Occasions for laughter and dementia risk: findings from a six-year cohort study

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Occasions for laughter and dementia risk: findings from a six-year cohort study

Aim: Currently, there is little evidence on the relationship between laughter and the risk of dementia, and since laughter is mainly a social behavior, we aimed to examine the association between various occasions for laughter and the risk of dementia in Japanese older adults.

Methods: We draw upon a 6-year follow-up data from the Japan Gerontological Evaluation Study, including 12,165 independent older adults aged 65 years and over. Occasions for laughter were assessed using a questionnaire, while dementia was diagnosed using the standardized dementia scale of the long-term care insurance system in Japan. Cox proportional hazards models were estimated, yielding hazard ratios (HRs)and 95% confidence intervals (CIs).

Results: The multivariable hazard ratio of dementia incidence for all participants in the high versus a low variety of occasions for laughter was 0.84 (95% confidence interval: 0.72–0.98, p for trend<0.001). A greater variety of occasions for laughter was associated with a lower risk of dementia 0.78 (95% confidence interval: 0.63-0.96, p for trend<0.001) among women, but less pronounced for men with significant associations only for the medium group. Laughing during conversations with friends, communicating with children or grandchildren, and listening to the radio was primarily associated with decreased risk.

Conclusion: A greater variety of laughter occasions in individual and social settings was associated with a reduced risk of dementia.

Keywords: cohort studies, dementia, laughter, older adults.

Introduction

An estimated 47 million people were living with dementia in 2015 worldwide, and it has been predicted that this figure will reach 75 million by 2030 and 132 million by 2050 [1]. Dementia is the second most common cause of disability among people aged 70 years and older [2]. In Japan, which has the highest proportion of older adults worldwide, nearly 7 million people, around 20% of older adults 65 and older, will live with dementia by 2025[3]. Moreover, since 2016, dementia has overtaken stroke as the leading cause of long-term care among the 65 and older population in Japan[4].

Nearly 40% of dementia cases are theoretically preventable due to modifiable risk factors, including low education, hypertension, obesity, hearing loss, depression, diabetes, physical inactivity, smoking, social isolation, excessive alcohol consumption, head injury, and air pollution [5]. Health behaviors play an important role, but maintaining a healthy lifestyle may challenge some older adults. Laughter may positively affect various aspects of health; for example, it may significantly reduce stress and enhance immune responses [6], improving cardiovascular function [7], preventing diabetes [8], and supporting mental health [9]. However, there is little evidence on the relationship between laughter and the risk of dementia.

Laughter is mainly a social behavior, predominantly occurring in conversations and social interactions as a signal of agreement and affection to establish and maintain social bonds [10]. It is usually caused by interaction with circumstances, emotions, and a sense of exhilaration and well-being. People are more likely to laugh when they are with others than alone [11], emphasizing the role of social bonds within the individual network and society [12]. Therefore, we examined the association between occasions of laughter and the risk of dementia in a population-based cohort study. We hypothesized that a greater variety of laughing occasions would be associated with a lower risk of dementia.

Materials and methods

Study population

This study is based on a 6-year follow-up survey of a prospective cohort, the Japan Gerontological Evaluation Study (JAGES), a longitudinal population-based cohort study that assessed the social

determinants of health among the Japanese older adult population. More detailed information has been introduced elsewhere[13].

A baseline survey for this study was conducted between October and December 2013 among independent older adults aged ≥ 65 years. Self-administered questionnaires were mailed to 193,694 registered residents of 30 municipalities, and 137,736 individuals responded to the questionnaire (response rate: 71.1%). The questionnaire included basic questions for all participants and additional questions in five modules (A-E) for specific municipalities. Of all the participants allocated to the module B, 16,051 in 19 municipalities responded to laughter-related questions (response rate=70.4 %) . Among them, 14,685 were successfully linked to the public long-term care insurance (LTCI) registry and administrative records in 2019 (response rate = 91.5%). We excluded those who did not answer questions about the frequency of laughter (n=670) and occasions for laughter (n=360), who answered 'almost never' for frequency of laughter (n=756) and 'Other' for occasions for laughter (n = 328), and those who self-reported a history of stroke (n=364) or dementia (n=42) at study baseline. The number of participants who provided valid responses to the questions was 12,165 (men: 5,463; women: 6,702)(Figure 1).

