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Changes in Social Interactions and Sleep Status of Older People in the Japanese Community

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Abstract

This study examined the relationship between changes in social interactions and sleep status, specifically sleep duration and restoration, among older adults in Japan to inform interventions for healthy aging. A 6-year longitudinal study (2017–2023) was conducted under the Community Empowerment and Care Project in suburban Japan. A total of 473 older adults with normal sleep in 2017 were followed. Sleep duration (<6 h defined as deprivation) and sleep restoration (subjective restfulness) were assessed according to national guidelines. Social interaction was measured using the 18-item Index of Social Interaction (ISI). Changes in the ISI were analyzed continuously and categorically. Logistic regression models were used to examine the association between ISI changes and sleep outcomes. After six years, 16.3% of the participants experienced sleep deprivation, and 26.2% reported non-restorative sleep. Declining ISI scores were significantly associated with a higher risk of sleep deprivation and non-restorative sleep. Persistently low or declining ISI scores increased the odds of poor sleep. A one-point ISI increase reduced the risk of sleep deprivation and non-restorative sleep, even after adjusting for confounders. Negative or persistently low social interaction is linked to worse sleep outcomes; maintaining or improving social interaction may protect sleep quality.

Keywords: Japanese community; older people; social interaction; sleep duration; sleep restoration

1. Introduction

In modern society, lack of proper sleep has become a public health problem of great concern, and the course of insomnia in older adults shows a trend toward chronic development [1]. A systematic evaluation noted that sleep disorders can increase an individual's risk of developing psychiatric disorders such as depression or cognitive decline [2]. In the basic policy of Health Japan 21 established by the Ministry of Health, Labour and Welfare (MHLW), the health goals in the sleep area are clearly stated as "an increase in the number of people who are rested from sleep" and "an increase in the number of people who are getting enough sleep" [3].

In this context, we defined the amount of enough sleep as "good sleep duration." According to the MHLW's National Healthy Sleep Guidelines, the recommended amount of sleep for elderly

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people in Japan is at least six hours a day. Some studies have shown that elderly people who have too little sleep over a long period of time, especially those who sleep for 5 h or less per night, have a higher mortality rate; particularly for those with a significantly increased risk of death related to cardiovascular and metabolic diseases, the mortality rate is further increased significantly [4]. Older adults who consistently sleep less than six hours a night are more likely to experience depression, anxiety, mood instability, and lower life satisfaction. Short sleep disrupts the hormonal balance (e.g., cortisol and serotonin), exacerbates stress responses, and impairs emotional regulation, thereby contributing to poor psychological well-being.

Sleep restoration is a subjective sleep quality index determined by night sleep and is presumed to reflect physiological sleep sufficiency. The lack of a sense of sleep restfulness can lead to non-restorative sleep (NRS), a state in which, despite getting enough sleep, one still feels fatigued or does not experience a sense of restored energy upon waking [5]. This sleep condition can lead to various health problems and affects the elderly and chronically ill in particular, as they are more susceptible to the physical and psychological effects of poor sleep quality [6]. One of the most well-documented outcomes of the NRS is its association with mental health disorders. Individuals with NRS frequently experience symptoms of depression, anxiety, and irritability. The lack of refreshing sleep affects emotional regulation and increases susceptibility to mood disorders [7]. A latent profile and moderated mediation analysis demonstrated an association between NRS and an increased risk of psychosis-like experiences [8]. Moreover, chronic NRS score has been identified as a predictor of suicidal ideation, particularly in populations already at risk [9]. NRS contributes to cognitive impairment, including difficulties in attention, concentration, memory, and decision-making [10]. Among older adults, persistent NRS may accelerate cognitive aging and is considered a potential risk factor for neurodegenerative diseases, such as Parkinson's disease and Alzheimer's disease [11]. Sleep is vital in neuroplasticity and memory consolidation; therefore, a lack of restorative sleep hampers these essential brain functions [12]. Although NRS is a subjective experience, its physiological impact is evident. It has been linked to an increased risk of cardiovascular diseases [13], type 2 diabetes [14], chronic pain [15], and weakened immune function [16]. The failure of the body to recover properly during sleep results in prolonged systemic stress, which may contribute to inflammatory processes and exacerbate chronic conditions.

