                               |
| Working experience of PT in charge | | | | |
| < 5 years            | 1.000                         | 1.000                            | 1.000                         |                               |
| ≥ 5 years            | 1.488 0.607 3.646 0.385        | 1.870 0.635 5.509 0.256          | 1.246 0.384 4.039 0.714       |                               |
| Needs factors        |                               |                                   |                               |                               |
| FIM: comprehension   |                               |                                   |                               |                               |
| 1-point increase     | 0.594 0.404 0.873 0.008        | –                                | 0.614 0.380 0.993 0.047       | 0.746 0.553 0.990 0.818       |

Abbreviations: OR: Odds ratio; AOR: Adjusted odds ratio; 95% CI: 95% confidence interval; OT: Occupational Therapist; PT: Physical Therapist; FIM: Functional Independence Measure.

\(^a\)Multivariate logistic regression analysis. Model 1: Predisposing factors. Model 2: Model 1 + Enabling factors. Model 3: Model 2 + Needs factors.
recommendation for home adaptation (71.8%), followed by the bathroom (59.3%), bedroom (50.0%), living room (46.8%), and toilet (43.7%). The types of home adaptations were classified into five groups: Group 1

Figure 2. The frequency of each type of housing adaptation for each location (n = 32).
preferred “Rearranging furniture or equipment”, Group 2 preferred “Adapting assistive device”, Group 3 preferred “Reconstructions”, Group 4 did not prefer any given option, and Group 5 stated that the total number of home adaptations is small.

**Discussion**

This study is the first to demonstrate the associations of determinant factors with the implementation of home evaluations based on Andersen’s (1995) and Andersen and Newman (1973) behavioral health model. Moreover, we illustrated the detailed characteristics of the types of proposed home adaptations in a distinctive regional housing typology with narrow floor space. Our data showed that female sex and low comprehension of the FIM cognition items were significantly associated with the implementation of home evaluations, and the different types of home adaptations in each location were classified into five groups as stated at the end of the previous section.

**The determinant factors of the implementation of home evaluations**

As for predisposing factors, gender was significantly associated with the implementation of home evaluations in multivariate models. Previous studies showed being a female is related to the use of home modifications among community-dwelling older adults (Mathieson et al., 2002), and opting for services related to home safety (Alkema et al., 2006). Our result adds that this gender difference remains among those with fall-related fractures; this includes the subgroup of patients for whom home evaluations were implemented. Moreover, females might be more amenable to gender and generational norms (Alkema et al., 2006), and likely to implement the suggestions received from rehabilitation professionals in charge. As for enabling factors, although the working experience of OT was significantly associated with the results of univariate regression analysis, this association disappeared after adjustments for predisposing factors and living arrangements were made. The characteristics of patients differed according to the working experience of OT, and the association diminished after adjustments for the basic characteristics of patients were made. Additionally, we considered that living alone had a positive association with the implementation of home evaluations, but these were not significantly associated. A previous study showed that living alone had a positive association with conducting home modifications (Mathieson et al., 2002); however, in our study, it did not show any significant association with home evaluations. This discrepancy may imply that the existing family members were more
important for rehabilitation professionals to ensure the successful implementation of home evaluations rather than living alone. In Japan, 59.7% of households are occupied by only older adults (Ministry of Health, Labor and Welfare, 2019a, 2019b), and someone who lives with the patients could be more vulnerable. Therefore, we need to comprehend the detailed characteristics of family members to examine the enabling factors of home evaluation implementation in future studies.

As for needs factors, comprehension in FIM cognition items was associated with the implementation of home evaluations. Comprehension was posed as the first step of communication, and problem-solving and expression soon followed to realize communication with another person (Chino et al., 2012). A lower ability in terms of comprehension intercepts the commencement of communication between the patients and rehabilitation professionals, and makes it difficult to identify the exact needs of home adaptations. On the other hand, it is strange that FIM motor items were not associated with the implementation of home evaluations. One possible explanation is that the rehabilitation specialists determine the need for home evaluation, not by the level of patients’ functional disability but by the estimated mismatch between functional ability as a personal competence and housing condition as an environmental press, as explained by Lawton & Nahemow’s (1973) person-environment fit model. However, in the case of lower comprehension, rehabilitation professionals tend to visit the patients with cognitive dysfunction more often to overcome the difficulty in effective needs assessments. To prioritize home evaluations correctly and maximize the benefits produced by rehabilitation professionals, it is imperative to seek strategies such as screening tools or guidelines to best estimate their needs.