Outcome: dementia

We determined dementia incidence using a nationally standardized computer-assisted long-term care insurance evaluation system that included in-home assessment and physician in charge. The dementia scale used in this system was developed by the Ministry of Health and Welfare and was based on assessing symptoms and behaviors that cause daily life impediments, degradation of cognitive functions, and communication difficulty. This study defined level II-a or higher on this scale as dementia. A validation study showed a high correlation with the Mini-Mental State Examination (Spearman rank correlation r =-0.74)[14].

Exposure: occasions for laughter

The JAGES 2013 baseline questionnaire included the following question: 'When do you often laugh ?' The possible responses were 'during conversations with friends', 'during conversations with spouse',

'during communication with children or grandchildren', 'watching TV and videos', 'listening to the radio', 'watching comedic storytelling and plays', 'when reading comics and magazines', and 'others'. We excluded participants who chose 'others' because it was not possible to determine the specific action. The total number of occasions for laughter was derived from aggregating the seven occasions described above. The overall number was grouped into tertiles (first tertile 1-2 =low, second tertile 3 =medium, and third tertile 4-7=high) because of its skewed distribution (range:1-7, median=3).

Covariates

We considered the following covariates: age (continuous), sex, marital status (living with a spouse, widowed, divorced, never married or other), education (<10 or ≥10 years), equivalized household income (< 2.00, 2.00–3.99, or ≥ 4.00 million Japanese yen), social participation (yes or no), geriatric depression scale (GDS, <5 or ≥5), history of diabetes and hypertension (yes or no), instrumental activities of daily living (IADL, independent as five or dependent as ≤ 4 points), body mass index (BMI, ≥25.0, 18.5–24.9, or < 18.5 kg/m^2), current smoking status (current smoker, former smoker or never), and daily walking time (<30 min, 30-59 min, 60-89 min, and ≥90 min).

Statistical analysis

The χ^2-test and Kruskal-Wallis test compared sex-specific proportions and mean values of sociodemographic characteristics, medical conditions, health behaviors, and psychological factors. Survival analyses were conducted using the Cox proportional hazards model. After adjusting for potential confounding factors, hazard ratios (HRs) and 95% confidence intervals (CIs) were calculated. Two models were considered: Model 1 was adjusted for age with or without sex; Model 2 was additionally adjusted for education, marital status, equivalized household income, geriatric depression scale, history of diabetes and hypertension, body mass index, walking time, current smoking status, instrumental activities of daily living, and social participation.

For sensitivity analysis, we excluded dementia cases occurring early in the observation period , namely during the first 180-1,080 days (half a year to 3 years) from baseline to consider reverse causation. All

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analyses were conducted using Stata (15.1, StataCorp LLC, College Station, TX, USA). A *P*-value less than .05 was considered to indicate a significant difference.

Ethical considerations

Ethical approval for this study was obtained from the Ethics Committee on the Research of Human Subjects at Nihon Fukushi University (No.10-05) and Chiba University (No.1777). The study was carried out by the principles of the Declaration of Helsinki.

Results

Table 1 shows the baseline characteristics, including sex-specific sociodemographic characteristics, medical conditions, health behaviors, and psychological factors, according to the three levels of occasions for laughter. During the median follow-up of 2,298 days, among 5,463 men and 6,702 women, there were 1,240 dementia cases in the analytical sample. Among the men, 2,764 (50.6%) had low variety in their occasions for laughter, 1,424 (26.1%) had medium variety, and 1,275 (23.3%) had high variety. The respective numbers for women were 2,957 (44.1%), 1,820 (27.2%), and 1,925 (28.7%).

Men and women with a greater variety of occasions for laughter were younger, with normal BMI, higher income and education, lower depressive tendency, and a higher level of IADL. They spent more time walking, had a spouse, and attended social activities. Women with a greater variety of occasions for laughter were less likely to have a smoking habit and a history of hypertension. The proportion of men with a history of diabetes mellitus or hypertension and current smoking status did not vary by occasion for laughter.

