BMJ Open

Does variety of social interactions associate with frequency of laughter among older people? The JAGES cross-sectional study

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To cite: Nagai M, Ohira T, Shirai K, *et al*. Does variety of social interactions associate with frequency of laughter among older people? The JAGES cross-sectional study. *BMJ Open* 2021;**11**:e039363. doi:10.1136/bmjopen-2020-039363

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-039363).

Received 14 April 2020
Revised 08 December 2020
Accepted 16 December 2020

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ABSTRACT

Objective Several studies have reported that laughter is associated with health benefits. In addition, social interactions, such as social relationships, social participation and so forth, have shown the association with not only health but also individual emotion. In this study, we conducted a cross-sectional study to examine the association between variety of social interactions and the frequency of laughter.

Design Cross-sectional study.

Setting Sampled from 30 municipalities in Japan.

Participants Non-disabled Japanese men (n=11 439) and women (n=13 159) aged ≥65 years using data from the Japan Gerontological Evaluation Study, which was conducted during October to December in 2013.

Primary outcome measures Laughing almost every day by self-reported questionnaire.

Results Poisson regression analysis with robust error variance was used to calculate prevalence ratios (PRs) for laughing almost every day according to each social relationship and its potential community-level environmental determinants. The prevalence of laughing almost every day tended to increase with increased variety in each social interaction after adjusting, instrumental activities of daily living, number of living together, working status, depression, self-reported economic status and residence year. Among men and women, multivariate-adjusted PRs (95% CIs) by comparing participants with the highest and lowest categories were 1.18 (1.04 to 1.35) and 1.16 (1.04 to 1.29) in positive life events; 1.26 (1.10 to 1.45) and 1.09 (0.96 to 1.24) in perceived positive changes in the area; 1.15 (1.04 to 1.28) and 1.17 (1.07 to 1.28) in social participations; 2.23 (1.57 to 3.16) and 1.47 (1.02 to 2.12) in social relationships and 1.25 (1.08 to 1.45) and 1.29 (1.15 to 1.45) in positive built environments. These associations were also preserved after the restriction of participants who were not in depression.

Conclusions This study shows that a greater variety of each social relationships and the potential community-level environmental determinants are associated with higher frequencies of laughter in Japan.

Strengths and limitations of this study

- ► This study is the first to examine the factors associated with laughing more, focusing on social interactions.
- ► There might be a measurement error regarding the index of social interactions and the frequency of laughter.
- ► As with past studies, because the definition of social interaction in this study is unique, it is difficult to compare the results with other studies directly.
- ► Present results might include residual confounding due to frequency of social participation and social relations because it is difficult to combine the frequency of each component.
- ► Study participants are older Japanese people; hence, results may not be generalisable.

INTRODUCTION

Laughter is a social activity and connects individuals' relationships with others in society.[1] Previous meta-analyses on the association of social relationships with mortality and morbidity have shown that individuals with weaker social ties have higher mortality and incidence of cardiovascular disease.[2 3] Then, it is considered that laughter is associated with individual health. Several studies have suggested the potential benefits of laughing more in conditions such as cancer,[4 5] cardiovascular disease[6 7] and so forth.[6 8–12] A proposed mechanism for these apparent health benefits is an improvement in immune functioning as a result of laughing more.[13] One trial studying the effect of laughter therapy on immune functioning revealed that immunity in the intervention group was higher than that in the control group.[14] Another study evaluating the relaxation response showed that participants who engaged in relaxation response practices for a prolonged time changed their gene expression patterns to possibly confer improved health outcomes.[15] Other studies have suggested the potential of positive emotions to have benefits for lipids,[16] inflammation[17] and vagal tone.[18] Laughter, therefore, is one of the important health

behaviours that can play a role not only in mental health but also in the prevention of diseases.[19 20]

Previously, we reported that equivalised income is positively associated with the frequency of laughter in both men and women.[21] Emotions are known to be influenced by social background, especially income[22 23]; however, the association of these factors with the frequency of laughter has not been studied. This study showed that the possibility of social relationships to modify the association between equivalised income and frequency of laughter. It is thought that the reason for this modification is the fact that interactions with a greater variety of social ties are associated with better mood due to engaging in a greater variety of behaviours, such as physical activity.[24] Another studies have shown that neighbourhoods and built environments are associated with loneliness[25] and mental health.[26 27]

Therefore, the purpose of the present study was conducted to examine the association between a variety of the aforementioned social interactions and the frequency of laughter among men and women aged ≥65 years in Japan.

METHODS

Study participants

A cross-sectional study was conducted using data from the Japan Gerontological Evaluation Study (JAGES).[28] The JAGES was designed to describe the health status and social determinants in older people aged 65 years or over without long-term care needs. We used data from the 2013 wave of JAGES, which was obtained from self-reported questionnaires mailed randomly to 193 694 community-dwelling individuals in 30 municipalities between the 1 October and 2 December 2013. In addition to basic questions, these questionnaires included one of five modules that covered different topics.[29] We targeted participants who were assigned to module B, which included questions related to the frequency of laughter. Of the 38 731 participants assigned to module B, 27 525 participants responded (response rate: 71.1 %). The final analysis involved 24 598 participants (11 439 men and 13 159 women) after excluding participants with missing information about age and sex (n=1597), the frequency of laughter (n=1277), and index of all social interactions (n=53).