Various biological, psychological, and social factors affect sleep health. Among these, social interaction has gained increasing attention in recent years as an important determinant of physical and mental health. Robust evidence indicates that older adults with diminished social networks or reduced frequency of interaction with others are more susceptible to depression and anxiety [17], cognitive deterioration [18], and even increased mortality [19]. Social relationships offer emotional support, cognitive engagement, and a daily structure, all of which may contribute positively to sleep regulation.

Despite this growing body of evidence, a notable gap in the literature regarding the direct association between changes in social interactions and sleep status, particularly in the aging Japanese population, exists. Most existing studies have examined social factors and sleep in a cross-sectional manner without evaluating long-term changes or causal relationships. Therefore, this study aimed to fill this gap by conducting a longitudinal analysis of the relationship between changes in social interactions and sleep health among older Japanese adults.

This study explored the relationship between changes in social interaction and sleep status, as represented by sleep duration and sleep restoration, among adults in Japan, and the results may provide a reference for effective intervention measures.

2. Results

As shown in Table 1, data from 473 individuals were analyzed. More than half of the individuals were females (56.7%), the rest were males (43.3%), 38.9% smoked, 33.2% drank alcohol, 56.2% exercised daily, 88.6% had at least one chronic disease at the time of participation, 74.0% were satisfied with their lives, 2.1% of the individuals were undernourished, and 16.9% had low motor

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function. After 6 years, 16.3% of the individuals had sleep deprivation (< 6 hours of sleep per day) and 26.2% had NRS. The median ISI among participants was 16 in both 2017 and 2023, with interquartile ranges of 14–17 in 2017 and 15–17 in 2023.

Variables such as age and social interaction were significantly associated with sleep deprivation (reduced sleep duration) among participants six years later ($p < 0.05$) (Table 2). Compared to their normally functioning peers, participants experiencing sleep deprivation were more likely to encounter negative changes in social relationships ($p < 0.05$).

Variables such as daily exercise, life satisfaction, and social interaction were significantly associated with NRS among participants six years later ($p < 0.05$) (Table 3). Participants with NRS were more likely to experience negative changes in social relationships compared to their normally functioning peers ($p < 0.05$).

As for the relationship between change in ISI score (change in score as a continuous variable) and sleep duration, after controlling for confounding variables, the results showed an association between positive change in ISI score and reduced risk of sleep deprivation (odds ratio=1.096, 95%CI [1.018, 1.180]) (Table 4).

The multiple logistic regression model revealed that participants who showed negative changes in ISI scores (odds ratio=2.719, 95%CI [1.382, 5.350]) were at higher risk for sleep deprivation compared with those who maintained steady social interactions (reference) over the 6-year study period. However, the participants who showed positive changes in ISI scores did not see significant changes in their risk of sleep deprivation compared to the stable group (p=0.630) (Table 5).

In the subgroup trend analysis of social relationships, compared with the group with high baseline and high follow-up (reference), the risk of sleep deprivation (sleep duration deficiency) was higher in the groups with high ISI scores at baseline and low at follow-up (odds ratio=2.610, 95%CI [1.413, 4.821]) or the groups with low ISI scores both at baseline and follow-up (odds ratio=2.089, 95%CI [1.064, 4.101]) (Table 6). This indicates that negative changes or continuing negative trends in the ISI score are predictive of a decline in sleep duration.

As for the relationship between change in ISI score (change in score as a continuous variable) and sleep restoration, after controlling for confounding variables, the results showed an association between positive change in ISI score and reduced risk of NRS (odds ratio=1.087, 95%CI [1.023, 1.156]) (Table 7).

The multiple logistic regression model revealed that participants who showed negative changes in ISI scores (odds ratio=2.715, 95%CI [1.387, 5.316]) were at higher risk for NRS compared with those who maintained steady social interactions (reference) over the 6-year study period (Table 8).