Table 2 shows the HRs for the incidence of dementia according to the three levels of occasions for laughter. Among the total participants and older women, compared with participants with a low variety of laughter occasions, participants with a greater variety for laughter occasions had an approximately 30% lower risk of dementia after adjusting by age. After further adjustment for socioeconomic status, medical condition, health behaviors, and psychological variables, these associations were attenuated but remained statistically significant. The multivariable HRs for dementia incidence in the highest versus the lowest variety of occasions for laughter were 0.84 (95% CI=0.72-0.98) for the total study population and 0.78 (95%

CI=0.63-0.96) for older women. Among older men, significant associations were only shown for the medium group (HR=0.76, 95% CI=0.61-0.96).

Table 3 shows the HRs for the incidence of dementia according to each level of occasion for laughter. For men and women combined, participants who laughed during conversations with friends, during communication with children or grandchildren, and while listening to the radio had a lower risk of dementia. Laughing while reading comics and magazines was marginally positively associated with the risk of dementia. The multivariable HRs were 0.85 (95% CI=0.75-0.95) for laughing during conversations with friends; 0.89 (95% CI=0.79-0.99) for laughing during communications with children/grandchildren; 0.84 (95% CI=0.71-1.00) for laughing while listening to the radio; and 1.20 (95% CI=0.96-1.50) for laughing while reading comics and magazines. For men, a decreased dementia risk was observed for laughing during conversations with friends, while an elevated risk was observed for laughing while watching TV and videos. A decreased dementia risk was observed for women laughing while listening to the radio, and we also observed marginally inverse associations for incident dementia with laughing during conversations with friends, communications with children or grandchildren, and laughing when watching TV or videos. We also found a marginally positive association with laughter while reading comics and magazines.

To assess the issue of reverse causation between laughter and dementia risk, multivariable HRs of dementia were examined after excluding patients with an early diagnosis of dementia (Supplementary Table 1). For all participants, excluding dementia patients after 180 to 1,080 days (half a year to 3 years) from the baseline, the associations were slightly weakened but remained statistically significant for the medium group. These associations were again more evident in women than in men.

Discussion

The current study found that a greater variety of occasions for laughter, representing a favorable psychosocial engagement with family and peers, was associated with a lower risk of dementia among Japanese older adult men and women. Exploring the range of the specific occasions, we found that laughing with friends, children, or grandchildren and listening to the radio was inversely associated with the risk of dementia, whereas this was not the case for the other occasions. Our results were consistent with previous

findings on the prospective association between laughter and optimal health outcomes, such as cardiovascular diseases and functional disability [7, 15, 16].

Our findings suggest that favorable interactions and laughing with friends and family can help maintain cognitive health for older adults. Laughter is an emotional response that promotes individual psychological well-being and social integration while facilitating interaction with others; it represents optimal functionality and sociality that could contribute to cognitive reserve and reduced stress [17, 18]. In a cohort of 1,540 Spanish community-dwelling adults older than 65, it was found that participants with high social integration and large social networks had a lower probability of developing cognitive decline after a 4-year follow-up [19]. This demonstrates that the social aspects surrounding greater occasions for laughter or interaction with others may enhance or maintain cognitive function and reduce the risk of decline.

Frequent laughter is related to high life satisfaction, a domain of emotional wellness. A prospective Canadian cohort study with a 5-year follow-up of 1,024 community-dwelling older adults aged 65 years and older showed that higher life satisfaction was associated with lower dementia risk among community-dwelling older adults [20]. Thus, the association between occasions for laughter and dementia may be impacted by life satisfaction.

In terms of the possible physiological pathway, laughter has been linked to more adaptive immune functioning. Laughter is well known to enhance natural killer cell activity [8]. Natural killer cells play an essential role in host defense as well as killing infected host cells. They are involved in the immunopathogenesis of Alzheimer`s disease, the most common form of dementia [21].

For behavioral pathways, positive psychological states, in general, have been associated with health behaviors such as physical activity [22]. Five or more hours of physical activity per week at midlife was associated with a lower risk of dementia than no physical activity after a 26-year follow-up in a cohort of 4,761 participants living in Iceland[23].

Furthermore, laughing while listening to the radio could be further extrapolated to reactions to interviews, stories, or music. Broadcast radio programs have a high proportion of musical content. A recent meta-analysis showed that music improves cognitive function in people living with dementia [24].