Social interactions

The definitions of various social interactions evaluated in this study are outlined in online supplemental table 1 based on our previous study which examined the association with depressive symptoms.[30] These interactions included the following: positive life events (eg, starting a new job, birth new grandchild), perceived positive changes in the area (eg, economy, administrative services), social participations (eg, volunteer group, sports group), social relationships (eg, social support, cooperating with neighbours) and positive built environments (eg, parks for exercise, fascinating views) as a social tie, and neighbourhood and built environments. The variety of social interactions was assessed by reviewing the number of variables based on previous study,[30] and was classified on the basis of the number of participants as follows: positive life events (0, 1 or 2–5), perceived positive changes in the area (0, 1 or 2–4), social participations (0, 1–2, 3–4 or 5–13), social relationships (0–2, 3–4, 5–6 or 7–9) and positive built environments (0, 1, 2, 3 or 4).

Laughter

The outcome variable was the frequency of laughter, which assessed the following question: 'How frequently did you laugh out loud during your daily life?'. The participants were asked to choose one of four answers: 'almost every day', '1–5 days per week', '1–3 days per month' or 'never or almost never'. Based on a previous studies,[7 21] participants who answered 'almost every day' were defined as laughing almost every day.

Statistical analysis

We used Poisson regression analysis with robust error variance to derive prevalence ratios (PRs) and 95% CIs for laughing almost every day according to each social interaction. We used the SAS V.9.4 statistical software package.[31] The lowest category of each social interaction was set as the reference. Missing information regarding covariates was imputed by multiple imputation using 20 iterations.

In the multivariate-adjusted model, we controlled for age (65–69, 70–74, 75–79, 80–84 or ≥85 years), instrumental activities of daily living (IADL: independent or not independent), number of living together (alone, 2 or ≥3), working status (working, retirement or never had a job), depression (not depression, mild depressives or severe depressives), self-reported economic status (tough, slightly tough, slightly rich or rich), and residence year (<10 years, 10–19 years, 20–29 years or ≥30 years). IADL was assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence,[32] and the results were classified as independent (5 points) or not independent (<5 points). The evaluation of depression was conducted using the Geriatric Depression Scale,[33 34] and the results were classified as not depression (<5 points), mild depressives (5–9 points) or severe depressives (≥10 points).[35 36] In addition, we also adjusted frequency of seeing friends (≥4 times/week, 2–3 times/week, 1 time/week, 1–3 times/month, a few times a year or rarely) in model 2. The p value for the trend was calculated by ordinal variables. All p values were two tailed, and differences of <0.05 were considered as statistically significant.

Patient and public involvement

There was no patient or public involvement in this study.

RESULTS

Baseline characteristics by frequency of laughter

Table 1 shows the baseline characteristics of the study participants according to the categories of laughter in men and women. The prevalence of laughing almost

Table 1 Baseline characteristics by frequency of laughter

	Men		Women	
	≤5 times/week	Almost every day	≤5 times/week	Almost every day
No. of participants	7240	4199	6942	6217
Age (years) (%)				
65–69	29.1	30	26	29.3
70–74	28	32.8	28.7	32.2
75–80	22.2	21.8	22.7	21.7
80–85	14.3	11.4	15.1	11.3
≥85	6.5	4.1	7.5	5.5
No. of positive life events (%)				
0	75.8	70.6	73.1	68.5
1	18.9	21.9	20.2	23.4
2–5	3.6	5.7	3.7	5.6
Missing	1.7	1.8	3	2.4
No. of perceived positive changes in the area (%)				
0	72.2	66.9	67.5	65.3
1	20	23.2	19.6	21.6
2–4	3.2	5.5	2.9	4
Missing	4.6	4.4	10	9
No. of social participations (%)				
0	26	20.2	23.9	19
1–2	26.6	26.3	24.5	23.2
3–4	16.1	16.9	12.9	15.3
5–13	13.8	18.6	10.5	15.7
Missing	17.6	18	28.2	26.9
No. of social relationships (%)				
0–2	3.8	0.7	1.7	0.5
3–4	8.4	4.2	8.1	3.4
5–6	27.1	21.1	27.6	21.2
7–9	48.5	63.2	45.4	59.9
Missing	12.3	10.8	17.2	15.1
No. of positive built environments (%)				
0	7.5	5.5	9.5	6.2
1	20.9	15.4	20.7	16.2
2	31.7	29.7	29.4	26.4
3	24.4	27.8	22.9	26.3
4	12.5	19	12.2	19.8
Missing	3	2.6	5.3	5.2
IADL (%)				
Independent	70.8	74	82.5	87.9
Not independent	26.4	23.7	14.5	9.8
Missing	2.8	2.3	2.9	2.3
Number of living together (%)				
Alone	10	4.2	20.9	11.7
2	45.3	49.5	38.7	41.6
≥3	39.6	42.5	34.1	41.8

