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Laughter associated with income among older Japanese people: The JAGES project cross-sectional study

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Research

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Running head:

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ABSTRACT

Objective: Laughter has positive and quantifiable effect on certain aspects of health. Additionally, previous studies have suggested income influences the emotion. In the present study, we examined the relationship between equivalent income and frequency of laughter by a cross-sectional study.

Design; Cross-sectional study and binomial regression analysis.

Setting; Sampled from 30 municipalities in Japan.

Participants; The 20,752 non-disabled Japanese individuals aged ≥65 years using data from the Japan Gerontological Evaluation Study.

Primary outcome; Frequency of laughter.

Results: We found laughter increased significantly with an increase in

equivalent income (P for trend <.0001). After adjustment for age, instrumental activity of daily living (IADL), depression, frequency of meeting friends, number of social groups, and family structure, the PRs with Q4 (men; ≥ €24,420, women; ≥ €21,154) were 1.21 (95% confidence interval: 1.13-1.30) among men and 1.14 (1.08-1.20) among women, as compared with Q1 (men; < €12,041, women; < €9,518), respectively. After the exclusion of participants with depression, the association was essentially unchanged. Additionally, we found that inadequate social relationship or living alone were associated with lower frequency of laughter. In comparison with the lowest equivalent income with meeting friends less frequently and living alone, the PRs of the highest equivalent income with meeting friends frequently and living with someone were higher, respectively.

Conclusions: We demonstrated that there was significant relationship between equivalent income and frequency of laughter. Social relationship and family structure were also associated with frequency of laughter.

(237 words)

Article summary

Article focus:

- Present study described the association between equivalent income, frequency of laughter and social relationship-related factor with 20,752 Japanese persons aged ≥65 years who were randomly collected throughout Japan

Key message:

- There was a positive relationship between equivalent income and frequency of laughter.
- Inadequate social relationship or living alone were associated with lower frequency of laughter.
- The positive association between income and health was explained partly by frequency of laughter.
- Intervention for social relation instead of income might be possible to improve laughter.

Strengths and limitations of this study:

- This is the first study to report relationships among equivalized income, frequency of laughter, and factors relating to social relationships and family structure
- The present study design was cross-sectional, and thus we cannot demonstrate causal relationships.
- The use of self-reported questionnaires may have introduced reporting bias for income and frequency of laughter.

INTRODUCTION

In most developed countries, the proportion of older people is growing faster than any other age group. Of these countries, Japan is experiencing population aging at the fastest pace (19.0% in 2003; 25.1% in 2013).[1, 2] The

need for health promotion and disease prevention targeting older people is increasing. Various health promotion strategies have been recommended for older people, and laughter therapy has been introduced as an important option.[3] Previous studies have suggested that laughter has positive and quantifiable effects on certain aspects of health, such as immune function,[4, 5] allergic dermatitis,[6-8] cancer,[9-11] psychiatric diseases,[12-15] dementia,[16] and cardiovascular diseases.[17, 18] Additionally, laughter therapy improves aspects of mental and physical function in older people,[3] and has therefore been incorporated into complementary medicine. One example of this is a randomized controlled trial of humor therapy in residential care: the Sydney Multisite Intervention of LaughterBosses and ElderClowns (SMILE).[3, 19] This trial has suggested that humor therapy decreases agitation and also increases happiness.[20, 21]

There is also growing interest in the influence of socioeconomic status on health.[22] Previous studies have reported that socioeconomic status, especially income, influences emotions.[23, 24] The threshold association between income and positive emotion was observed.[24] Income has a positive dose-response relationship with positive emotion up to $75,000 per year, while insufficient income is a significant predictor for depression.[23] Indeed, the proportion of people with depression in the lowest income group is 15.8% among men and 15.0% among women.[25] Depression is 6.9 times more prevalent for men and 4.1 times more prevalent for women in this income group than it is in the highest income group among Japanese aged 65–69

years. However, no studies have demonstrated a relationship between income and frequency of laughter.