In terms of the sex-specific results, our findings showed that the association between the number of occasions for laughter and risk of dementia was more evident in women than in men; various occasions or events for laughter were marginally associated with a decreased risk of dementia among women while laughing while accompanied by friends was solely associated with a lower risk among men. Rich social networks and efficient social support usually play a more critical role in health status for women than for men [25]. In a large prospective cohort study conducted in the United States, more extensive social networks were associated with a lower risk of incident dementia over four years among 2,249 women aged 78 years or older from a health maintenance organization [26]. Although it did not share the same outcome as our study, a sense of humor was significantly associated with a lower risk of all-cause mortality in women but not in men in a Norwegian 15-year follow-up study [27]. It was suggested that older adult women might maintain better social networks than older adult men, which can support the complex cognitive processes of humor to decrease mortality risk. Moreover, our result of laughing while listening to the radio was associated with a reduced risk of dementia only among women, consistent with the other JAGES research findings regarding music [28]. Additionally, the inverse association between laughing during conversations with friends and risk of dementia among both men and women in the current study was consistent with the findings of the importance of friendship on decreased dementia risk from the Whitehall II cohort study, a study with 28 years follow-up that included 10,228 UK participants aged 35–55 participants [29].

In our study, laughing while watching TV or videos was associated with dementia risk among men, and reading comics and magazines was associated with dementia risk among women. It may be the case that because retirement often leads to social isolation and loneliness for older men, laughing while watching TV and videos may be laughing alone as well as staying in a sedentary position. Sedentary behavior was associated with cognitive impairment among older adult men and women in an English national cohort study with six years follow-up [30]. For women, laughing while reading comics and magazines is an individual and sedentary behavior as well, which will, in turn, increase the risk of dementia; however, this is a marginal association.

To the best of our knowledge, this is the first study to explore and report associations between occasions for laughter and the risk of dementia while controlling for a set of key sociodemographic characteristics and health conditions to help address potential bias from confounding. The outcome measure was validated, and we captured the variety of occasions and provided a detailed perspective of laughter in various settings and occasions by using the questionnaire. There were also some limitations to the current study. Even though we found a similar association after excluding dementia cases within three years, a 6-year follow-up was insufficient to support a causal relationship between laughter and risk of dementia since this is a slow-developing disorder with long 'latency periods' for decades before the clinical presentation. Furthermore, the occasions for laughter were self-reported at one point in time, leading to recall bias, especially for participants with mild cognitive dysfunction at baseline.

Conclusions

A greater variety of laughter occasions in individual and social settings was associated with a reduced risk of dementia. Our study highlights the important role of positive psychology and psychosocial factors in delaying dementia risk in older adults.

Disclosure statement

The authors declare no conflict of interest.