Continued

Table 1 Continued

	Men		Women	
	≤5 times/week	Almost every day	≤5 times/week	Almost every day
Missing	5.1	3.8	6.2	4.9
Working status (%)				
Working	25	35.5	13.6	20.9
Retirement	67.1	58.8	56.1	53.6
Never had a job	4.8	3.1	19.3	16.7
Missing	3.1	2.6	11.1	8.9
Depression (%)				
Not depression	57	75.7	50.7	71
Mild depressives	21.5	11.7	19.7	9.9
Severe depressives	8.1	2	8	1.5
Missing	13.4	10.7	21.7	17.6
Economic status (%)				
Tough	9.8	5.5	9	4.9
Slightly tough	38.3	31.5	35.3	28.5
Slightly rich	44.5	50.9	45.8	52
Rich	6.3	11	7.6	12
Missing	1.1	1.1	2.4	2.6
Residence year (%)				
<10 years	8	6.9	8.5	7.4
10–19 years	9.8	10	9.9	10
20–29 years	11	10.9	11.1	10.4
≥30 years	67.8	69.5	67.1	68.8
Missing	3.3	2.7	3.4	3.3
Frequency of seeing friends (%)				
≥4 times/week	10.3	20.8	14.1	24.5
2–3 times/week	14.4	17.2	22.3	22.3
1 time/week	10.6	11.3	14.7	13.4
1–3 times/month	22.1	20.6	22.2	19.2
A few times a year	25.6	19.5	13.5	11.3
Rarely	12.6	6.8	7.7	4.1
Missing	4.4	3.9	5.5	5.1

IADL, instrumental activity of daily living.

every day was 36.7% (n=4199) in men and 47.2% (n=6217) in women. A greater variety of each social interaction tended to be associated with a high prevalence of laughing. Better status in IADL, depression, economic status and frequency of seeing friends also had the same tendency. Current worker also had a higher prevalence while participants living alone had a lower prevalence.

Variety of social interactions and frequency of laughter

Tables 2 and 3 show the association between a variety of social interactions and the frequency of laughter. Multivariate-adjusted PRs1 for laughing almost every day increased with an increase in a variety of each social interaction among both sexes without perceived positive changes in the area in women. These PRs1 (95% CIs) for laughing almost every day were calculated by comparing participants with the highest and lowest categories in each social interaction. Among men and women, the PRs1 were 1.18 (1.04 to 1.35) and 1.16 (1.04 to 1.29) in positive life events, 1.26 (1.10 to 1.45) and 1.09 (0.96 to 1.24) in perceived positive changes in the area, 1.15 (1.06 to 1.28) and 1.17 (1.07 to 1.28) in social participations, 2.23 (1.57 to 3.16) and 1.47 (1.02 to 2.12) in social relationships, and 1.25 (1.08 to 1.45) and 1.29 (1.15 to 1.45) in positive built environments. In multivariate-adjusted PRs2, the

Table 2 PRs and 95 % CIs of frequency of laughing almost every day according to each social interactions in men

