The Journal of Frailty & Aging 14 (2025) 100070

Contents lists available at ScienceDirect

The Journal of Frailty & Aging

journal homepage: www.elsevier.com/locate/tjfa

Original Research

# Association between the frequency of going outdoors by life space and incident disability among older adults

Takehiko Doi *, Sho Nakakubo, Fumio Sakimoto, Soichiro Matsuda, Hiroyuki Shimada

*Department of Preventive Gerontology Center for Gerontology and Social Science, Research Institute, National Center for Geriatrics and Gerontology, Obu, Aichi, Japan*

ARTICLE INFO

*Keywords:*
Activity
Physical activity
Social activity

ABSTRACT

*Background:* Going outdoors is crucial in promoting older adults' health. This study examined the association between incident disability and the frequency of going outdoors in certain life spaces.
*Methods:* This prospective study included 19,822 older adults (mean age ± standard deviation: 73.5 ± 5.8 years; 53.6 % women). The frequency of going outdoors within the past month was collected based on life space, categorized by distance from home (up to 1 km; 1–10 km; and >10 km). Participants were classified into three groups (called "Rarely": less than 1 day, "Sometimes": 1 to 3 days, and "Often": 4 days or more) for each life space. Incident disability was defined using the Long-Term Care Insurance system data (mean follow-up: 23.3 months). A Cox proportional hazards model was used to examine the association between incident disability and the frequency of going outdoors for each life space, adjusted for covariates.
*Results:* A total of 1038 (5.2 %) participants had an incident disability. Within the "up to 1 km" category, no frequency group was associated with disability; within "1–10 km," two frequency groups were associated with disability ("Sometimes" group: hazard ratio [HR] 0.85, [95 % confidence interval [CI]: 0.73–0.99]; "Often" group: HR 0.68, [95 % CI: 0.57–0.81]); within ">10 km," similar results were observed ("Sometimes" group: HR 0.84, [95 % CI: 0.72–0.98]; "Often" group: HR 0.75, [95 % CI: 0.53–1.07]).
*Conclusions:* The frequency of going outdoors at specific distances from home is associated with disability.

## 1. Introduction

Disability among older adults is a significant and complex issue, with substantial evidence of its worldwide impact [1,2]. Disability rates increase with age and affect a considerable proportion of the older population [1]. To ensure a healthy life expectancy, the establishment of preventive strategies and approaches at an early and reversible stage of the disability process, such as frailty, is required [3].

Emerging evidence shows that several lifestyle elements are disability risk factors [2]. Physical inactivity is a major risk factor [4] and an important component of the frail phenotype [5]. A long-term structured physical activity program has positive effects on reducing the risk of disability [6], and going outdoors is crucial for maintaining physical activity among older adults. A higher frequency of going outdoors has been associated with a lower risk of disability [7]. Outdoor activities have also been suggested for assessing the life space associated with the risk of disability [8,9]. However, the frequency of going outdoors by life space and its implications are not yet fully understood. Thus, this study reconsidered the association between the frequency of going outdoors and disability in specific life spaces.

## 2. Materials and methods

### 2.1. Participants

The participants were aged 60 years or older and were recruited from the National Center for Geriatrics and Gerontology Study of Geriatric Syndromes (NCGG-SGS) [10]. This was a prospective cohort study. At the baseline examination, participant characteristics were noted and assessments related to going outdoors were conducted. Incident disabilities were monitored during the follow-up period. The potential participants were selected from the NCGG-SGS database ($n$ = 20,740). Participants were excluded if they had any disability based on the Long-Term Care Insurance (LTCI) system data before the baseline examination, dementia, and severe cognitive impairment (MMSE score < 20), or there were missing data for the analysis. This study analyzed data from 19,822 older adults, with the study protocol having been approved by the Ethics Committee of the National Center for Geriatrics and

* Corresponding author.
*E-mail address:* take-d@ncgg.go.jp (T. Doi).

https://doi.org/10.1016/j.tjfa.2025.100070
Received 27 February 2025; Received in revised form 5 June 2025; Accepted 27 June 2025
Available online 3 September 2025

Gerontology (approval numbers: 637, 791, 770, 1067, and 1440).