In the present study, therefore, we examined the relationship between equivalized income and frequency of laughter among men and women aged 65 years and older in Japan. Our hypothesis was that frequency of laughter would be positively associated with equivalized income. We further hypothesized that social relationships and family structure would modify the association between laughter and income for older people, because personal relationships have been associated with laughter,[26] and living alone has been correlated with reduced psychological well-being.[27]

METHODS

Study sample

This study was a cross-sectional study using data from the Japan Gerontological Evaluation Study (JAGES). The JAGES was designed to describe the health status and social determinants of non-disabled people aged 65 years and older, sampled from 30 municipalities in Japan. We used the 2013 wave of JAGES, which was obtained from self-reported questionnaires mailed to 195,290 community-dwelling individuals aged 65 years and older who were not eligible to receive benefits from public long-term care insurance services. Of these, 138,293 individuals responded to the survey (response rate = 70.8%). In addition to basic questions, there were five modules in the survey covering different topics.[28] We used one of

these modules, which included questions about frequency of laughter. Respondents to this module comprised 12,174 men and 14,194 women. We analyzed a total of 20,006 participants (9,912 men and 10,094 women), after excluding 6,362 participants with missing information on frequency of laughter (n = 1,306), annual household income (n = 3,386), and number of people living together (n = 1,670).

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.

Laughter

The outcome variable was frequency of laughing. Laughter was assessed through each participant's response to a question about how frequently they laughed out loud during their daily life. The possible item answers were: almost every day, 1–5 days/week, 1–3 days/month, and < 1 day/month. We defined participants as laughing often if they answered "almost every day."

Equivalized income

Equivalized income was calculated by dividing the median value of the multiple-choice annual household income by the square root of the number of people living together. The annual household income question had 15 categories (< 0.5, 0.5–1.0, 1.0–1.5, 1.5–2.0, 2.0–2.5, 2.5–3.0, 3.0–4.0, 4.0–5.0,

5.0–6.0, 6.0–7.0, 7.0–8.0, 8.0–9.0, 9.0–10.0, 10.0–12.0, and ≥ 12.0 million Japanese yen). We used a purchasing power parity rate of EUR€1.00 = JPN¥130 (as of July 2017). We divided the participants into quartiles according to their equivalized income: Q1 (men < €12,041; women < €9,518), Q2 (men €12,041–€15,543; women €9,518–€14,957), Q3 (men €15,544–€24,426; women €14,958–€21,153), and Q4 (men ≥ €24,420; women ≥ €21,154).

Measures and definitions

Instrumental activity of daily living (IADL) was assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence,[29] and the results were classified as high IADL (5 points) or low IADL (≤ 4 points). The evaluation of depression was made using the Geriatric Depression Scale (GDS).[30] GDS is a 15-item questionnaire, with a score range of 1–15.[31] Following previous research,[32, 33] participants were classified into two groups: not depressed (GDS < 5) and depressed (GDS ≥ 5).

Frequency of meeting friends and acquaintances was measured with a question comprising six categories (≥ 4 days/week, 2–3 days/week, 1 day/week, 1–3 days/month, several times/year, and none). We divided the respondents into three groups: < 2 times/week, ≥ 2 times/week, or missing.

Participants were also presented with 14 different civic associations and social groups, and asked with which ones they were regularly connected; this provided a measurement, divided into six categories, for each type of

social group (≥ 4 days/week, 2–3 days/week, 1 day/week, 1–3 days/month, several times/year, no participation). The total number of types of groups in which each respondent participated at least several times per year was tallied, and respondents were divided into four groups: 0, 1 or 2, ≥ 3, or missing.

Family structure was assessed through two questions: one regarding the number of people living together, and the other regarding marital status. The marital status question provided five answer categories (married, bereaved, divorced, never married, and other). Based on answers to these questions, we divided the participants into four groups: alone, ≥ 2 without partner, ≥ 2 with partner, or ≥ 2 with no information about marital status.