In the subgroup trend analysis of social relationships, compared with the group with high baseline and high follow-up (reference), the risk of NRS was higher in the groups with high ISI scores at baseline and low at follow-up (odds ratio=3.014, 95%CI [1.635, 5.557]) or the groups with low ISI scores both at baseline and follow-up (odds ratio=2.670, 95%CI [1.356, 5.258]) (Table 9). This indicates that negative changes or continuing negative trends in the ISI score are predictive of a decline in sleep restoration.

Table 1. Demographic Characteristics of the Participants (N=473).

Variables	Categories	*n*	%
Age	Mean value = 70.27	Standard deviation = 6.496	
Sex	Male	205	43.3
	Female	268	56.7
Smoking	Yes	184	38.9
	No	289	61.1
Drinking	Yes	157	33.2
	No	316	66.8
Disease	Yes	419	88.6
	No	54	11.4

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Exercise	Yes	266	56.2
	No	207	43.8
Life satisfaction	Yes	350	74.0
	No	123	26.0
Motor function level	Normal	393	83.1
	Low	80	16.9
Nutrition level	Normal	463	97.9
	Low	10	2.1
Sleep Duration per day	≥6 hours	396	83.7
	<6 hours	77	16.3
Restorative sleep	Yes	349	73.8
	No	124	26.2
ISI (median and [Q25-Q75]; 2017)		16	14-17
ISI (median and [Q25-Q75]; 2023)		16	15-17

Table 2. Association Between Characteristics at Baseline and Sleep Duration.

Characteristic	Sleep duration				χ^2/Z	p
	Low		Normal			
	N	%	n	%		
Age (years; mean and SD)	72.35	6.751	69.87	6.376	-3.154	0.002
Change in ISI (continuous variable; mean and SD)	-0.11	3.260	0.28	3.946	-2.992	0.003
Sex					0.119	0.730
Male	32	41.6	173	43.7		
Female	45	58.4	223	56.3		
Smoke					0.606	0.436
No	44	57.1	245	61.9		
Yes	33	42.9	151	38.1		
Drink					0.170	0.680
Yes	24	31.2	133	33.6		
No	53	68.8	263	66.4		
Disease					2.204	0.138
Yes	72	93.5	347	87.6		
No	5	6.5	49	12.4		
Exercise					0.334	0.563
Yes	41	53.2	225	56.8		
No	36	46.8	171	43.2		
Life satisfaction					0.315	0.575
Yes	55	71.4	101	25.5		
No	22	28.6	295	74.5		
Motor function level					0.072	0.788
Normal	63	81.8	329	83.1		
Low	14	18.2	67	16.9		
Nutrition level					0.098	0.754
Normal	75	97.4	388	98.0		
Low	2	2.6	8	2.0		
Change in ISI (grouped by different values)					12.433	0.002
Negative	30	39.0	81	20.5		
Positive	31	40.3	198	50.0		

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Steady	16	20.7	117	29.5		
Change in ISI (subgroup by medians)					15.485	0.001
Low to Low	20	26.0	69	17.4		
High to Low	26	33.8	78	19.7		
Low to High	5	6.5	20	5.1		
High to High	26	33.8	229	57.8		

Table 3. Association Between Characteristics at Baseline and Sleep Restoration.

Characteristic	Sleep Restoration				χ^2/Z	p
	Low		Normal			
	n	%	n	%		
Age (years; mean and SD)	70.05	6.863	70.35	6.369	-0.668	0.504
Change in ISI (continuous variable; mean and SD)	-0.16	3.075	0.34	4.138	-2.907	0.004
Sex					0.135	0.713
Male	52	41.9	153	43.8		
Female	72	58.1	196	56.2		
Smoke					1.043	0.307
No	71	57.3	218	62.5		
Yes	53	42.7	131	37.5		
Drink					1.155	0.282
Yes	46	37.1	111	31.8		
No	78	62.9	238	68.2		
Disease					1.077	0.299
No	11	8.9	43	12.3		
Yes	113	91.1	306	87.7		
Exercise					10.994	0.001
Yes	54	43.5	212	60.7		
No	70	56.5	137	39.3		
Life satisfaction					6.570	0.010
Yes	81	65.3	269	77.1		
No	43	34.7	80	22.9		
Motor function level					2.560	0.110
Normal	97	78.2	295	84.5		
Low	27	21.8	54	15.5		
Nutrition level					2.988	0.084
Normal	119	96.0	344	98.6		
Low	5	4.0	5	1.4		
Change in ISI (grouped by different values)					6.746	0.034
Negative	38	30.6	73	20.9		
Positive	60	48.4	169	48.4		
Steady	26	21.0	107	30.7		
Change in ISI (subgroup by medians)					17.630	0.001
Low to Low	33	26.6	56	16.0		
High to Low	35	28.2	69	19.8		
Low to High	9	7.3	16	4.6		
High to High	47	37.9	208	59.6		