### 2.2. Frequency of going outdoors

Data on going outdoors were obtained from the Active Mobility Index to evaluate the life-space activities [8,11]. The frequency of going outdoors within the past month was collected based on living space and distance from home (up to 1 km from the participant's residence; 1–10 km from the participant's residence; and >10 km from the participant's residence). Data were collected daily every week. Based on the frequency, participants were classified into three categories ("Rarely" group: less than one day, "Sometimes" group: one to three days, and "Often" group: four days or more) for each life space.

### 2.3. Disability

Incident disability was assessed using LTCI data [12], monitored using LTCI, and defined to be a certification of LTCI for all participants. LTCI has the purpose of helping those in need of long-term care "to maintain dignity and an independent daily life routine according to each person's own level of abilities." The LTCI certifies a person with "Support Level 1 or 2″ if the person needs support for daily activities, and "Care Level 1, 2, 3, 4, or 5" if the person needs continuous care [13]. In this study, incident disability was defined as a new certification at any level. The follow-up duration was set to 24 months (mean follow-up duration: 23.3 months).

### 2.4. Covariates

Demographic data such as age, sex, and years of education were collected. Chronic diseases (hypertension, hyperlipidemia, and diabetes mellitus) and the number of medications used were assessed by co-medical staff. Lifestyle assessments were performed to evaluate smoking and alcohol consumption. Depressive symptoms were assessed using the Geriatric Depression Scale-15 [14].

### 2.5. Statistical analysis

To examine whether incident disability is associated with the frequency of going outdoors, a log-rank test was conducted. Categorical groups based on frequency ("Rarely," "Sometimes," and "Often" groups) were set as explanatory variables. Incident disability in the time-series data was set as the objective variable. A Cox proportional hazards model was employed to examine the association between the frequency of going outdoors and incident disability, adjusted for covariates. Frequency groups were set as the explanatory variable, and the "Rarely" group was set as the reference group. Incident disability was set as the objective variable, and the covariates were age, sex, years of education, hypertension, hyperlipidemia, diabetes mellitus, medication use, the Geriatric Depression Scale-15 score, smoking habits (current smoker), and alcohol consumption (current drinker). Hazard ratio (HR) and 95 % confidence intervals (CIs) were calculated. However, the incidence of death is potentially a competing risk against disability. Thus, the HR for disability was also calculated using a Fine and Gray subdistribution hazard model. Considering the variations in going-out activities [15], the differences in frequency between men and women were examined using the $\chi^2$ test. A test using the Cox proportional hazards model was also conducted by sex. For sensitivity analysis, tests using the Cox proportional hazards model were conducted, excluding early-onset incidents within the first 6 months. SPSS (version 26; IBM Corp., Armonk, NY, USA) and the R software (version 4.5.0; R Core Team, Vienna, Australia) were used for statistical analyses, with significance set at $p < .05$.

## 3. Results

A total of 19,822 older adults (mean age ± standard deviation: 73.5 ± 5.8 years; 53.6 % women) were analyzed. The participants' characteristics are summarized in Table 1. The number of participants with incident disability was 1038 (5.2 %) during the follow-up duration (mean duration ± standard deviation: 23.3 ± 3.1 months). The participants who moved out ($n = 110$, 0.6 %) or had an incident death ($n = 166$, 0.8 %) were treated as censored.

The participants were classified into three groups based on the frequency of going outdoors in each life space. Within the "up to 1 km" category, there were 809 participants (incident disability: $n = 56$) in the "Rarely" group; 4440 participants (incident disability: $n = 294$) in the "Sometimes" group; and 14,573 participants (incident disability: $n = 688$) in the "Often" group. Within the "1–10 km" category, there were 3053 participants (incident disability: $n = 284$) in the "Rarely" group; 8712 participants (incident disability: $n = 475$) in the "Sometimes" group; and 8057 participants (incident disability: $n = 279$) in the "Often" group. Within the ">10 km" category, there were 12,501 participants (incident disability: $n = 786$) in the "Rarely" group; 5922 participants (incident disability: $n = 219$) in the "Sometimes" group; and 1399 participants (incident disability: $n = 33$) in the "Often" group. The number of participants for each frequency group by life space and sex are summarized in Fig. 1. In each life space, the frequency differed between men and women (all $p < .001$).