	No. of participants	No. of events	Crude PRs (95% CIs)	Age-adjusted PRs (95% CIs)	Multivariate-adjusted PRs1* (95% CIs)	Multivariate-adjusted PRs2† (95% CIs)
No. of positive life events						
0	8451	2963	Reference	Reference	Reference	Reference
1	2287	921	1.15 (1.08 to 1.22)	1.15 (1.09 to 1.22)	1.10 (1.02 to 1.18)	1.07 (0.998 to 1.16)
2–5	500	238	1.36 (1.23 to 1.50)	1.37 (1.25 to 1.51)	1.18 (1.04 to 1.35)	1.15 (1.01 to 1.32)
P for trend‡			<0.001	<0.001	0.001	0.009
No. of perceived positive changes in the area						
0	8041	2811	Reference	Reference	Reference	Reference
1	2422	974	1.15 (1.09 to 1.22)	1.15 (1.08 to 1.21)	1.08 (1.01 to 1.17)	1.07 (0.99 to 1.15)
2–4	462	230	1.42 (1.29 to 1.57)	1.42 (1.29 to 1.57)	1.26 (1.10 to 1.45)	1.23 (1.07 to 1.41)
P for trend			<0.001	<0.001	<0.001	0.002
No. of social participations						
0	2730	848	Reference	Reference	Reference	Reference
1–2	3027	1103	1.17 (1.09 to 1.26)	1.15 (1.07 to 1.23)	1.03 (0.94 to 1.13)	1.00 (0.92 to 1.10)
3–4	1873	710	1.22 (1.13 to 1.32)	1.19 (1.10 to 1.29)	1.04 (0.94 to 1.15)	0.99 (0.89 to 1.10)
5–13	1778	782	1.42 (1.31 to 1.53)	1.38 (1.27 to 1.49)	1.15 (1.04 to 1.28)	1.07 (0.96 to 1.18)
P for trend			<0.001	<0.001	0.008	0.292
No. of social relationships						
0–2	308	34	Reference	Reference	Reference	Reference
3–4	778	175	2.04 (1.45 to 2.87)	2.06 (1.46 to 2.91)	1.54 (1.07 to 2.24)	1.53 (1.05 to 2.22)
5–6	2835	883	2.82 (2.05 to 3.89)	2.82 (2.05 to 3.90)	1.80 (1.27 to 2.56)	1.75 (1.22 to 2.50)
7–9	6175	2653	3.89 (2.83 to 5.35)	3.90 (2.84 to 5.37)	2.23 (1.57 to 3.16)	2.11 (1.48 to 3.02)
P for trend			<0.001	<0.001	<0.001	<0.001
No. of positive built environments						
0	776	232	Reference	Reference	Reference	Reference
1	2162	648	1.00 (0.88 to 1.14)	1.00 (0.88 to 1.13)	0.94 (0.81 to 1.09)	0.93 (0.80 to 1.08)
2	3539	1247	1.18 (1.05 to 1.32)	1.17 (1.04 to 1.32)	1.04 (0.91 to 1.20)	1.03 (0.90 to 1.19)
3	2933	1168	1.33 (1.19 to 1.50)	1.32 (1.18 to 1.49)	1.12 (0.97 to 1.29)	1.09 (0.95 to 1.26)
4	1705	797	1.56 (1.39 to 1.76)	1.55 (1.38 to 1.75)	1.25 (1.08 to 1.45)	1.20 (1.03 to 1.39)
P for trend			<0.001	<0.001	<0.001	<0.001

*Multivariate-adjusted PRs1 was adjusted for age (65–69, 70–74, 75–79, 80–84 or ≥85 years), instrumental activity of daily living (independent or not independent), number of living together (alone, 2 or ≥3), working status (working, retirement or never had a job), depression (not depression, mild depressives or severe depressives), economic status (tough, slightly tough, slightly rich or rich), residence year (<10 years, 10–19 years, 20–29 years or ≥30 years).
†Multivariate-adjusted PRs2 was adjusted for variables in multivariate-adjusted PRs1 plus frequency of seeing friends (≥4 times/week, 2–3 times/week, 1 time/week, 1–3 times/month, a few times a year or rarely).
‡P for trend was calculated by ordinal variables.
PR, prevalence ratio.

association was attenuated but showed a similar tendency by adjustment of the frequency of seeing friends without social participations in men. In addition, the associations in PRs1 were preserved after the restriction of participants who were not in depression (online supplemental table 2).

DISCUSSION

The present study examined the association between a variety of social interactions and the frequency of laughter. We found that a greater variety of each social interaction tends to associate with a higher frequency of laughter in both Japanese older men and women. To the best of our knowledge, this is the first study to examine the associated factors of laughing more, focusing on social interactions.

The present results showed that women had a higher prevalence of laughter than men. Previous study showed that this tendency was consistently observed in all the age groups (<40 years, 40–49 years, 50–59 years, 60–69 years and ≥70 years).[37] Then, sex difference may be caused by difference of socialising skills,[38] gender and so forth.

Considering component variables, a greater variety of social interactions without perceived positive changes in the area may represent many opportunities to interact

Table 3 PRs and 95% CIs of frequency of laughing almost every day according to each social interactions in women