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┌─────────────────────────────────┐
│ Baseline enrollment             │
│ (n=193,694,in 30 municipalities)│
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              │
              ▼
┌─────────────────────────────────┐
│ Respondents                     │        ┌──────────────────────────────────┐
│ (n=137,736, response rate:71.1%,│───────▶│ Respondents allocated to modules  │
│ in 30 municipalities)           │        │ A, C, D, and E                    │
└─────────────────────────────────┘        │ (n=110,211, in 30 municipalities) │
              │                             └──────────────────────────────────┘
              ▼
┌─────────────────────────────────┐
│ Respondents allocated to module │
│ B (n=27,525 out of 38,731, in 30│
│ municipalities)                 │        ┌──────────────────────────────────┐
└─────────────────────────────────┘        │ Respondents in 11 municipalities  │
              │                    ────────▶│ who were inaccessible to laughter-│
              │                             │ related questions                 │
              │                             │ (n=11,474)                        │
              ▼                             └──────────────────────────────────┘
┌─────────────────────────────────┐
│ Respondents in 19 municipalities│
│ who were accessible to laughter-│
│ related questions(n=16,051 out of│
│ 22,789, response rate 70.4%)    │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ Linked to LTCI                  │
│ (n=14,685)                      │        ┌──────────────────────────────────┐
└─────────────────────────────────┘        │ Exclusions, details see the       │
              │                    ────────▶│ manuscript  (n=2,520)             │
              │                             └──────────────────────────────────┘
              ▼
┌─────────────────────────────────┐
│ Enrolled for analysis           │
│ (n=12,165)                      │
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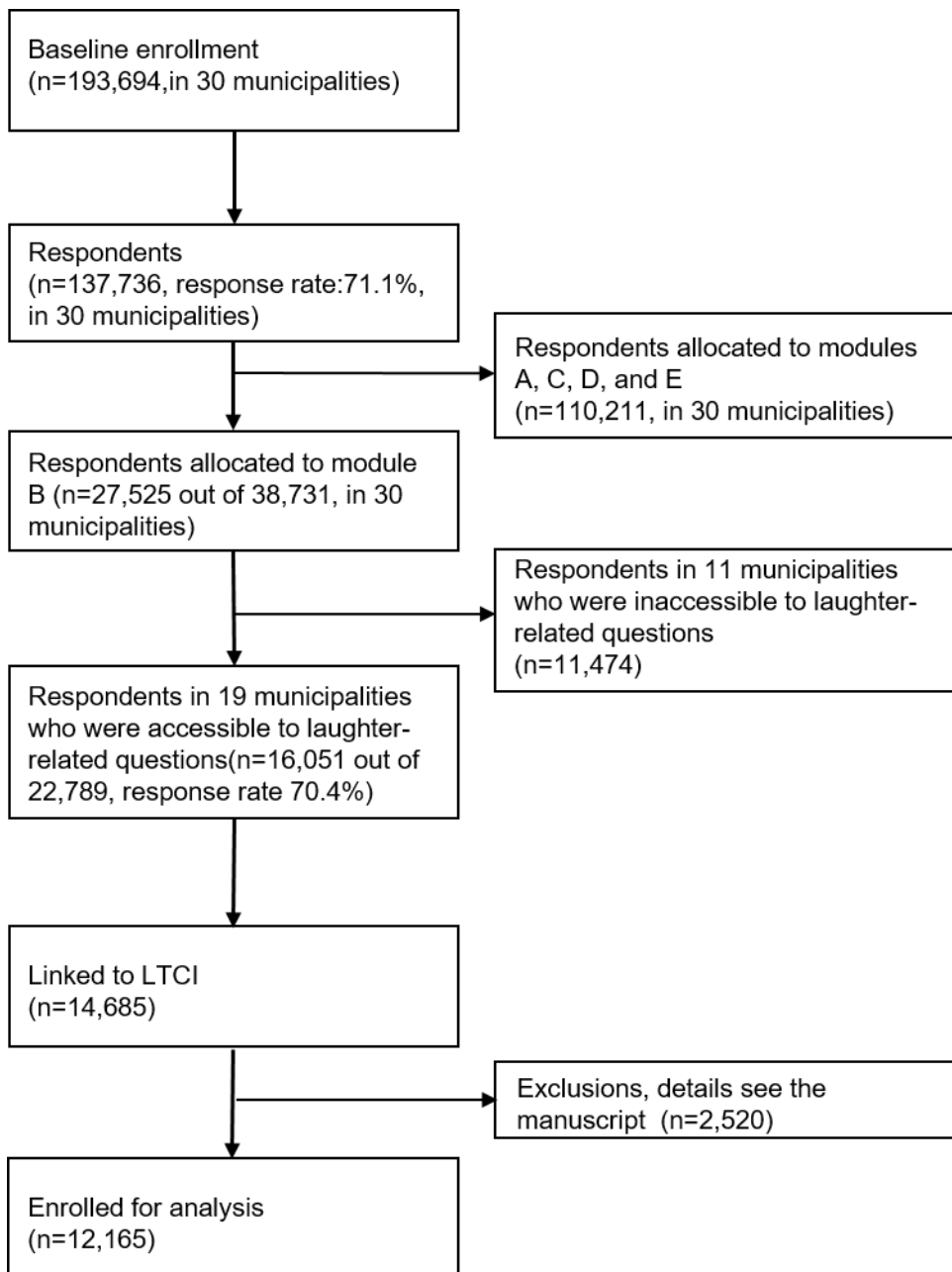
Figure 1 Flowchart of the included older adults.