The results of the log-rank test showed a different association between the frequency of going outdoors and disability. These results and the number of incident disabilities are summarized in Table 2 by group (i.e., "Rarely," "Sometimes," and "Often" groups) and life space (up to 1 km; 1–10 km; and >10 km). The results of the analysis using the Cox proportional hazards model showed an association between the frequency of going out and incident disability. The results for all participants are summarized in Fig. 2.

In the analysis considering death as a competing risk, similar results were obtained. Specifically, within the "up to 1 km" category both the "Sometimes" (HR: 1.06, [95 % CI: 0.79–1.42]) and "Often" (HR: 0.89, [95 % CI: 0.67–1.18]) groups were not associated with disability. Within the "1–10 km" category, the "Sometimes" (HR: 0.85, [95 % CI: 0.73–0.99]) and "Often" (HR: 0.68, [95 % CI: 0.57–0.81]) groups were associated with disability. HRs were observed in the "Sometimes" (HR: 0.84, [95 % CI: 0.72–0.98]) and "Often" (HR: 0.75, [95 % CI: 0.53–1.07]) groups for the ">10 km" category. For the sensitivity analysis excluding early-onset incidents within the first 6 months ($n = 19,579$) the results were as follows. Within the "up to 1 km" category, all groups were not associated with disability ("Sometimes" group: HR 1.16, [95 % CI: 0.83–1.62]; "Often" group: HR 1.03, [95 % CI: 0.75–1.42]); for "1–10 km," the "Often" group was associated with disability (HR: 0.72, [95 % CI: 0.59–0.87]); for ">10 km," HRs were observed in the "Sometimes" (HR: 0.89, [95 % CI: 0.75–1.05]) and "Often" (HR: 0.71, [95 % CI: 0.48–1.06]) groups. In the sub-analysis, an

**Table 1**
Participants' characteristics.

| Variables | Values |
|---|---|
| Age, years | 73.5 ± 5.8 |
| Sex (woman), % | 53.6 |
| Education, years | 11.7 ± 2.5 |
| Hypertension, % | 47.2 |
| Hyperlipidemia, % | 36.9 |
| Diabetes mellitus, % | 13.7 |
| Medication use, number | 3.1 ± 2.8 |
| GDS, score | 2.7 ± 2.6 |
| Smoking habits (current smoker), % | 7.7 |
| Alcohol consumption (current drinker), % | 40.8 |

Data are shown as the mean ± standard deviation (SD) or proportion ( %).
GDS means Geriatrics Depression Scale 15.

