

Analysis of fluctuation in falls in nursing homes
using combined data from recorded text and environmental measures

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In Japan, the population of adults aged 65 years and older is growing rapidly and is expected to continue to increase in the future. Therefore, measures to maintain and promote the health of older adults are being promoted in various fields, with the aim of maintaining and improving healthy life expectancy and reducing social security costs, such as long-term and health care insurances. There are various research perspectives from which the architectural field can contribute to maintaining and promoting the health of older adults, the most representative of which is fall prevention. Falls and fractures are the main causes of the need for nursing care among older adults, and the preventive effect of improving the physical environment is expected to be more effective than other factors that lead to the need for nursing care.

Therefore, in this study, we conducted a survey and analysis of fluctuations in the occurrence of falls with the aim of creating a nursing home environment where older adults can spend a long period in good health and safety. By conducting this study, we also aimed to propose an analytical method to obtain evidence on the relationship between the environment and older adults' behavior and cognition in the future.

In this study, various statistical analyses, including text mining, were performed to clarify the variation in fall occurrence and near misses by combining recorded text and measured environmental data obtained in nursing homes. Based on the results of the analysis and discussion, we explored proposed interventions to prevent falls in nursing homes.

Chapter 1 provides definitions of the terms used in this study, reviews and summarizes various reports and previous studies on the environment of older adults, the long-term care industry, the psychological and physical characteristics of older adults, and the relationship between the environment and the health of older adults, and concludes with the purpose of this study.

Chapter 2 provides an overview of Special Care Nursing Home A (Special Care A), the facility studied in this research, and its position among various nursing care facilities in Japan; it also provides an overview of the survey data, data collection methods, and data items obtained. The four main types of data (described in detail in the chapter) used are as follows: recorded incidents of falls and near misses, survey data of the environment of Special Care A, survey data of participants in Special Care A, and external meteorological data published by the Japan Meteorological Agency.

In Chapter 3, our analyses of the correspondence between data from the actual environmental

measurement survey conducted at Special Care A and external weather data are illustrated. There was a correlation between the indoor environment of Special Care A and external weather data. With the exception of some rooms, there was a correlation between the room temperature and external temperature. This suggests that the thermal environment inside the facility, where air conditioning was used, was also affected by changes in the external environment. However, no correlation was found between the global solar radiation and illuminance inside the rooms. This may be because the illuminance was measured at a location above the participants' pillow; the actual indoor environment may not have been adequately understood because understanding the human perspective was prioritized.

In Chapter 4, we used text mining to quantitatively analyze textual data on falls and near misses to visualize the responses and investigated the relationship with external variables, such as the time and place of occurrence. Furthermore, we verified whether it is possible to extract the characteristics of fall occurrences and near misses using the text data obtained at nursing care facilities.

In Section 4.1, the data obtained on fall occurrences and near misses are tabulated with respect to the year, time, and location of the event. An analysis of the seasons in which falls and near misses occurred showed that the number of accidents and near misses per day was significantly lower in the spring and summer than in the fall and winter, indicating a seasonal trend in fall occurrences and near misses. In 4.2, we illustrate that the word "toilet" was used most frequently in the textual record data. This suggests that not only did accidents and near misses happen at the toilet as a place or space of occurrence but also falls and near misses that were caused by "toilet" as an action or purpose.

In Section 4.2, to analyze the textual record data of falls and near misses in more detail, we classify them into several types using the characteristic words in each textual record data set as classification conditions. The text-recorded data is classified into nine types: (1) getting up; (2) moving; (3) walking; (4) crawling; (5) around the bed; (6) wheelchair transfer; (7) toilet; (8) center reaction; and (9) portable toilets. Text mining analysis was also conducted for each type to visualize and provide an overview of the content of each type.

In Section 4.3, we attempt to clarify the characteristics of accidents and near misses that occur in each season by tabulating and analyzing the seasons in which accidents and near misses occurred for each of the nine types of accidents and near misses classified in Section 4.2. The results suggest that accidents and near misses related to moving, such as getting up and walking, occur more frequently in the spring, accidents and near misses occur more frequently in the bed area in the summer, and accidents and near misses related to toilets occur more frequently in autumn and winter.

In Chapter 4, using recorded text data on falls and near misses as input data, we categorized the falls and near misses that occurred at the facility in question and clarified their characteristics in each season by linking them to the season in which they occurred.

In Chapter 5, based on the suggestion in the previous chapter that each season is characterized by the

types of falls and near misses that occur, an analysis was conducted by combining external weather data, one of the factors that constitute seasonal characteristics, and the nine types classified in the previous chapter. The results showed that the number of accidents and near misses tended to increase with lower external temperatures and decrease on days with higher global solar radiation. In particular, the results showed that on days with lower average temperatures, accidents and near misses classified as (2) moving, (3) while walking, (5) around the bed, (7) toilet, (8) sensor reaction, and (9) portable toilets tended to occur significantly more than on days with higher temperatures.

In Chapter 5, we analyzed the types of falls and near misses classified using text data and their number of occurrences in relation to external meteorological data. We also confirmed the correlation between the occurrence of falls and near misses in Special Care A and meteorological data.

In Chapter 6, to further discuss the relationship between seasons and environment and the occurrence of falls among older adults, as suggested in the previous chapters, a multilevel model was constructed for winter and summer, with the sleep indicator as one of the health indicators, as the dependent variable, and the environmental indicator in the facility as the explanatory variable; the correlation between the two variables was quantified. In winter, the model showed that the lower the room temperature and illumination during the residents' bedtime, the more efficient their sleep. The summer model suggested that the lower the room temperature during bedtime, the shorter the time to fall asleep.

This study analyzes and clarifies the variation in the occurrence of falls by combining seasonal and environmental data with textual records, which can be used as evidence when considering intervention measures to prevent falls in nursing homes. We use textual data on falls and near misses recorded at Special Care A, the facility under study, and actual environmental measurement data inside and outside the facility to conduct the analysis. The results clarified the characteristics of the variation in falls that occurred at the facility and the relationship or correlation between the number of falls and near misses and seasonal and external weather data. Furthermore, to deepen the discussion of the analysis using text data, a statistical analysis was conducted using the measured environmental and physiological data at the facility in question, suggesting that indoor environmental indicators correlate with the quality of sleep of older adults.

Finally, Chapter 7 summarizes the chapters of this thesis and findings obtained. Additionally, we discuss the proposed intervention fall prevention measures that could be considered based on the findings of this study, the reproducibility and generalizability of this thesis, the limitations of the evidence, and future prospects.