The types of proposed home adaptations in a distinctive area with narrow floor space

To understand home adaptations proposed in a distinctive area with narrow floor space, we also examined the frequency and classified it into five groups. The most proposed locations for home adaptations were the entrance, bathroom, and bedroom. In a previous study conducted in a rural prefecture in Japan (Mitoku & Shimanouchi, 2014), the entrance and bedroom were not included as locations that were frequently targeted for home adaptations. This difference could be caused by the variance in the definition of home adaptations. That is, the previous study (Mitoku & Shimanouchi, 2014) defined home adaptations as “Adapting assistive device” or “Reconstructions”, but we also included “Rearranging furniture or equipment” as a type of home adaptations. By including this, we
elucidated that the entrance and bedroom should be noted as viable targets for improving the environment of patients with fall-related fractures.

Moreover, we need to focus on the results whereby these two locations are categorized into group 1 (Preferred “Rearranging furniture and equipment”) together with a living room. Entrances in Japanese housing usually have level differences, thus resulting in a high risk of falls, because the building standard law established that a wooden housing should be constructed 45 cm higher than the ground level (e-GOV, 1950). Moreover, it is a social custom to take off shoes, which further increases the risk of falls for the older adults (Makigami & Pynoos, 2002). Additionally, the living room and bedroom typically have tatami mats installed, which increases the risk of falls because people tend to lay on mattresses instead of a bed (Hasegawa & Kamimura, 2018) and need to stand up from the floor (Takikawa et al., 2019). The locations categorized into group 1 have high needs but have the potential to be improved by the rearrangement of the furniture alone.

On the other hand, a bathroom, which is categorized into group 2 (Preferred “Adapting assistive device”), has the second-highest frequency of being selected for home adaptations. Notably, a bathroom is a priority of home adaptations worldwide (see e.g., Carter et al., 1997; Mitoku & Shimanouchi, 2014), but the strategy happens to be more intricate in Japan. For instance, a modular bath is uncommon in Japan, and the fine segmentation of the washroom, bathroom, and toilet causes difficulty in using wheelchairs and walking aids (Makigami & Pynoos, 2002). Furthermore, soaking in a bathtub every day is a predominant social custom for the Japanese, but getting over the edge of the bathtub will be a high risk for vulnerable people (Makigami & Pynoos, 2002). Hence, Group 2 certainly needs comprehensive solutions based on adapting assistive devices with the rearranging of furniture or reconstructions.

Stairs, which are categorized into Group 3 (Preferred “Reconstructions”), were proposed to be reconstructed more frequently in comparison to a previous study (this study: 21.8%; previous study: 8.1%) (Mitoku & Shimanouchi, 2014). This finding reveal unique characteristics of the area since medical professionals generally propose the changing of rooms to avoid stairs in daily activities (Nomura & Hashimoto, 2012). Although the result was not shown, 85.7% of patients who proposed reconstructing stairs were residing on the second floor. Hence, it could be difficult to change their room to the first floor. Moreover, stairs impose a risk of head injuries that could prove fatal (Nagata, 1992), and we surely need to prevent such accidents. However, home adaptation grants in Japanese long-term care have not yet included facilities such as stair lift chairs or elevators (Ministry of Health, Labor and Welfare, n.d.-b). The required equipment
depends on the characteristic of area. Therefore, we need to clarify what
type of home adaptations are suitable for the characteristics of each area
and allow people to select them accordingly.