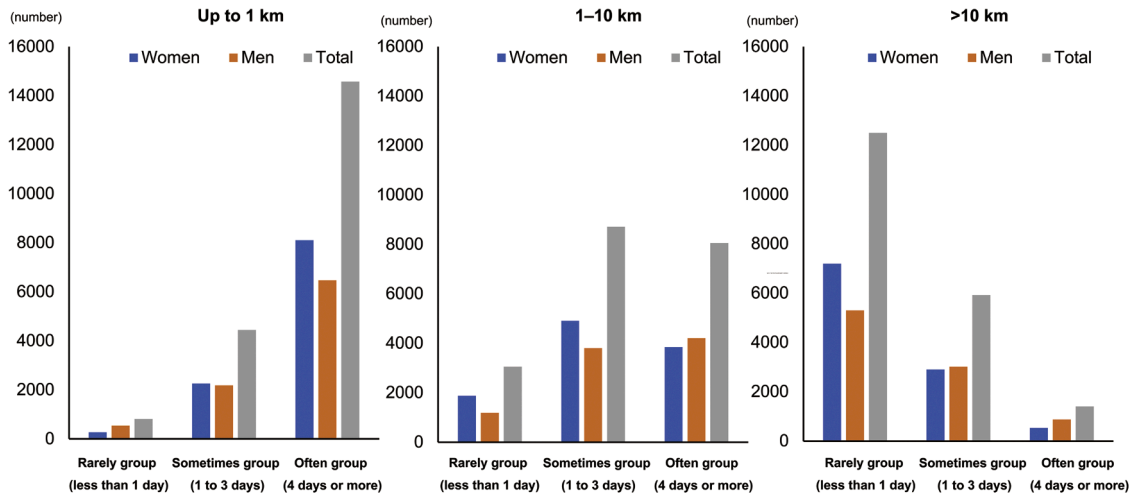


**Fig 1.** Number of participants for each frequency group by life space.

**Table 2**
Results of the log-rank test for incident disability.

| | Incident disability/number | "Rarely" group | | "Sometimes" group | | "Often" group | |
|---|---|---|---|---|---|---|---|
| | | $\chi^2$ | p | $\chi^2$ | p | $\chi^2$ | p |
| Up to 1 km | | | | | | | |
| "Rarely" group | 56/809 | | | 0.1 | 0.752 | 8.3 | 0.004 |
| "Sometimes" group | 294/4440 | 0.1 | 0.752 | | | 25.9 | < 0.001 |
| "Often" group | 688/14,573 | 8.3 | 0.004 | 25.9 | < 0.001 | | |
| 1–10 km | | | | | | | |
| "Rarely" group | 284/3053 | | | 56.4 | < 0.001 | 159.8 | < 0.001 |
| "Sometimes" group | 475/8712 | 56.4 | < 0.001 | | | 38.6 | < 0.001 |
| "Often" group | 279/8057 | 159.8 | < 0.001 | 38.6 | < 0.001 | | |
| >10 km | | | | | | | |
| "Rarely" group | 786/12,501 | | | 52.4 | < 0.001 | 34.4 | < 0.001 |
| "Sometimes" group | 219/5922 | 52.4 | < 0.001 | | | 6.0 | 0.014 |
| "Often" group | 33/1399 | 34.4 | < 0.001 | 6.0 | 0.014 | | |

To examine the differences in the association of frequency with disability, a log-rank test was conducted for each region of the participants' life space (up to 1 km, 1–10 km, and >10 km). The objective variable was incident disability, and the explanatory variable was each group based on frequency ("Rarely" group: less than one day, "Sometimes" group: one to three days, "Often" group: four days or more).

association between the frequency of going out and disability was not observed within the "up to 1 km" category among men and women. For "1–10 km," the "Sometimes" (HR: 0.74, [95 % CI: 0.58–0.94]) and "Often" (HR: 0.56, [95 % CI: 0.43–0.72]) groups had a lower HR among men, while the "Often" group (HR: 0.78, [95 % CI: 0.62–0.99]) also had a lower HR among women. For ">10 km," two frequency groups tended to be associated with disability among men ("Sometimes" group: HR 0.79, [95 % CI: 0.63–0.99]; "Often" group: HR 0.71, [95 % CI: 0.44–1.14]), and no frequency group was associated with disability among women. Additionally, stratified analysis by sex was conducted using the Cox proportional hazards model (Fig. 2).

## 4. Discussion

Our study revealed that going outdoors is associated with incident disability among community-dwelling older adults. A higher frequency of going outdoors was associated with a lower risk of disability for areas more than 1 km from the residence. Although the frequency of going outdoors differed between men and women, the association between frequency and disability did not significantly differ by sex.

The association between going outdoors and disability is supported by numerous studies, including our own. In particular, going outdoors is associated with prospective changes in functional capacity, intellectual activity, and self-efficacy during daily activities [16]. In fact, objectively measured outdoor time assessed using the global positioning system (GPS) was indirectly associated with physical and psychological functions through physical activity [17]. A meta-analysis reported that a higher level of physical activity prevents disability [4]. Additionally, going outdoors is crucial for older adults' social engagement. The frequency of going outdoors is also associated with social networks [18]. In fact, it has been suggested that changes in the frequency of going outdoors can be used to assess social status, such as social frailty, which is a risk factor for disabilities [19]. Thus, increasing the frequency of going outdoors may contribute to coping with the risk of disability. Furthermore, more frequent outdoor activities are associated with a decrease in cumulative LTCI costs [20]. Therefore, developing effective interventions to increase outdoor travel is necessary.