	No. of participants	No. of events	Crude PRs (95% CIs)	Age-adjusted PRs (95% CIs)	Multivariate-adjusted PRs1* (95% CIs)	Multivariate-adjusted PRs2† (95% CIs)
No. of positive life events						
0	9334	4261	Reference	Reference	Reference	Reference
1	2858	1457	1.12 (1.07 to 1.17)	1.14 (1.09 to 1.19)	1.09 (1.03 to 1.16)	1.08 (1.02 to 1.15)
2–5	604	347	1.26 (1.17 to 1.35)	1.28 (1.19 to 1.37)	1.16 (1.04 to 1.29)	1.13 (1.01 to 1.27)
P for trend‡			<0.001	<0.001	<0.001	0.002
No. of perceived positive changes in the area						
0	8748	4060	Reference	Reference	Reference	Reference
1	2707	1345	1.07 (1.02 to 1.12)	1.06 (1.01 to 1.11)	1.02 (0.96 to 1.09)	1.01 (0.95 to 1.08)
2–4	450	250	1.20 (1.10 to 1.30)	1.18 (1.08 to 1.28)	1.09 (0.96 to 1.24)	1.08 (0.95 to 1.22)
P for trend			<0.001	<0.001	0.203	0.307
No. of social participations						
0	2839	1178	Reference	Reference	Reference	Reference
1–2	3141	1443	1.11 (1.05 to 1.17)	1.09 (1.03 to 1.16)	1.01 (0.93 to 1.09)	0.98 (0.91 to 1.07)
3–4	1843	948	1.24 (1.17 to 1.32)	1.21 (1.14 to 1.29)	1.09 (0.996 to 1.19)	1.05 (0.96 to 1.15)
5–13	1705	976	1.38 (1.30 to 1.47)	1.35 (1.27 to 1.43)	1.17 (1.07 to 1.28)	1.10 (1.01 to 1.21)
P for trend			<0.001	<0.001	<0.001	0.015
No. of social relationships						
0–2	145	30	Reference	Reference	Reference	Reference
3–4	768	211	1.33 (0.95 to 1.86)	1.29 (0.92 to 1.82)	1.00 (0.68 to 1.47)	0.98 (0.67 to 1.45)
5–6	3231	1309	1.96 (1.42 to 2.70)	1.88 (1.36 to 2.59)	1.21 (0.84 to 1.75)	1.18 (0.81 to 1.71)
7–9	6882	3731	2.62 (1.90 to 3.61)	2.51 (1.83 to 3.46)	1.47 (1.02 to 2.12)	1.40 (0.96 to 2.03)
P for trend			<0.001	<0.001	<0.001	<0.001
No. of positive built environments						
0	1041	383	Reference	Reference	Reference	Reference
1	2443	1009	1.12 (1.02 to 1.23)	1.11 (1.01 to 1.22)	1.03 (0.92 to 1.16)	1.03 (0.92 to 1.16)
2	3682	1638	1.21 (1.11 to 1.32)	1.19 (1.09 to 1.30)	1.06 (0.95 to 1.19)	1.06 (0.94 to 1.18)
3	3223	1633	1.38 (1.26 to 1.50)	1.35 (1.24 to 1.47)	1.15 (1.03 to 1.29)	1.13 (1.01 to 1.27)
4	2076	1229	1.61 (1.48 to 1.76)	1.58 (1.45 to 1.72)	1.29 (1.15 to 1.45)	1.26 (1.12 to 1.42)
P for trend			<0.001	<0.001	<0.001	<0.001

*Multivariate-adjusted PRs1 was adjusted for age (65–69, 70–74, 75–79, 80–84 or ≥85 years), instrumental activity of daily living (independent or not independent), number of living together (alone, 2 or ≥3), working status (working, retirement or never had a job), depression (not depression, mild depressives or severe depressives), economic status (tough, slightly tough, slightly rich or rich), residence year (<10 years, 10–19 years, 20–29 years or ≥30 years).
†Multivariate-adjusted PRs2 was adjusted for variables in multivariate-adjusted PRs1 plus frequency of seeing friends (≥4 times/week, 2–3 times/week, 1 time/week, 1–3 times/month, a few times a year or rarely).
‡P for trend was calculated by ordinal variables.
PR, prevalence ratio.

with other people. In fact, our participants tended to have more opportunities to see their friends with an increase in social interactions (online supplemental table 3). We asked participants, 'When do you often laugh?', to which 63.1% of the respondents answered 'talking with friends'. Other studies have reported that casual conversation with others induces laughter,[39] and that friendship plays an important role in subjective well-being, loneliness, anxiety and happiness.[40 41] Therefore, it can be deduced that one of the main reasons for the association between social interactions and the frequency of laughter is that an increase in meeting others with a greater variety of social interactions leads to more opportunities to laugh.

Laughter is one of the social activities between human relationships.[1] It smooths each relationship with interaction. In the result, these social relationships associate with health outcomes.[2 3] Previous studies have also observed the association between laughter and health outcomes.[4 5 7–12] However, when we adjusted the analysis according to the frequency of seeing friends, the associations were still observed without social participations in men. There are two possible reasons for this result. First, people have casual conversations not only with friends but also on several associations throughout daily life, such as with an acquaintance, a salesperson and so forth. It might be a residual effect due to meeting people other than friends.

Second, although laughter has been found to occur most frequently during casual conversations,[39] there are other activities that could lead to laughter, such as watching television. Of note, 72.3% of respondents, when asked 'When do you often laugh?', answered 'watching television', while 15.9%, 14.0%, and 6.2% answered 'listening to the radio', 'seeing a comic storyteller or a play', or 'reading comics or magazines', respectively.

In addition, despite the definition being different between studies, several observational studies have shown the association between residential neighbourhood environment and individual mental health. Kemperman *et al* showed that loneliness was indirectly associated with perceived safety and satisfaction with local amenities and services.[25] Furthermore, green spaces and parks have been associated with positive mental health.[26] Another study suggested that the safety and availability of infrastructure (eg, sidewalks, or bicycle paths) as well as natural features may encourage residents to walk or cycle more often, leading to physical activity that affects mental health.[27]

Therefore, a greater variety of perceived positive changes in the area and positive built environments may allow people to be in the right mental state to laugh. In addition, neighbourhood environments, public open spaces and places to use on a daily, such as restaurant, market, grocery store, and so forth, induce interactions directly among people.[42–45] These people have more chances to laugh through gossiping and playing together. Not only social activity groups but also these places that present elastic ties may exist as a third place in older people.[42 46] In contrast, improving green infrastructure has an effect on quality of life and social isolation; however, randomised control trials have shown that urban regeneration and improving green infrastructure did not have an effect on mental health.[47] Thus, the causal pathway of neighbourhood environment to frequency of laughter remains unclear. It is possible that these inconsistencies are in part affected by different associations between men and women in perceived positive changes in the area.