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Table 4. Results of logistic regression analysis between the change in ISI (continuous variable) and sleep duration.

Variable	OR	95%CI	*p*
Age	0.951	[0.918, 0.987]	0.007
Change in ISI	1.096	[1.018, 1.180]	0.015

Table 5. Results of logistic regression analysis between change in ISI (grouped by different values) and Sleep duration.

Variable	OR	95%CI	*p*
Age	0.947	[0.914, 0.982]	0.003
Change in ISI			
Negative	2.719	[1.382, 5.350]	0.004
Positive	1.173	[0.612, 2.247]	0.630
Steady			Ref

Table 6. Results of logistic regression analysis between the change in ISI (subgroup by medians) and sleep duration.

Variable	OR	95%CI	*p*
Age	0.962	[0.927, 0.998]	0.045
Change in ISI			
Low to Low	2.089	[1.064, 4.101]	0.032
High to Low	2.610	[1.413, 4.821]	0.002
Low to High	2.149	[0.740, 6.241]	0.159
High to High			Ref

Table 7. Results of logistic regression analysis between the change in ISI (continuous variable) and sleep restoration.

Variable	OR	95%CI	*p*
Exercise	1.947	[1.277, 2.968]	0.002
Life satisfaction	1.874	[1.180, 2.977]	0.008
Change in ISI	1.087	[1.023, 1.156]	0.007

Table 8. Results of logistic regression analysis between the change in ISI (grouped by different values) and sleep restoration.

Variable	OR	95%CI	*p*
Exercise	0.919	[0.558, 1.515]	0.741
Life satisfaction	0.837	[0.481, 1.457]	0.530
Change in ISI			
Negative	2.715	[1.387, 5.316]	0.004
Positive	1.149	[0.602, 2.193]	0.673
Steady			Ref

Table 9. Results of logistic regression analysis between the change in ISI (subgroup by medians) and sleep restoration.

Variable	OR	95%CI	*p*
Exercise	1.149	[0.680, 1.941]	0.604
Life satisfaction	0.949	[0.543, 1.661]	0.855
Change in ISI			

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Low to Low	2.670	[1.356, 5.258]	0.005
High to Low	3.014	[1.635, 5.557]	<0.001
Low to High	2.277	[0.778, 6.671]	0.113
High to High			Ref

3. Discussion

This study explored the impact of changes in social relationships on two key aspects of sleep—sleep duration and sleep restoration—among older adults in a Japanese community. Over a six-year follow-up and after controlling for potential confounders, we found that negative changes in social interactions were significantly associated with an increased risk of both sleep deprivation and NRS. Furthermore, analysis of continuous variables indicated that each incremental increase in the ISI exerted a protective effect on both sleep duration and sleep restoration.

The results of this longitudinal study suggest that negative changes in social interactions among older adults adversely affect both sleep duration and restoration, whereas positive changes in social interactions have a protective effect. These findings align with those of a previous cross-sectional study that reported that social relationships were positively correlated with sleep quality, with lower levels of social engagement predicting shorter sleep duration and poorer sleep quality [20]. High levels of social support are associated with better sleep quality [21,22]. Yu et al. showed that loneliness resulting from a lack of social interaction negatively impacted sleep satisfaction and overall sleep quality in older adults [23]. Restorative sleep has been proposed as the key mechanism linking social relationships to health outcomes [20]. NRS, exacerbated by low levels of social interaction, may further contribute to a decline in both physical and mental health, potentially leading to adverse health outcomes, including increased mortality risk [24,25].