Our study showed that the association between the frequency of going outdoors and incident disability depended on the life space. An association was confirmed at a certain distance from one's residence, but no association was observed for areas close to the residence (<1 km). The participants in our study were independent of activities of daily living at baseline and were not certified by the LTCI. Among these participants, the effects of the frequency of going outdoors might have been obscured. In fact, the frequency distribution for areas close to one's residence indicated that most participants belonged to the "Sometimes" (1–3 days) or "Often" (4 days or more) groups. Furthermore, a study found that the trend of disability has changed over time, and the prevalence of ADL limitation has declined among older adults in high-income countries, including Japan [21]. Thus, among independent

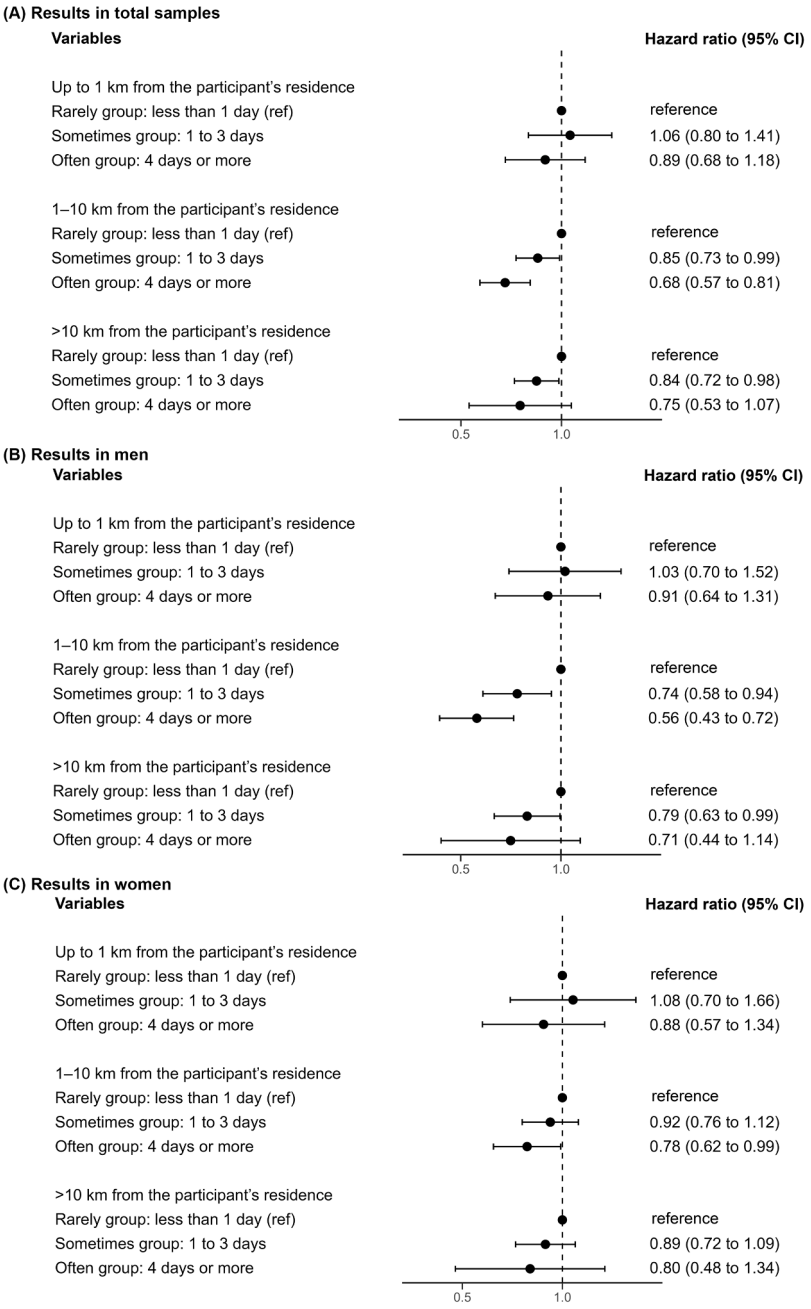


**Fig 2.** Association between the frequency of going outdoors and incident disability.
The results of the Cox proportional hazards model and hazard ratios of each frequency group are shown by life space (up to 1 km, 1–10 km, and >10 km), adjusted for covariates. The objective variable was incident disability, and the explanatory variable was each group based on frequency ("rarely" group: less than 1 day, "sometimes" group: 1 to 3 days, "often" group: 4 days or more). (A) indicates the results for the total sample; (B), for men; and (C), for women.