Note: LTCI= longterm care insurance

Table 1. Sex-specific baseline characteristics according to three levels of occasions for laughter

	Men(n=5463)			P value	Women(n=6702)			P value
	Occasions for laughter				Occasions for laughter			
	Low	Medium	High		Low	Medium	High	
No. at risk, n	2764	1424	1275		2957	1820	1925	
Age (mean±SD)	73.7±6.14	73.1±5.75	73.2±5.43	.008	74.7±6.57	73.4±5.77	72.4±5.03	<.001
Equivalised income(million yen)				<.001				<.001
<2.00	1275(46.1)	571(40.1)	510(40.0)		1345(45.5)	731(40.2)	735(38.2)	
2.00–3.99	914(33.1)	586(41.2)	486(38.1)		724(24.5)	562(30.9)	648(33.7)	
≥ 4.00	258(9.3)	138(9.7)	150(11.8)		189(6.4)	161(8.9)	179(9.3)	
Missing	317(11.5)	129(9.1)	129(10.1)		699(23.6)	366(20.1)	363(18.9)	
Marital status				<.001				<.001
With Spouse	2271(82.2)	1315(92.4)	1205(94.5)		1467(49.6)	1094(60.1)	1514(78.7)	
Widowed	263(9.5)	59(4.1)	33(2.6)		1160(39.2)	579(31.8)	323(16.8)	
Divorced	105(3.8)	19(1.3)	12(0.9)		147(5.0)	67(3.7)	32(1.7)	
Never married	64(2.3)	12(0.8)	1(0.1)		60(2.0)	35(1.9)	13(0.7)	
Others	23(0.8)	8(0.6)	6(0.5)		26(0.9)	7(0.4)	5(0.3)	
Missing	38(1.4)	11(0.8)	18(1.4)		97(3.3)	38(2.1)	38(2.0)	
Social participation				<.001				<.001
No	700(25.3)	245(17.2)	178(14.0)		742(25.1)	330(18.1)	246(12.8)	
Yes	1812(65.6)	1059(74.4)	998(78.3)		1810(61.2)	1319(72.5)	1493(77.6)	
Missing	252(9.1)	120(8.4)	99(7.8)		405(13.7)	171(9.4)	186(9.7)	
Education(years)				.001				<.001
<10	1051(38.0)	460(32.3)	456(35.8)		1434(48.5)	772(42.4)	708(36.8)	
≥10	1677(60.7)	953(66.9)	810(63.5)		1437(48.6)	1022(56.2)	1184(61.5)	
Missing	36(1.3)	11(0.8)	9(0.7)		86(2.9)	26(1.4)	33(1.7)	
Diabetes				.27				.040
No	2165(78.3)	1104(77.5)	994(78.0)		2466(83.4)	1513(83.1)	1610(83.6)	
Yes	422(15.3)	242(17.0)	215(16.9)		294(9.9)	196(10.8)	163(8.5)	
Missing	177(6.4)	78(5.5)	66(5.2)		197(6.7)	111(6.1)	152(7.9)	
Hypertension				.24				.027
No	1391(50.3)	757(53.2)	673(52.8)		1419(48.0)	909(50.0)	977(50.8)	
Yes	1196(43.3)	589(41.4)	536(42.0)		1341(45.4)	800(44.0)	796(41.4)	

