

## Effects of consultation for voiding behavior on nocturnal urination status of older adults living alone: A preliminary study

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**SUMMARY** Nocturia and its related arousal may impair the quality of life and increase the risk of falls in older adults. This study aimed to clarify the change in urination status during the main sleeping period within 1 year. We also aimed to examine the effects of a consultation for voiding behavior in addition to the traditional behavioral therapy on urination status during sleep in a group of independent community-dwelling older adults. A single-arm intervention study was conducted in 10 older adults, with a mean age of 80.1 years and nocturia frequency of 1-4 times/day. Natural changes in urination status were observed between 2016 and 2017. Participants received traditional behavioral therapy and a consultation related to voiding behavior four times from summer 2017 to spring 2018. Urination status was monitored using sensing devices placed in the participant's home. The average time staying in the toilet significantly increased after 1 year. Although this parameter significantly decreased after the first consultation in 2017, this change was not observed with the subsequent consultation. A combination of traditional behavioral therapy and consultation for voiding behavior may be effective in improving urination status during the main sleeping period.

**Keywords** community-dwelling older adults, living alone, nocturia, arousal time, sensing device

### 1. Introduction

In 2018, the International Continence Society defined nocturia as waking to pass urine during the main sleeping period (1). Clinically, nocturia is diagnosed when a person awakens during sleep more than once to urinate. In Japan, approximately 38% of individuals aged > 40 years experienced nocturia, which increases in older adults (2). However, most older adults assume that nocturia is a sign of aging; therefore, they do not seek consult for appropriate treatment.

In community-dwelling older adults, nocturia can cause falls, which are associated with bone fractures, increased mortality, and impaired quality of life (3-5); therefore, detecting nocturia is important in this population. The Japanese Continence Society guideline recommends that patients with nocturia caused by storage dysfunction undergo pharmaceutical and behavioral therapy, such as water and salt restriction, regardless of nocturnal polyuria (6). Additionally, the guideline recommends a multidisciplinary team to manage the voiding behavior including removing underwear, sitting on the toilet seat, cleaning after voiding, wearing clothes, and toilet environment to improve the cognitive and motor dysfunctions of older adults in need of long-term

care. However, the recommendations remain lacking for older adults who live alone.

Our previous study (7) revealed that older adults with sufficient mental and behavioral function to live alone awakened several times for several minutes during night sleep to urinate. However, being awake for certain duration increases the difficulty in subsequent sleeping attempts, which may lead to sleeping disorders. In addition to medication and water and salt restriction, consulting nurses for voiding behavior may resolve problems and shorten the awake time during nocturia. However, the deterioration of voiding behavior in older adults and the effect of consultations on improving voiding behavior and shortening awakened time remain unclear. Therefore, this longitudinal study aimed to clarify urination status changes during the main sleeping period in 1 year. Additionally, we aimed to examine the effects of a consultation and traditional behavioral therapy by a nurse on the voiding behavior during the main sleeping period of independent community-dwelling older adults.

### 2. Methods

#### 2.1. Study design and participants

This single-arm interventional study was conducted from July 2016 to March 2018. Data regarding urination status during the main sleeping period were collected during five research periods: 1 week during summer 2016, 2 weeks each during summer, autumn, and winter 2017, and 2 weeks during spring 2018. Consultations were provided on the intermediate day in the four research periods, except during the summer of 2016.

The study was approved by the Medical Ethics Review Committee of Kanazawa University (No. 555-1) and complied with the provisions of the Declaration of Helsinki (revised 2013).

Flyers containing the research introduction were distributed by staff to older adults who had support from one of three regional comprehensive support centers in Kanazawa City. Older adults who were interested in the study attended a briefing session at a university. At the session, they received a written explanation of the study from a researcher and provided their informed consent for participation.

This study included older adults aged  $\geq 65$  years who lived alone, with the following characteristics: 1) experiencing nocturia, 2) evaluated as at risk of falls by the staff of the centers, 3) allowed setting of sensing devices in their homes, and 4) their families agreed with the participation. The exclusion criteria were as follows: 1) diagnosis of dementia or higher brain dysfunction and 2) lives with animals, which may cause noise for sensing data.