Statistical analysis

We used binomial regression analyses to derive prevalence ratios (PRs) based on 95% confidence intervals (CIs) for "laughing almost every day" according to equivalized income. Following recent statistical recommendations, we calculated PRs rather than odds ratios because prevalence of laughing almost every day was not rare (≥10%).[34] We used the SAS version 9.4 statistical software package. In each model, the lowest equivalized income category was set as the reference category. A "missing" category was used in analysis to account for missing values in response to questions. In Model 1, we controlled for age (65–69, 70–74, 75–79, 80–84, ≥ 85), IADL (high IADL, low IADL, or missing), and depression (no depression,

depression, or missing). Model 2 was adjusted for the covariates in Model 1 plus social relationship-related factor such as frequency of meeting friends (< 2 times/week, ≥ 2 times/week, or missing) and number of social groups (0, 1 or 2, ≥ 3, or missing), and family structure (alone, ≥ 2 without partner, ≥ 2 with partner, or ≥ 2 with no information about marital status). Additionally, to confirm the robustness of our results we also carried out the same series of analysis using the sample excluding subjects with depression (GDS ≥ 5) and missing information about depression. There might be bias due to depression because people with depression might seldom laugh and depression influences employment and income.

To assess whether the prevalence of laughter associated with equivalized income differed between social relationships (frequency of meeting friends or number of social groups) or family structure, we conducted a sub-analysis in which participants were cross-classified into groups according to their equivalized income; the lowest equivalized income group was treated with each inadequate social relationship (meeting friends less frequently or non-participation in an organization) or living alone as the reference categories. The *p* value for the trend was calculated by categorical variables. All *p* values were two-tailed, and differences of < 0.05 were accepted as statistically significant.

RESULTS

Baseline characteristic by equivalized income

Table 1 shows the baseline characteristics of the study participants according to the categories of equivalized income. The proportions for laughing almost every day were 37.2% for men and 47.6% for women; these proportions increased as equivalized income increased for both men and women. The proportion of respondents who reported laughing < 1 time/month was 9.7% for men and 5.3% for women. The mean age was highest in the lowest equivalized income group for both men and women. The proportion of low IADL and depression decreased as equivalized income increased. Meeting friends and participating in social groups increased with a rise in equivalized income. The proportion of people co-habiting was highest in Q2 for men and in Q3 for women.

Table 1. Baseline characteristics by categories of household income

	Equivalized income[a]				
	Q1	Q2	Q3	Q4	*P* value[b]
Men					
Number of participants	2628	2454	2739	2480	
Frequency of laughing (%)					
Almost everyday	30.9	35.3	38.7	44.2	<0.0001
1-5 times/week	37.6	38.7	39.0	37.4	
1-3 times/month	16.7	16.5	14.3	12.0	
<1 time/month	14.8	9.6	8.0	6.4	
Age (years) (%)					
65-69	24.5	30.2	32.3	36.8	<0.0001
70-74	29.9	31.3	31.0	28.9	
75-80	25.5	23.4	19.8	17.8	
80-85	14.3	10.8	12.0	11.4	
≥85	5.9	4.3	5.0	5.1	
Mean age (years) (SD[c])	74.3 (6.0)	73.3 (5.8)	73.2 (6.0)	72.8 (6.1)	<0.0001
IADL[c] (%)					
High IADL	64.7	74.0	77.1	77.6	<0.0001
Low IADL	30.0	22.9	20.0	20.5	
Missing	5.4	3.1	2.9	1.9	
Frequency of meeting friends (%)					
<2 time/week	67.2	68.3	68.2	62.8	<0.0001
≥2 time/week	27.6	28.0	28.7	34.5	
Missing	5.3	3.8	3.2	2.7	
Number of social groups (%)					
0	29.0	22.9	21.1	19.1	<0.0001
1 or 2	25.3	27.4	29.5	28.1	
≥3	30.2	36.8	38.8	42.6	
Missing	15.5	12.9	10.7	10.2	
Family structure (%)					
alone	10.5	6.4	8.9	6.7	<0.0001
≥2 without partner	7.5	4.7	4.1	4.9	
≥2 with partner	79.5	88.2	86.7	88.1	
≥2 with no information about marital status	2.6	0.6	0.3	0.3	
Depression (%)					
No depression	49.3	64.7	71.5	78.4	<0.0001
Depression	35.8	24.5	19.5	13.5	
Missing	14.9	10.9	9.0	8.2	