Missing	177(6.4)	78(5.5)	66(5.2)		197(6.7)	111(6.1)	152(7.9)
Current smoking status				.27				<.001
Current smoker	530(19.2)	266(18.7)	206(16.2)		123(4.2)	48(2.6)	27(1.4)
Former smoker	808(29.2)	443(31.1)	405(31.8)		67(2.3)	40(2.2)	31(1.6)
Never	1387(50.2)	696(48.9)	649(50.9)		2690(91.0)	1716(94.3)	1843(95.7)
Missing	39(1.4)	19(1.3)	15(1.2)		77(2.6)	16(0.9)	24(1.3)
Depression				<.001				<.001
GDS<5	1719(62.2)	1020(71.6)	990(77.7)		1614(54.6)	1204(66.2)	1415(73.5)
GDS≥5	693(25.1)	254(17.8)	154(12.1)		722(24.4)	299(16.4)	197(10.2)
Missing	352(12.7)	150(10.5)	131(10.3)		621(21.0)	317(17.4)	313(16.3)
IADL				.006				<.001
5 points	2013(72.8)	1078(75.7)	997(78.2)		2394(81.0)	1623(89.2)	1797(93.4)
≤4 points	681(24.6)	315(22.1)	255(20.0)		463(15.7)	164(9.0)	101(5.3)
Missing	70(2.5)	31(2.2)	23(1.8)		100(3.4)	33(1.8)	27(1.4)
BMI(kg/m^2)				.002				<.001
<18.5	160(5.8)	57(4.0)	40(3.1)		233(7.9)	105(5.8)	150(7.8)
18.5-24.9	1875(67.8)	1003(70.4)	878(68.9)		1855(62.7)	1280(70.3)	1319(68.5)
≥25	621(22.5)	324(22.8)	308(24.2)		655(22.2)	351(19.3)	369(19.2)
Missing	108(3.9)	40(2.8)	49(3.8)		214(7.2)	84(4.6)	87(4.5)
Walking time				<0.001				<0.001
<30 min	733(26.5)	297(20.9)	204(16.0)		845(28.6)	403(22.1)	341(17.7)
30-59 min	1001(36.2)	535(37.6)	425(33.3)		1057(35.8)	681(37.4)	737(38.3)
60-89 min	487(17.6)	290(20.4)	288(22.6)		498(16.8)	339(18.6)	359(18.7)
≥90 min	493(17.8)	283(20.0)	347(27.2)		470(15.9)	358(19.7)	459(23.8)
Missing	50(1.8)	19(1.3)	11(0.9)		87(2.9)	39(2.1)	29(1.5)

Notes: BMI= body mass index, IADL=instrumental activities of daily living, GDS=geriatric depression scale, SD=standard deviation, No.=number. This study includes12, 165 participants. Data are presented as n (%) for categorical variables.

Table 2. The adjusted HRs and 95% CIs of dementia incidence according to occasions for laughter

	Total(n=12165)				Men(n=5463)				Women(n=6702)			
	Low	Medium	High	*P* for	Low	Medium	High	*P* for	Low	Medium	High	*P* for
No. at risk, n	5721	3244	3200	trend	2764	1424	1275	trend	2957	1820	1925	trend
No. of cases, n	747	261	232		303	108	102		444	153	130	
Model 1[†]	1.00	**0.70(0.61-0.80)**	**0.71(0.61-0.83)**	<.001	1.00	**0.75(0.60-0.94)**	0.80(0.64-1.01)	.018	1.00	**0.66(0.55-0.80)**	**0.65(0.53-0.79)**	<.001
Model 2[‡]	1.00	**0.76(0.66-0.87)**	**0.84(0.72-0.98)**	<.001	1.00	**0.76(0.61-0.96)**	0.90(0.72-1.14)	.039	1.00	**0.73(0.60-0.88)**	**0.78(0.63-0.96)**	<.001

Notes: [†] Adjusted for age and sex in the total; Adjusted for age in sex stratification;

[‡] Adjusted further for education, marital status, equivalized household income, geriatric depression scale, history of diabetes and hypertension, body mass index, walking time, current smoking status, instrumental activities of daily living, and social participation;

Bold results indicate p < 0.05. Abbreviations: HR, hazard ratio; CI, confidence interval; No.,number

Table 3. The multivariate HRs and 95% CIs of disabling dementia incidence according to each occasion for laughter

	Total(n=12165)			Men(n=5463)			Women(n=6702)		
	No. at risk	No. of cases	Multivariate HRs[†]	No. at risk	No. of cases	Multivariate HRs[†]	No. at risk	No. of cases	Multivariate HRs[†]
Conversations with friends	8107	701	**0.85(0.75-0.95)**	3060	231	**0.79(0.66-0.95)**	5047	470	0.88(0.75-1.04)
Conversations with spouse	5627	439	0.95(0.82-1.10)	3122	273	0.90(0.75-1.10)	2505	166	0.98(0.78-1.23)
Communications with children or grandchildren	6136	564	**0.89(0.79-0.99)**	2471	217	0.90(0.75-1.08)	3665	347	0.87(0.75-1.02)
Watching TV and videos	9015	891	0.99(0.87-1.12)	3988	378	**1.23(1.01-1.51)**	5027	513	0.86(0.73-1.01)
Listening to the radio	2033	159	**0.84(0.71-1.00)**	770	57	0.89(0.67-1.18)	1263	102	**0.80(0.65-0.99)**
Watching comedic storytelling and plays	1761	162	0.99(0.84-1.17)	689	61	0.94(0.71-1.23)	1072	101	1.00(0.81-1.24)
Reading comics and magazines	812	87	1.20(0.96-1.50)	352	35	1.14(0.80-1.61)	460	52	1.25(0.94-1.66)