## 2.2. Intervention

An expert nurse in continence care provided consultations and traditional behavioral therapy regarding nocturia and voiding behavior. Prior to the consultations, participants were asked to complete a 3-day bladder diary. At the beginning of the intervention, the nurse measured the residual urine volume and interviewed participants regarding lower urinary tract symptoms, bed environment, sleeping clothes, and toilet environment. A portable ultrasound device, Lilliam<sup>®</sup>  $\alpha$ -200 (Lilliam Otsuka Co., Ltd., Tokyo, Japan), was used to measure residual urine volume, with a measurement accuracy of  $\pm 15\%$  or  $\pm 20$  mL.

Regarding traditional behavioral therapy, the nurse provided explanations to all participants regarding appropriate volume and timing of fluid intake to improve nocturia and nocturnal polyuria. The main lower urinary tract symptoms and their causes were identified. Subsequently, for participants with urinary incontinence, the nurse instructed them to perform pelvic floor muscle training using a pamphlet, recommended an appropriate pad based on the amount of urinary leakage, and taught them methods to easily change pads. In participants without residual urine, but had voiding difficulty or fear of residual urine, the

nurse reassured them that no problematic residual urine was observed and instructed them to leave the toilet after urination.

Regarding voiding behavior care, the nurse recommended the use of handrails and other devices to allow easier getting up from a bed in participants who complained of physical symptoms including back and knee pain. For participants with weak grip strength or those who wore clothing with buttons around the waist, the nurse suggested wearing clothes with an elastic waistband that is easily worn and removed. Participants at risk of falls were instructed regarding footwear and environment safety (electricity, removing luggage from the hallway) to prevent falls.

## 2.3. Measurements

### 2.3.1. Urination status during the main sleeping period

To monitor the urination status during the main sleeping time, we used an electrical device that utilizes an infrared sensor to detect nearby motions. The device was set at four places: two were placed 20 cm and 1.5 m above the floor on the wall adjacent to the bed, one on the outside wall of the toilet, and one on the inside wall of the toilet. Sensing data were continuously stored *via* the Internet (Wireless Smart Utility Network) in the cloud using Nippon Electric Company Solution Innovators, Ltd. (Tokyo, Japan) throughout the research period. Using these data, we detected three timings: leaving the bed, opening the door of the toilet, and lying on the bed. A urination-related arousal included the three timings. These arousals were quantified as the number of nocturnal urinations during the main sleeping period.

We measured three times: the time from leaving the bed to the first opening of the toilet door (time going to the toilet), the time from the first to the second opening of the toilet door (time staying in the toilet), and the time from the second opening of toilet door to sitting on bed (time going back to the toilet). Nocturia was represented as the sum of the time going to the toilet and staying in the toilet because some older adults loitered and stayed in other rooms before returning to bed from the toilet. The arousal time related to nocturia was calculated as the sum of the three times (from leaving to sitting on the bed).

The 1-week data in the summer of 2016 and data from 2 weeks before (control period) and after (intervention period) the consultation in the summer, autumn, and winter of 2017 and the spring of 2018 were extracted.

### 2.3.2. Basic characteristics

Age, sex, walking ability, assistive devices used, and major diseases were collected through interviews during the recruitment period.

## 2.4. Statistical analysis

Variables related to nocturnal urination status including the cumulative number of nocturnal urinations, cumulative nocturia-related time, and cumulative arousal time were calculated using the 7-day data. The average nocturia-related time and the average arousal time were calculated by dividing each variable by the cumulative number of nocturnal urinations.

A paired *t*-test was performed to analyze the changes in nocturnal urination between the summers of 2016 and 2017. Similarly, a paired *t*-test was performed to compare the control and intervention periods to evaluate the effect of the intervention. Differences in nocturnal urination among the four seasons were examined by multivariate analysis of variance with repeated measures using the values of the four control periods. JMP ver. 16 (SAS Institute Japan Ltd.) was used for data analysis. Statistical significance was set at  $p < 0.05$ .