Meanwhile, it has been reported that depression decreases the frequency of laughter[48] and that it is linked to SES and social participation.[21 49–51] Our group also previously reported that composed variables about each social interaction were associated with smaller income-based inequalities in depression by using the same dataset in present study.[30] To demonstrate the result without the effect of depression, we conducted further analysis, restricting participants reporting no depression. However, this sensitivity analysis revealed the same relationship before the aforementioned restriction. The present results are not affected by residual confounding of depression.

In recent decades, evidence of the impact of social interactions on health has been established as important for public health and policy determination. Considering present and past studies,[4 5 7–12] laughter exists as an intermediate between social interactions and health, and might be one of the pathways to explain the impact of social interactions on health.

This study has potential limitations that should be considered. First, there is a possibility of the existence of a measurement error. The 1 year test–retest reliability of the item was assessed in a previous study with 2680 men and women aged 30–74 years by using the Spearman correlation coefficient, which was found to be 0.61 ($p<0.001$).[52] In addition, there were no regional and seasonal differences in the frequency of laughter among Japanese men and women.[53] This suggests that the present results were not obtained by chance due to low validity of the questionnaire. However, misclassification might have occurred due to recall bias. In this case, the present results were underestimated toward the null. Meanwhile, in the index of social interactions, it should also be considered that people who laugh more may tend to respond with greater variety of social interactions. If this bias exists, the present result is overestimated. Second, as with other past studies, the definition of social interaction in this study is unique. Thus, it is difficult to compare the results with other studies directly. Third, we could not fully consider about the frequency of social participation and social relationship because it is difficult to combine the frequency of each component. Then, present results might include residual confounding due to these frequencies. Fourth, study participants are older Japanese people; therefore, it is unknown whether the present association is also observed or not in another age groups and ethnicities. However, interaction with people induces laughter, and this situation does not differ either in age groups or in ethnicities.[42 44 45] Then, the present association would be observed in another age groups and ethnicities. Actually, younger people laugh more frequently than older ones.[37] There is a greater possibility to observe stronger associations between variety of social interactions and the frequency of laughter in younger people than that in older ones.

CONCLUSION

The present study shows that greater variety of each social interaction is associated with laughing often in Japan. Laughter may be one of the important pathways linking psychosocial, socioeconomic, and relevant environmental contexts to an individual's health. The measurement of laughter is considered useful as an index of psychological and socioeconomic activity in health promotion among older population.

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Correction notice This article has been corrected since it first published. The provenance and peer review statement has been included.

Acknowledgements This study used data from the JAGES, conducted by the Nihon Fukushi University Center for Well-Being and Society, for one of their research projects. The authors are extremely grateful to the study participants for the use of their personal data. They would like to express their deepest gratitude to everyone who participated in the surveys. They are also grateful for the insightful comments and suggestions by Naoki Kondo, MD, PhD (Department of Health and Social Behavior / Department of Health Education and Health Sociology, School of Public Health, The University of Tokyo, Tokyo, Japan). Masato Nagai would like to thank all members of the Department of International and Community Oral Health, Tohoku University Graduate School of Dentistry, for their generous support.

Contributors MN and TO contributed to the design of the study. KS and KK participated in data collection. MN participated in data analysis. MN and TO participated in writing the report. All authors participated in critical revision of the manuscript and approved the final version of the report for submission.

Funding This study was supported by Health Labor Sciences Research Grant, Comprehensive Research on Aging and Health (H30-Junkanki-Ippan-004, H28-Choju-Ippan-002, H26-Choju-Ippan-006, H25-Choju-Ippan-003, H25-Kenki-Wakate-015, H25-Irryo-Shitei-003 (Fukkou), H24-Junkanki (Syosyu)-Ippan-007) from the Ministry of Health, Labor and Welfare, Japan; Grant-in-Aid for Scientific Research (20319338, 22390400, 23243070, 23590786, 23790710, 24140701, 24390469, 24530698, 24653150, 24683018, 25253052, 25870573 2587881, 15H01972, 15KT0007, 18K19688, 19H03901, 19H03901, 20H00557, 20K21719) from the Japan Society for the Promotion of Science; the Japan Agency for Medical Research and Development (16769793, JP19dk0110034, JP20dk0110034); a grant from the National Center for Geriatrics and Gerontology, Japan (20-19, 24-17, 24-23, J09KF00804); and OPERA (JPMJOP1831) from JST.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The JAGES protocol was reviewed and approved by the Ethics Committee on Research of Human Subjects at Nihon Fukushi University (Approval No. 10-05). Written informed consent was assumed with voluntary return of the questionnaire.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The JAGES data used in this study will be made available upon request.