community-dwelling older adults, the frequency of going outdoors to areas within a certain distance from home would be more important. Another possible explanation of the results for areas close to one's residence (<1 km) is that only the frequency of going outdoors was examined in this study, and the type of outdoor activity was not considered. This may have impacted the results for areas close to home, given the heterogeneity of the outdoor activities in which the participants engaged (e.g., walking, gardening, and visiting neighborhood shops). Therefore, to examine the association more precisely, the nature of the outdoor activity should also be considered. Neglecting to do so is a limitation of this study, which must be addressed in future works.

In addition, differences in the frequency of going outdoors that are attributable to sex require further investigation. Both types of results have been reported in the past; that is, a difference was observed in certain studies [18,22,23], whereas no difference was observed in another study [7]. Although the sample size and participant characteristics differed among these studies, a relatively large cohort study with participant characteristics similar to those in our study showed comparable sex differences in frequency [23]. Additionally, the differences between the studies partly depended on the differences in the procedures used to assess the frequency. Studies have used cutoff days based on the number of days (e.g., daily or not daily) [18,22], categorized into a few groups based on frequency [7,23]. However, studies examining the frequency of going outdoors for different life spaces, such as the present study, are lacking. Therefore, further studies are warranted in this regard.

The strengths of the current study lie in its large sample size and prospective design; nonetheless, it has limitations. First, the study participants were potentially healthy, owing to a selection bias in being able to attend a health check. Thus, future studies involving participants with decreased functioning are required. Second, this study was based on self-reported questionnaire data, which make it prone to recall and social desirability biases. This might have caused underestimation of the effects of going outdoors and impacted the results. To address this limitation, further studies could assess the effects of going outdoors using quantitative methods, for example by using GPS. Third, while the study set incident disability as the outcome, death is potentially a competing risk. Although an analysis accounting for competing risks indicated results similar to those of the main analysis, further investigation is required to elucidate the effects of competing risks. Fourth, disability was defined here as certification of LTCI. However, the cause of the certification could not be considered. Further studies should elaborate on the type of disability, whether physical or cognitive. Lastly, the follow-up period in this study was relatively short. If data with a longer duration are acquired, an explanation of whether the results would depend on the follow-up duration should be provided.

In conclusion, the frequency of going outdoors to areas beyond a certain distance from one's residence was associated with incident disability. Considering the limitations of this study, further work is necessary for an in-depth understanding of the association between going outdoors and disability among older adults.

## CRediT authorship contribution statement

**Takehiko Doi:** Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sho Nakakubo:** Writing – review & editing, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Fumio Sakimoto:** Writing – review & editing, Formal analysis, Data curation. **Soichiro Matsuda:** Writing – review & editing, Formal analysis, Data curation. **Hiroyuki Shimada:** Writing – review & editing, Project administration, Funding acquisition, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

*Acknowledgments*

We thank all of those who participated in the survey.

*Funding*

This work was supported by the Japan Agency for Medical Research and Development (grant numbers: 15dk0107003h0003, 15dk0207004h0203, 15dk0207019h0001, 18dk0110021h0003 and 18le0110004h0002), JSPS KAKENHI Grant-in-Aid for Scientific Research (A) (grant number: 26242059), The Funds of Obu City Local Government, Japan Science and Technology Agency (the Strategic Basic Research Programs: RISTEX Redesigning Communities for Aged Society), the Japanese Ministry of Health Labour and Welfare (Health Labour Sciences Research Grants: H24-tyoujyu-ippan-004, Research project on health and welfare promotion for the elderly), and the National Center for Geriatrics and Gerontology (the Research Funding for Longevity Sciences: 24–18, 25–26, 27–22, 28–30).

*Sponsor's role*

None.

*Data availability*

The datasets generated and/or analyzed in the current study are not publicly available because participant consent to share datasets was not acquired. However, they are available from the corresponding author upon reasonable request.

*Ethics statement*

The study protocol was approved by the Ethics Committee of the National Center for Geriatrics and Gerontology (approval numbers: 637, 791, 770, 1067, and 1440).

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2025.100070.

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