## 3. Results and Discussion

Initially, 12 participants provided their consent; however, one was unable to attend consultation due to conflicting schedules, and another was unable to

provide sensing data for > 50% of the day in both summers of 2016 and 2017. Therefore, this study included 10 older adults with a mean age of  $80.1 \pm 5.8$  years. Among them, eight (80%) were female, and four (40%) walked with an assistive device occasionally. The prevalence of back and knee pain was 40%. All participants can urinate independently. All participants experienced nocturia, four experienced urinary incontinence, and three experienced voiding difficulty (Table 1).

One participant had missing sensing data in 2016. The remaining nine participants had an 11.2 cumulative number of nocturnal urinations in 2017, which was not significantly different from 2016. Additionally, the average nocturia-related time and the average time staying in the toilet in 2017 were significantly increased compared with 2016 data ( $p = 0.030$  and  $p = 0.035$ , respectively) (Table 2).

Seasonal changes in nocturnal urination status were examined in five participants who had complete data for all four seasons from summer 2017 to spring 2018; however, no significant difference was observed between the cumulative numbers of nocturnal urinations among the four seasons (Table 3). A significant difference was observed in the average time staying in the toilet among the four seasons; among them, the 2017 winter obtained the shortest time ( $208.0 \pm 43.5$  s). The average arousal time in summer and autumn were 428.2 and 333 s, respectively, which were approximately 7 and 5 min, respectively (Table 3).

In the summer of 2017, the intervention was initiated in 10 participants. Based on the bladder diary, all 10 participants had nocturia, with a frequency of 1-4 times/day and a residual urine volume of < 100 mL. After the behavioral therapy and consultation for voiding behavior, the average nocturia-related time significantly decreased ( $p = 0.024$ ) (Table 4). Similarly, the average time staying in the toilet was significantly decreased ( $p = 0.027$ ). After consultation at autumn 2017, a significant decrease was observed in the cumulative time going to the toilet in eight participants ( $p = 0.027$ ). However, no changes were observed in nocturnal urination status after the intervention in five participants who underwent consultation during winter

**Table 1. Participant characteristics**

Items	
Age (years)	80.1 ± 5.8
> 75 years	8 (80%)
65 to < 75 years	2 (20%)
Sex	
Female	8 (80%)
Male	2 (20%)
Walking condition	
Independent	6 (60%)
Occasional use of assistive device	4 (40%)
Back pain	4 (40%)
Knee pain	4 (40%)
Lower urinary tract symptoms	
Nocturia	10 (100%)
Urinary incontinence	4 (40%)
Voiding difficulty	3 (30%)

Data are mean ± standard deviation, or n (%).

**Table 2. Change in nocturnal urination status after 1 year (n = 9)**

Items	Summer 2016	Control period in 2017 summer	<i>p</i> -value
Cumulative number of nocturnal urinations	10.2 ± 3.0	11.2 ± 3.0	0.382
Cumulative nocturia-related time	2596.2 ± 1679.1	3696.7 ± 2756.4	0.161
Cumulative time going to the toilet	274.5 ± 132.1	284.4 ± 141.8	0.866
Cumulative time staying in the toilet	2321.8 ± 1675.5	3412.3 ± 2768.1	0.170
Cumulative arousal time	4402.8 ± 2059.0	6660.4 ± 4123.0	0.189
Average nocturia-related time	254.1 ± 160.8	320.4 ± 173.9	0.030
Average time going to the toilet	27.5 ± 12.5	25.6 ± 11.3	0.751
Average time staying in the toilet	226.6 ± 158.7	294.8 ± 175.1	0.035
Average arousal time	438.2 ± 204.7	576.0 ± 269.6	0.213

Unit: Seconds. Data are mean ± standard deviation. Paired *t*-test.