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REFERENCES

1 Coser RL. Some social functions of laughter. *Hum Relat* 1959;12:171–82.
2 Holt-Lunstad J, Smith TB, Baker M, *et al*. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. *Perspect Psychol Sci* 2015;10:227–37.
3 Valtorta NK, Kanaan M, Gilbody S, *et al*. Loneliness and social isolation as risk factors for coronary heart disease and stroke: systematic review and meta-analysis of longitudinal observational studies. *Heart* 2016;102:1009–16.
4 Penson RT, Partridge RA, Rudd P, *et al*. Laughter: the best medicine? *Oncologist* 2005;10:651–60.
5 Noji S, Takayanagi K. A case of laughter therapy that helped improve advanced gastric cancer. *Jpn Hosp* 2010;29:59–64.
6 Sakurada K, Konta T, Watanabe M, *et al*. Associations of frequency of laughter with risk of all-cause mortality and cardiovascular disease incidence in a general population: findings from the Yamagata study. *J Epidemio* 2020;30:188–93.
7 Hayashi K, Kawachi I, Ohira T, *et al*. Laughter is the best medicine? A cross-sectional study of cardiovascular disease among older Japanese adults. *J Epidemiol* 2016;26:546–52.
8 Kimata H. Laughter counteracts enhancement of plasma neurotrophin levels and allergic skin wheal responses by mobile phone-mediated stress. *Behav Med* 2004;29:149–54.
9 Kimata H. Laughter elevates the levels of breast-milk melatonin. *J Psychosom Res* 2007;62:699–702.
10 Kimata H. Increase in dermcidin-derived peptides in sweat of patients with atopic eczema caused by a humorous video. *J Psychosom Res* 2007;62:57–9.
11 Gelkopf M, Gonen B, Kurs R, *et al*. The effect of humorous movies on inpatients with chronic schizophrenia. *J Nerv Ment Dis* 2006;194:880–3.
12 Takeda M, Hashimoto R, Kudo T, *et al*. Laughter and humor as complementary and alternative medicines for dementia patients. *BMC Complement Altern Med* 2010;10:28.
13 Martin RA, Humor MRA. Humor, laughter, and physical health: methodological issues and research findings. *Psychol Bull* 2001;127:504–19.
14 Sakai Y, Takayanagi K, Ohno M, *et al*. A trial of improvement of immunity in cancer patients by laughter therapy. *Jpn Hosp* 2013;32:53–9.
15 Dusek JA, Otu HH, Wohlhueter AL, *et al*. Genomic counter-stress changes induced by the relaxation response. *PLoS One* 2008;3:e2576.
16 Boehm JK, Williams DR, Rimm EB, *et al*. Relation between optimism and lipids in midlife. *Am J Cardiol* 2013;111:1425–31.
17 Steptoe A, Demakakos P, de Oliveira C, *et al*. Distinctive biological correlates of positive psychological well-being in older men and women. *Psychosom Med* 2012;74:501–8.
18 Kok BE, Fredrickson BL. Upward spirals of the heart: autonomic flexibility, as indexed by vagal tone, reciprocally and prospectively predicts positive emotions and social connectedness. *Biol Psychol* 2010;85:432–6.
19 Shahidi M, Mojtahed A, Modabbernia A, *et al*. Laughter yoga versus group exercise program in elderly depressed women: a randomized controlled trial. *Int J Geriatr Psychiatry* 2011;26:322–7.
20 Ko H-J, Youn C-H. Effects of laughter therapy on depression, cognition and sleep among the community-dwelling elderly. *Geriatr Gerontol Int* 2011;11:267–74.
21 Imai Y, Nagai M, Ohira T, *et al*. Impact of social relationships on income-laughter relationships among older people: the JAGES cross-sectional study. *BMJ Open* 2018;8:e019104.
22 Ahmed D, El Shair IH, Taher E, *et al*. Prevalence and predictors of depression and anxiety among the elderly population living in geriatric homes in Cairo, Egypt. *J Egypt Public Health Assoc* 2014;89:127–35.
23 Kahneman D, Deaton A. High income improves evaluation of life but not emotional well-being. *Proc Natl Acad Sci U S A* 2010;107:16489–93.
24 Fingerman KL, Huo M, Charles ST, *et al*. Variety is the spice of late life: social integration and daily activity. *J Gerontol B Psychol Sci Soc Sci* 2020;75:377–88.
25 Kemperman A, van den Berg P, Weijs-Perrée M, *et al*. Loneliness of older adults: social network and the living environment. *Int J Environ Res Public Health* 2019;16:E406.
26 Wood L, Hooper P, Foster S, *et al*. Public green spaces and positive mental health - investigating the relationship between access, quantity and types of parks and mental wellbeing. *Health Place* 2017;48:63–71.
27 Hartig T, Mitchell R, de Vries S, *et al*. Nature and health. *Annu Rev Public Health* 2014;35:207–28.
28 Kondo K, Rosenberg M. *Advancing universal health coverage through knowledge translation for healthy ageing: lessons learnt from the Japan Gerontological evaluation study*. Geneva: World Health Organization, 2018.
29 Hayashi K, Kawachi I, Ohira T, *et al*. Laughter and subjective health among community-dwelling older people in Japan: cross-sectional