Notes: [†] Adjusted for age, sex, education, marital status, equivalized household income, geriatric depression scale, history of diabetes and hypertension, body mass index, walking time, current smoking status, instrumental activities of daily living, and social participation; Bold results indicate p < 0.05. Abbreviations: HR, hazard ratio; CI, confidence interval; No.,number

Supplementary Table 1. The multivariate HRs and 95% CIs of dementia incidence according to occasions for laughter with diagnosed dementia cases occurred after 180 to 1080 days from baseline excluded

	Total				Men				Women			
	Low	Medium	High	*P* for trend	Low	Medium	High	*P* for trend	Low	Medium	High	*P* for trend
180 days exclusion (n=12 117)												
No. at risk, n	5685	3237	3195		2748	1422	1272		2937	1815	1923	
No. of cases, n	711	254	227		287	106	99		424	148	128	
Multivariate HRs†	1.00	**0.77(0.66-0.89)**	**0.85(0.73-0.99)**	<.001	1.00	**0.78(0.62-0.98)**	0.92(0.72-1.16)	.074	1.00	**0.73(0.60-0.88)**	**0.79(0.64-0.97)**	<.001
360 days exclusion (n=12 061)												
No. at risk, n	5644	3228	3189	<.001	2734	1418	1271	.143	2910	1810	1918	.001
No. of cases, n	670	245	221		273	102	98		397	143	123	
Multivariate HRs†	1.00	**0.78(0.67-0.91)**	0.87(0.74-1.02)		1.00	**0.79(0.62-0.99)**	0.95(0.75-1.21)		1.00	**0.75(0.61-0.91)**	**0.80(0.64-0.99)**	
540 days exclusion (n=11 993)												
No. at risk, n	5594	3217	3182	.001	2720	1413	1266	.158	2874	1804	1916	.002
No. of cases, n	620	234	214		259	97	93		361	137	121	
Multivariate HRs†	1.00	**0.80(0.69-0.93)**	0.90(0.76-1.06)		1.00	0.79(0.62-1.01)	0.95(0.74-1.21)		1.00	**0.77(0.63-0.95)**	0.84(0.68-1.05)	
720 days exclusion (n=11 914)												
No. at risk, n	5544	3200	3170	.004	2704	1409	1259	.138	2840	1791	1911	.008
No. of cases, n	570	217	202		243	93	86		327	124	116	
Multivariate HRs†	1.00	**0.80(0.68-0.94)**	0.91(0.77-1.08)		1.00	0.81(0.64-1.04)	0.93(0.72-1.20)		1.00	**0.76(0.62-0.94)**	0.88(0.70-1.11)	
900 days exclusion (n=11 834)												
No. at risk, n	5498	3179	3157	.007	2684	1401	1252	.157	2814	1778	1905	.016
No. of cases, n	524	196	189		223	85	79		301	111	110	
Multivariate HRs†	1.00	**0.78(0.66-0.93)**	0.93(0.78-1.10)		1.00	0.81(0.62-1.04)	0.92(0.71-1.20)		1.00	**0.74(0.59-0.92)**	0.91(0.72-1.15)	
1080 days exclusion (n=11 746)												
No. at risk, n	5447	3163	3136	.005	2663	1391	1245	.144	2784	1772	1891	.010
No. of cases, n	473	180	168		202	75	72		271	105	96	
Multivariate HRs†	1.00	**0.79(0.66-0.94)**	0.90(0.75-1.08)		1.00	0.78(0.59-1.02)	0.92(0.70-1.21)		1.00	**0.76(0.60-0.96)**	0.86(0.67-1.10)	

Notes: † Adjusted for age, sex, education, marital status, equivalized household income, geriatric depression scale, history of diabetes and hypertension, body mass index, walking time, current smoking status, instrumental activities of daily living, and social participation; Bold results indicate p < 0.05. Abbreviations: HR, hazard ratio; CI, confidence interval; No.,number