**Table 3. Seasonal changes in nocturnal urination status (n = 5)**

Items	Control period in summer 2017	Control period in autumn 2017	Control period in winter 2017	Control period in spring 2018	p-value
Cumulative number of nocturnal urinations	9.4 ± 2.2	10.2 ± 2.7	10.2 ± 2.2	10.0 ± 2.3	0.365
Cumulative nocturia-related time	2526.8 ± 785.5	2672.9 ± 1293.9	2410.0 ± 681.3	2508.0 ± 929.8	0.609
Cumulative time going to the toilet	238.6 ± 121.6	266.5 ± 118.5	239.6 ± 87.8	243.2 ± 115.9	0.946
Cumulative time staying in the toilet	2288.2 ± 696.4	2406.4 ± 1190.6	2170.4 ± 633.7	2264.8 ± 923.5	0.717
Cumulative arousal time	3988.5 ± 1057.8	3540.8 ± 1631.9	3843.3 ± 1303.5	3869.0 ± 2054.6	0.829
Average nocturia-related time	268.6 ± 60.5	249.0 ± 65.4	230.8 ± 41.6	254.8 ± 102.0	0.062
Average time going to the toilet	24.3 ± 7.3	25.2 ± 8.6	22.8 ± 4.8	23.4 ± 7.7	0.802
Average time staying in the toilet	244.3 ± 57.5	223.8 ± 59.6	208.0 ± 43.5	231.4 ± 107.6	0.046
Average arousal time	428.2 ± 90.7	333.0 ± 80.8	371.5 ± 129.0	393.4 ± 229.9	0.428

Unit: Seconds. Data are mean ± standard deviation. Multivariate analysis of variance with repeated measures.

and spring.

Daily monitoring of nocturnal urination status is difficult; therefore, the actual nocturia-related behaviors in community-dwelling older adults remain unclear. Sensing devices allow continuous monitoring of the daily urination status without changing voiding behavior. Despite the relatively small sample, this study revealed a significant increase in average time staying in the toilet in 1 year. Annual age-induced motor function decline may be observed (8-10); therefore, the time staying in the toilet may be prolonged by the deterioration of voiding behaviors. When motor function deteriorates due to paralysis or muscle weakness, older adults easily lose truncal balance when wearing and removing underwear and clothes, cleaning the buttocks, and standing from the toilet seat (11-13). This functional deterioration may gradually manifest as difficulties in performing repeated joint movements, such as dressing and standing. However, this study found no decrease in the time going to the toilet. This might be attributed to the presence of back and knee pain in most participants; additionally, their walking ability may have already deteriorated in 2016, since their average age at time was already at > 80 years.

The first consultation in summer 2017 significantly decreased the average nocturia-related time, especially the time staying in the toilet; however, no significant change in average nocturia-related time was observed in the following three sessions. This may be due to the ease of application of the recommendations for voiding behaviors that were provided during the first consultation, such as avoiding clothing that interferes with urination. Moreover, the older adults seemed to continue to follow this advice, which may explain the non-effectiveness of the consultation. Another possible reason was the non-problematic nature of residual urine volume; therefore, older adults may completely urinate without uncertainty. The average time staying in the toilet decreased by approximately 1 min before and after the consultation in every season; despite the non-significant difference, this may cause improvements in the quality of life in older adults. Therefore, the results of this study suggest that consultation related to voiding

behavior is effective for older adults living alone.

In autumn 2017, the cumulative time going to the toilet significantly decreased after consultation, which may be related to the 30-s increase during the control period. Many people tend to use socks or slippers in colder climates, including autumn and winter, while they prefer walking barefoot during summer. Indoor footwear influences balance and gait patterns (14); therefore, wearing inappropriate footwear could prolong the cumulative time going to the toilet in the autumn, which may be reduced by a consultation regarding appropriate footwear. The cumulative time going to the toilet was similar between the control and the intervention periods of winter 2017. This suggests that older adults with cognitive function sufficient to live independently in the community can maintain behaviors with a single instruction at summer 2017.

No change in the cumulative number of nocturnal urinations was observed before and after the consultation at any time. The habit of going to the toilet during sleeping time has been associated with anxiety related to urinary incontinence (15,16). For older adults with this habit and fear of urinary leakage, it is psychologically difficult to avoid urination during the sleeping period, despite healthcare professionals explaining that voiding is not needed. This study found a large discrepancy between the urination-related time and the arousal time, indicating that older adults did not directly return to the toilet after urination. Previous studies have found that polyuria is caused by lifestyle habits, such as drinking excessive amounts of water at night because of dehydration-induced stroke (6,17,18). It is presumed that the older adults did not return to their bedrooms immediately after voiding but stayed in other rooms performing other activities. Staying in a bright place for long periods promotes arousal and interferes with subsequent falling asleep (19-21); thus, providing advice to sleep promptly and to immediately return from the toilet is more beneficial than to ignore going to the toilet considering their lower urinary function.