analysis of the Japan Gerontological evaluation study cohort data. *J Nerv Ment Dis* 2015;203:934–42.
30 Haseda M, Kondo N, Ashida T, *et al*. Community social capital, built environment, and Income-Based inequality in depressive symptoms among older people in Japan: an ecological study from the JAGES project. *J Epidemiol* 2018;28:108–16.
31 Spiegelman D, Hertzmark E. Easy SAS calculations for risk or prevalence ratios and differences. *Am J Epidemiol* 2005;162:199–200.
32 Koyano W, Shibata H, Nakazato K, *et al*. Measurement of competence: reliability and validity of the TMIG index of competence. *Arch Gerontol Geriatr* 1991;13:103–16.
33 Wada T, Ishine M, Kita T, *et al*. Depression screening of elderly community-dwelling Japanese. *J Am Geriatr Soc* 2003;51:1328–9.
34 Burke WJ, Roccaforte WH, Wengel SP. The short form of the geriatric depression scale: a comparison with the 30-item form. *J Geriatr Psychiatry Neurol* 1991;4:173–8.
35 Murata C, Kondo K, Hirai H, *et al*. Association between depression and socio-economic status among community-dwelling elderly in Japan: the Aichi Gerontological evaluation study (AGEs). *Health Place* 2008;14:406–14.
36 Schreiner AS, Hayakawa H, Morimoto T, *et al*. Screening for late life depression: cut-off scores for the geriatric depression scale and the Cornell scale for depression in dementia among Japanese subjects. *Int J Geriatr Psychiatry* 2003;18:498–505.
37 Ohira T, Course L. Life course and health -The associations of laughter with stress and Lifestyle-related diseases. *Compr Med* 2018;17:20–7.
38 Morgan T, Wiles J, Park H-J, *et al*. Social connectedness: what matters to older people? *Ageing Soc* 2019;37:1–19.
39 Provine RR. Laughter Punctuates speech: linguistic, social and gender contexts of laughter. *Ethology* 1993;95:291–8.
40 Okabayashi H, Hougham GW. Gender differences of social interactions and their effects on subjective well-being among Japanese elders. *Aging Ment Health* 2014;18:59–71.
41 Litwin H, Shiovitz-Ezra S. Social network type and subjective well-being in a national sample of older Americans. *Gerontologist* 2011;51:379–88.
42 Cheang M. Older adults' frequent visits to a fast-food restaurant: Nonobligatory social interaction and the significance of play in a "third place". *J Aging Stud* 2002;16:303–21.
43 Noon RB, Ayalon L. Older adults in public open spaces: age and gender segregation. *Gerontologist* 2018;58:149–58.
44 Torres S, Alone A. Aging alone, Gossiping together: older adults' talk as social glue. *J Gerontol B Psychol Sci Soc Sci* 2019;74:1474–82.
45 Murphy SP. Humor Orgies as ritual insult: Putdowns and solidarity maintenance in a corner Donut shop. *J Contemp Ethnogr* 2017;46:108–32.
46 Torres S. On elastic ties: distance and intimacy in social relationships. *SocScience* 2019;6:235–63.
47 Moore THM, Kesten JM, López-López JA, *et al*. The effects of changes to the built environment on the mental health and well-being of adults: systematic review. *Health Place* 2018;53:237–57.
48 Navarro J, del Moral R, Alonso MF, *et al*. Validation of laughter for diagnosis and evaluation of depression. *J Affect Disord* 2014;160:43–9.
49 Croezen S, Avendano M, Burdorf A, *et al*. Social participation and depression in old age: a fixed-effects analysis in 10 European countries. *Am J Epidemiol* 2015;182:168–76.
50 Zhang L, Sui M, Yan T, *et al*. A study in persons later after stroke of the relationships between social participation, environmental factors and depression. *Clin Rehabil* 2017;31:394–402.
51 Sibalija J, Savundranayagam MY, Orange JB, *et al*. Social support, social participation, & depression among caregivers and non-caregivers in Canada: a population health perspective. *Aging Ment Health*. In Press 2020;24:765–73.
52 Hirosaki M, Ohira T, Yasumura S, *et al*. Lifestyle factors and social ties associated with the frequency of laughter after the great East Japan earthquake: Fukushima health management survey. *Qual Life Res* 2018;27:639–50.
53 Noda A. Partial research report of health and labour science research, 2014. Available: http://www.fmu.ac.jp/home/epi/report/images/pdf/2014/pdf2-8.pdf [Accessed 16 Sep 2020].