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(Cont Table 1)

	Equivalized income				
	Q1	Q2	Q3	Q4	*P* value
Women					
Number of participants	2688	2169	2863	2731	
Frequency of laughing (%)					
Almost everyday	41.9	40.5	51.1	55.2	<0.0001
1-5 times/week	38	41	37.9	35.1	
1-3 times/month	11.4	12.2	7.7	6.6	
<1 time/month	8.7	6.3	3.4	3.1	
Age (years) (%)					
65-69	23	28.3	33.7	34.5	<0.0001
70-74	30.4	31.2	32.3	29.6	
75-80	25.3	21.5	20.8	17.7	
80-85	14.5	13.1	9.4	12.5	
≥85	6.9	5.9	3.8	5.8	
Mean age (years) (SD)	74.6 (6.1)	73.8 (6.0)	72.8 (5.7)	73.2 (6.3)	<0.0001
IADL (%)					
High IADL	80.7	86.7	90.3	88.4	<0.0001
Low IADL	15.1	10.5	7.7	9	
Missing	4.3	2.8	2	2.7	
Frequency of meeting friends (%)					
<2 time/week	53.5	55.2	54.4	54	<0.0001
≥2 time/week	40	40.6	42.3	43.4	
Missing	6.5	4.2	3.3	2.7	
Number of social groups (%)					
0	26.1	23.1	18.6	19.4	<0.0001
1 or 2	25.7	26.1	28.9	26.9	
≥3	25.6	34.1	38.8	41.8	
Missing	22.7	16.7	13.7	11.9	
Family structure (%)					
alone	17.6	39.5	9.8	11.4	<0.0001
≥2 without partner	27.1	12.3	15.3	22.6	
≥2 with partner	51.8	47.2	74.2	65.4	
≥2 with no information about marital status	3.5	1.1	0.7	0.6	
Depression (%)					
No depression	52	57.3	68.2	73	<0.0001
Depression	28.1	24.9	17.5	13.6	
Missing	19.9	17.9	14.3	13.5	

[a] Q1 (men; <€12,041, women; <€9,518), Q2 (men; €12,041-€15,543, women; € 9,518-€14,957), Q3 (men; €15,544-€24,426, women; €14,958-€21,153), Q4 (men; ≥€24,427, women; ≥€21,154).

[b] P values were calculated by chi-squared test (categorical variables), or ANOVA (continuous variables).

[c] SD, standard deviation; IADL, instrumental activity of daily living.

Equivalized income and frequency of laughter

Table 2 shows the results of our binomial regression models for frequency of laughter according to equivalized income. Equivalized income was significantly associated with frequency of laughter among both men and women. The PRs tended to amplify as equivalized income increased. Compared with those in the lowest equivalized income group, the age-adjusted PRs of laughing almost every day for participants in the highest equivalized income group were greater: 1.43 (95% CI, 1.33–1.54) for men, and 1.30 (1.23–1.38) for women. After adjusting for age, IADL, depression, frequency of meeting friends, number of social groups, and family structure, the PRs decreased to 1.21 for men and 1.14 for women in this group; however, the association was essentially unchanged.

Table 2. Prevalence Ratios and 95% confidence intervals of frequency of laughing according to equivalized income.