The subgroup analysis of changes in social interaction among older adults in this study suggests that both negative changes and prolonged persistence of low social interaction may contribute to adverse sleep outcomes, including sleep deprivation and NRS. In a longitudinal study that examined social relationships and social support among older adults, Asante et al. found a significant association between the quality of social relationships and physical and mental health, including poor sleep quality due to depression and anxiety [26]. Similarly, in an Iranian case-control study, Salehi et al. selected 400 older adults with sleep problems and 400 older adults without sleep problems and proved through analysis that social support for older adults plays a significant role in improving their sleep quality [27]. However, the primary focus of these prior studies has centered on differences in patterns of social relationships but has not examined the effects of changes in social relationships over time. The present study utilized differences in older adults' social interaction scores between two time points (2017 to 2023) to identify different categories of changes in social interactions, and assessed the effects of these differences on each of the two aspects of older adults' sleep status, sleep duration, and sleep restoration. Our results revealed that enhanced or maintained social interaction in older adults is a protective factor against deterioration in sleep status, whereas lower levels of social interaction further contribute to insufficient sleep duration and deterioration in sleep restoration.

The strengths of this study are its robust longitudinal design, large sample size, and use of the Social Interaction Index, a validated and reliable measure within Japanese communities. The six-year follow-up period enabled us to examine the causal relationship between changes in social interactions and sleep status among older Japanese adults, addressing a critical gap in the existing literature.

However, this study has some limitations. First, reliance on self-reported data on sleep duration and sleep restoration may have introduced a reporting bias. Although previous studies suggested that subjective sleep assessments can serve as reasonable substitutes for objective measures [28], future studies should incorporate objective sleep measurements to enhance their accuracy. Second, this study controlled for several confounding factors, including age, sex, disease history, physical activity, smoking and alcohol consumption, life satisfaction, motor function, and nutritional status; however, other potential confounders, such as marital status, family and child relationships, and

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economic status, were not considered. Addressing these factors in future studies could provide a more comprehensive understanding of the relationship between social interaction and sleep. Finally, the study population was drawn from a suburban area of Japan, which may limit the generalizability of the findings to other cultural and geographical contexts. Future studies should replicate these findings in diverse populations to enhance their applicability in different settings.

The primary contribution of this study was its focus on the longitudinal relationship between changes in social interactions and sleep status among older adults, which has received limited attention in previous research. By demonstrating the protective effects of improved or sustained social interaction on sleep quality, this study provides valuable evidence to support the inclusion of social interaction as a key dimension of sleep health interventions for older adults. Additionally, the use of the Social Interaction Index as a comprehensive and culturally relevant measure within the local community underscores the importance of considering contextual factors in health research. This study also addresses a critical gap in the understanding of the role of social interactions as a determinant of health among older Japanese adults. As populations continue to age, the insights from this study can inform policies aimed at enhancing the quality of life of older individuals, not only in Japan but also in other countries facing similar demographic shifts.

4. Materials and Methods

4.1. Participants and Setting

This 6-year longitudinal research from 2017 to 2023 is part of the Community Empowerment and Care for Well-being and Longevity (CEC) study implemented in a suburban area in Japan [29]. This ongoing cohort study was first initiated in 1991. Data is collected using self-reported questionnaires every three years. All residents were invited, and all agreed to participate. In this study, older people aged > 65 years at baseline (2017) who participated in the survey were included, and those who had missing data or were lost to follow-up were excluded. In addition, we excluded participants with sleep deprivation or NRS and those with a complete loss of independent living ability.

In 2017, 1162 individuals with normal sleep status were initially enrolled as participants. In 2023, a follow-up study was conducted to assess the incidence of sleep deprivation and NRS among these participants. In the analysis, data from 473 participants were used after excluding individuals who were lost to follow-up or whose data were completely missing.