A toilet and corridor, which was categorized into Group 4 (None is pre-
ferred), did not clearly divide into specific patterns. The constructs of these
locations could differ distinctively, and the types of housing adaptations did
not have apparent characteristics. Meanwhile, approach and kitchen, which
were categorized into Group 5 (i.e., the total number of home adaptation is
small), witnessed a low frequency of housing adaptations. Typical houses lack
approaches in this area to begin with because the entrance is directly con-
nected to the outdoor path. As for the kitchen, it happens to be the most fre-
quently targeted for housing adaptation in Sweden but is rarely focused on in
Japan (Murata et al., 2003; Takahashi et al., 2002; Tsuchiya-Ito et al., 2019).
It could be because the need for it can be replaced by home help services or
food delivery services. Moreover, the upper limit of expenditure in housing
adaptation grants might hinder prioritizing adaptations for the kitchen.
However, cooking is one of the essential activities of daily living, and it is
worth the investment to support independent living. Thus, there is a need to
improve both the clinical proposal and the public system to maximize
patients’ functional abilities and promote aging in place for the future.

This study revealed how important comprehension in cognitive function
is in deciding the needs of home evaluations and helped to clarify the
research gap of housing evaluation, which is the second step in the housing
adaptation process. In this context, there are many people who hope to be
aging in place in Japan (Cabinet Office, Government of Japan, 2015), and
these results can help rehabilitation professionals systematically select
patients who would benefit from home adaptations as one of the strategies
to ensure aging in place is successful.

Limitations and strengths of the study

This study is the first to examine the determinants of implementing home
evaluations for patients with fall-related fractures living in a distinctive area
in the eastern district of Tokyo. We comprehensively illustrated the pro-
posed home adaptations by including “Rearranging furniture or equipment”
as one type of housing adaptations. As a result, we were able to elucidate
the unique characteristics of housing adaptations in an area that reports
the most severe aging rates in Japan (Cabinet office, Government of Japan, 2018a).

However, this study has three limitations. First, it utilizes secondary data
elicited from one general hospital in the eastern district of Tokyo, and hence,
generalizability is limited. However, our data is valuable as it can illustrate
detailed housing evaluations for rehabilitation professionals; therefore, these results will be helpful for urban hospitals that attempt to conduct housing evaluations systematically. Second, there is a very limited amount of data on actual home adaptation proposals. Due to this, we could not analyze this data in detail regarding the differences in age, especially in terms of the reasons for falls for younger and older people. However, this data is valuable from the viewpoint of including detailed contents for each home adaptation. Third, this study refers only to the implementation of home evaluations and proposed home adaptations, and we cannot identify whether the proposed home adaptations were conducted successfully. Moreover, aspects such as dignity, autonomy, and independence are closely linked to the home (Ekstam et al., 2016), and many related to housing adaptations affected the decision to have housing adapted such as the appearance of housing adaptations, costs, and space available in the home (Aplin et al., 2013). Such decisions should be respected. However, this study used data about home evaluations, and we could not identify whether the housing was actually adapted; therefore, we cannot discuss this point adequately.

**Conclusion**

This study examined the associations of three possible determinant factors with the implementation of home evaluations and adaptations at a convalescent ward in one district with the smallest average floor space in Tokyo, Japan. Being a female and having a lower ability of comprehension were associated with the implementation of home evaluations. In urban hospitals with a limited number of rehabilitation professionals, it may be necessary to consider patients’ cognitive function in deciding who to target for housing evaluations. At the same time, it is important to seek strategies to best estimate their needs.

**Ethical Approval**

We obtained approval for the study protocol and used data secondarily in accordance with the ethics committee of the University of Tokyo (approval no.: 10700-(4)). The study protocol was shown on both organizational web pages, and we requested information with opt-out recruitment if participants wished to be excluded from this study.

**Disclosure statement**

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ORCID

Rumiko Tsuchiya-Ito http://orcid.org/0000-0002-6817-6817
Keiko Maruyama-Sakurai http://orcid.org/0000-0001-6100-2227
Takashi Yamanaka http://orcid.org/0000-0002-6259-0195

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