	Equivalized income[a]				
	Q1	Q2	Q3	Q4	P for trend[b]
Men					
No. of participants	2628	2454	2739	2480	
No. of participants laughing almost everyday	812	866	1060	1096	
Crude	reference	1.14(1.06-1.24)	1.25(1.16-1.35)	1.43(1.33-1.54)	<0.0001
Age-adjusted	reference	1.13(1.05-1.22)	1.25(1.16-1.34)	1.43(1.33-1.54)	<0.0001
Multi-adjusted Model 1[c]	reference	1.04(0.96-1.13)	1.12(1.04-1.21)	1.24(1.16-1.34)	<0.0001
Multi-adjusted Model 2[d]	reference	1.03(0.96-1.11)	1.12(1.05-1.21)	1.21(1.13-1.30)	<0.0001
Women					
No. of participants	2688	2169	2863	2731	
No. of participants laughing almost everyday	1126	879	1462	1507	
Crude	reference	0.97(0.90-1.04)	1.22(1.15-1.29)	1.32(1.25-1.39)	<0.0001
Age-adjusted	reference	0.96(0.89-1.02)	1.19(1.13-1.26)	1.30(1.23-1.38)	<0.0001
Multi-adjusted Model 1[c]	reference	0.92(0.86-0.99)	1.09(1.03-1.15)	1.16(1.10-1.23)	<0.0001
Multi-adjusted Model 2[d]	reference	0.98(0.92-1.05)	1.06(1.00-1.12)	1.14(1.08-1.20)	<0.0001

[a] Q1 (men; <€12,041, women; <€9,518), Q2 (men; €12,041-€15,543, women; €9,518-€14,957), Q3 (men; €15,544-€24,426, women; €14,958-€21,153), Q4 (men; ≥€24,427, women; ≥€21,154).

[b] P for trend was calculated by categorical variables.

[c] Model 1 is adjusted for age (5-years category), instrumental activity of daily living (independent, not independent, missing), depression (no depression , depression, missing).

[d] Model 2 is adjusted for the covariates in Model 1 plus frequency of meeting friends (<2 time/week, ≥2 time/week, missing), number of social groups (0, 1 or 2, ≥3, missing), family structure(alone, ≥2 without partner, ≥2 with partner, ≥2 with no information about marital status).

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Table 3 shows the results of our binomial regression models for frequency of laughter according to equivalized income, using a sample that excluded participants with depression (GDS ≥ 5) and missing information about depression. The associations remained unchanged after these exclusions. The PRs of laughing almost every day for men and women with the highest equivalized income were 1.23 (95% CI, 1.13–1.34) and 1.10 (1.04–1.17), respectively.

Table 3. Prevalence Ratios and 95% confidence intervals of frequency of laughing according to equivalized income for no depression people.

		Equivalized income[a]				
		Q1	Q2	Q3	Q4	P for trend[b]
Men						
	No. of participants with no depression	1296	1587	1958	1943	
	No. of participants laughing almost everyday	499	634	875	945	
	Multi-adjusted[c]	reference	1.01(0.93-1.11)	1.15(1.06-1.25)	1.23(1.13-1.34)	<0.0001
Women						
	No. of participants with no depression	1398	1242	1953	1993	
	No. of participants laughing almost everyday	755	602	1122	1209	
	Multi-adjusted	reference	0.94(0.87-1.01)	1.03(0.97-1.09)	1.10(1.04-1.17)	<0.0001

[a] Q1 (men; <€12,041, women; <€9,518), Q2 (men; €12,041-€15,543, women; €9,518-€14,957), Q3 (men; €15,544-€24,426, women; €14,958-€21,153), Q4 (men; ≥€24,427, women; ≥€21,154).

[b] P for trend was calculated by categorical variables.

[c] Prevalence Ratios is adjusted for age (5-years category), instrumental activity of daily living (independent, not independent, missing), frequency of meeting friends (<2 time/week, ≥2 time/week, missing), number of social groups (0, 1 or 2, ≥3, missing), family structure(alone, ≥2 without partner, ≥2 with partner, ≥2 with no information about marital status).