This study has two limitations. First, the sample size is relatively small due to difficulties in monitoring behaviors in homes using sensors; therefore, this study

Table 4. Changes in nocturnal urination status with consultation

Items	Summer 2017 (n = 10)			Autumn 2017 (n = 8)			Winter 2017 (n = 5)			Spring 2018 (n = 5)		
	Control period	Intervention period	p-value	Control period	Intervention period	p-value	Control period	Intervention period	p-value	Control period	Intervention period	p-value
Cumulative number of nocturnal urinations	11.0 ± 2.9	11.4 ± 3.4	0.591	11.1 ± 3.1	10.0 ± 2.6	0.268	10.2 ± 2.2	10.0 ± 2.5	0.749	10.0 ± 2.3	10.6 ± 2.3	0.208
Cumulative nocturia-related time	3416.9 ± 2745.2	3120.0 ± 2415.1	0.386	4118.9 ± 2435.4	3026.2 ± 1592.1	0.282	2410.0 ± 681.3	1796.4 ± 836.2	0.100	2508.0 ± 929.8	1975.7 ± 849.6	0.279
Cumulative time going to the toilet	273.7 ± 137.8	263.1 ± 126.7	0.642	298.8 ± 116.4	235.5 ± 91.7	0.027	239.6 ± 87.8	222.6 ± 50.2	0.430	243.2 ± 115.9	249.3 ± 104.3	0.782
Cumulative time staying in the toilet	3143.2 ± 2745.0	2856.9 ± 2365.2	0.394	3820.1 ± 2345.8	2790.8 ± 1598.8	0.302	2170.4 ± 633.7	1573.7 ± 791.5	0.109	2264.8 ± 923.5	1726.4 ± 767.2	0.275
Cumulative arousal time	6114.3 ± 4253.6	4607.7 ± 2654.9	0.223	4989.1 ± 2541.3	4065.8 ± 1492.6	0.390	3843.3 ± 1303.5	3046.4 ± 847.5	0.166	3869.0 ± 2054.6	3443.3 ± 2157.1	0.693
Average nocturia-related time	298.4 ± 178.2	250.4 ± 143.7	0.024	350.2 ± 151.5	316.7 ± 175.1	0.622	230.8 ± 41.6	173.2 ± 50.2	0.163	254.8 ± 102.0	180.8 ± 53.2	0.195
Average time going to the toilet	25.0 ± 10.8	22.8 ± 8.0	0.208	26.3 ± 7.7	24.0 ± 9.0	0.306	22.8 ± 4.8	22.8 ± 4.3	0.977	23.4 ± 7.7	22.7 ± 4.9	0.747
Average time staying in the toilet	273.3 ± 178.5	227.6 ± 144.4	0.027	323.8 ± 147.9	292.7 ± 172.7	0.644	208.0 ± 43.5	150.4 ± 50.0	0.168	231.4 ± 107.6	158.1 ± 51.8	0.206
Average arousal time	531.7 ± 290.2	388.2 ± 156.1	0.088	432.7 ± 169.4	429.8 ± 191.6	0.967	371.5 ± 129.0	310.6 ± 69.4	0.303	393.4 ± 229.9	306.4 ± 144.2	0.483

Unit: Seconds. Data are mean ± standard deviation. Paired t-test.

was unable to detect any significant seasonal variation in nocturnal urination status. Second, the content of the consultation covered individual's symptoms, lifestyle, and house conditions. However, to maintain the quality of the intervention, a nurse conducted the consultation. After identifying the components of the consultation that lead to beneficial effects on voiding behavior during sleeping, protocols should be standardized and further studies with larger sample sizes are needed.

In conclusion, sensors were installed at the participant's homes to continuously detect nocturnal urination status in this study, and we found a 1-year increase in the average nocturia-related time among community-dwelling older adults. This study also showed that consultation for voiding behavior effectively decreased the average time staying in the toilet and the cumulative time going to the toilet. Future interventional studies with a larger sample size are warranted to validate the results of this study.

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