4.2. Assessment of Sleep Status

Sleep status was evaluated following the 2023 Guidelines for Health-Promoting Sleep issued by the MHLW of Japan, and the quality of sleep was assessed in terms of both the sense of sleep restoration and sleep duration, as follows: (a) Sleep Duration: By self-reporting, we counted the sleep duration of the participants and a sleep duration of less than six hours per day was considered insufficient sleep. (b) Sleep Restoration: Subjective NRS was investigated using the following question: Do you get adequate rest during sleep? Individuals who answered “No” were considered to have NRS [30]. The Cronbach’s α coefficient for the items in this study is 0.741, indicating acceptable internal consistency.

4.3. Assessment of Social Interactions

Changes in social interactions were assessed using the total score of the Index of Social Interaction (ISI), which consists of 18 items and 5 subscales [31]. Positive responses were scored 1 point, and negative responses were scored 0, with the total score used to evaluate social interactions. The ISI showed high validity and reliability among Japanese community residents, with a Cronbach’s alpha of 0.78 [32].

The change in ISI score was calculated by subtracting the 2017 score from the 2023 score, with values ≥ 0 indicating stable or improved social relations, and values < 0 indicating a decline [33,34].

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The stable group was used as the reference for the analysis. The value representing the change in social interaction was treated as a continuous variable to examine the effect of a 1-point increase in ISI on sleep status. Due to the skewed distribution of ISI scores, participants were categorized into high (ISI ≥ 16) and low (ISI < 16) groups based on the median ISI score at both baseline and follow-up (ISI = 16). Four groups were formed: low-to-low, high-to-low, low-to-high, and high-to-high (reference group).

The covariates used in this study included age, sex, exercise, smoking, alcohol intake, and life satisfaction (measured by the question, "Are you satisfied with your current life?" with yes/no response), history of diseases in the past year (hospitalization or treatment for more than two weeks), nutritional level, and motor function level. The nutritional and motor function levels of older adults were assessed using a subscale from the Kihon Checklist of the Ministry of Health, Labor, and Welfare, which has proven reliable and valid in Japan [35].

Data analysis was conducted using the SPSS software (version 26.0). Descriptive statistics were calculated for the demographic characteristics of participants. In the univariate analysis, categorical variables were analyzed using the chi-square test, whereas continuous variables were analyzed using the Mann-Whitney U test because of their skewed distribution. Logistic regression was used to test the changes in ISI values, subgroups, and covariates with significant correlations, examining their causal relationship with sleep duration or restoration.

5. Conclusions

In this study, 16.3% reported sleeping for less than six hours per day, while 26.2% experienced NRS during the follow-up period. Correlation analysis indicated that age and changes in social interactions were associated with sleep duration, whereas exercise, life satisfaction, and changes in social interactions were linked to sleep restoration. The subgroup analysis further revealed that a decline in social interaction significantly increased the risk of both sleep deprivation and NRS. Specifically, individuals who experienced a reduction in social engagement or consistently maintained low levels of interaction faced heightened risk, whereas those who improved their social connections exhibited better sleep outcomes.

These findings suggest that social interactions may play an important role in sleep quality among older adults over time. A decline in social engagement is associated with a greater risk of sleep disturbance, whereas maintaining or enhancing social ties appears to offer protective benefits. This study highlights the importance of fostering social connectedness through targeted interventions and policies to support healthy aging, improve sleep, and enhance the overall well-being of the older population.

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Institutional Review Board Statement: This study was approved by the Ethics Committee of the University of Tsukuba, Japan (1331-6). Data were anonymized and made available by the municipality through formal written agreements.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent for publication must be obtained from participating patients who can be identified (including by the patients themselves). Please state "Written informed consent has been obtained from the patient(s) to publish this paper" if applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. (Due to the sensitive nature of the questions asked in this study, survey respondents were assured that raw data would remain confidential and would not be shared. The data that have been used are confidential.).

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

Abbreviation	Explanation
ISI	The Index of Social Interaction
NRS	Non-restorative sleep
CEC	Community Empowerment and Care for Well-being and Longevity
MHLW	Ministry of Health, Labour and Welfare
CI	Confidence interval
OR	Odds ratio
SD	Standard deviation

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