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Frequency of laughter according to equivalized income, by social relationships and family structures

Figure1, 2, and 3 shows the results of a sub-analysis, which examined interactions between income and laughing almost every day, by social relationships and family structure. While we observed no significant interactions (*p* for interaction: frequency of meeting friends = 0.73 for men; number of social groups = 0.20 for men, 0.11 for women; family structure = 0.86 for men, 0.52 for women) without frequency of meeting friends in women, we found that inadequate social relationships (particularly meeting friends less frequently or living alone) were associated with lower frequency of laughter. The PR for men in the lowest equivalized income group who met more often with friends was 1.39 (95% CI: 1.24–1.56), while for men in the highest equivalent income group who met less frequently with friends, the PR was 1.29 (1.17–1.42). The PR for women in the lowest equivalized income group who met more often with friends was 1.28 (1.17–1.40), while for women in the highest equivalized income group who met with friends less frequently, the PR was 1.23 (1.13–1.33). In family structure, the PR for men in the lowest equivalized income group who lives ≥2 with partner was 1.67 (95% CI: 1.28–2.17), while for men in the highest equivalent income group who lives alone, the PR was 1.31 (0.92–1.87). The PR for women in the lowest equivalized income group who met more often with friends was 1.45 (1.25–1.68), while for women in the highest equivalized income group who met with friends less frequently, the PR was 1.10 (0.90–1.34). Among women but not

men, we observed statistically significant associations between equivalized income and frequency of laughter if there were inadequate social relationships such as meeting friends less frequently or non-participation in organizations. However, we observed no statistically significant associations between equivalized income and frequency of laughter if the women had richer social relationships such as meeting friends more frequently or participating in more social groups.

DISCUSSION

The aim of this study was to examine and describe a relationship between frequency of laughter and equivalized income amongst older people in Japan. We found a positive association between equivalized income and frequency of laughter in both men and women. Importantly, this association differed depending on family structure and frequency of meeting friends. Among women participants, moreover, this association became weaker when they met friends frequently or participated in more social groups; we did not find a similar trend among participating men. Therefore, social relationships and family structure may be a factor that could be used to modify the association between equivalized income and frequency of laughter.

While the present study showed an association between equivalized income and frequency of laughter, previous studies have shown that depression decreases frequency of laughter,[35] and that household income

influences mental health.[36] Recognizing that our results may have reflected bias because of participant depression, we conducted further analyses after excluding participants with depression. Nevertheless, the tendency did not change. We believe that this result supports the original design of this study, which posited that frequency of laughter is associated with income regardless of depression.

Previous studies, however, have indicated that people who had more money had more opportunity to come in contact with others.[37] Coming in contact with others, moreover, is considered important to subjective well-being.[38] It is possible, then, that wealthier people laugh more frequently because they have more opportunities to meet others. Therefore, we examined the influence of social relationship factors and family structure on the relationship between equivalized income and frequency of laughter.

In a cross-classification analysis of equivalized income and frequency of meeting friends, we found that meeting friends was associated with frequency of laughter for both men and women. A study of older Japanese people indicated that friendship was important for subjective well-being;[38] friendship decreases loneliness and anxiety, and increases happiness.[39] These findings suggest that meeting friends leads to increasing opportunities for laughter.

In a cross-classification analysis of equivalized income and number of social groups, we observed no significant associations between participating in social groups and frequency of laughter among men in Q1–3; however, the

PRs of men in Q4 tended to amplify as their number of social groups increased. Previous research has suggested that relative poverty might be a risk factor for poor emotional well-being among older men;[40] for an older man, relative poverty had a bigger impact on well-being than social isolation. In the present study, relatively poor men (Q1–3) laughed less frequently regardless of the number of social groups in which they participated. By contrast, the PRs were higher for women in wealthier groups (Q3 and Q4) and/or those participating in three or more social groups. For older women, interpersonal relationships might have a strong protective or buffering effect for psychosocial stress.[40] In the present study, they laughed frequently even if they had a low equivalized income. Larson reviewed research from the past 30 years about subjective well-being of older Americans,[41] and found a positive correlation between social activity and well-being.

In our cross-classification analysis on equivalized income and family structure, we found positive association between number of family members and frequency of laughter for both men and women. However, for men without a partner, no association was evident. Particularly for men, a spouse has a bigger influence than someone else.[42] The present study showed that poor men living with a wife laughed more frequently than wealthy men without a wife. For women, however, living with someone was important for laughter, whether that partner was their husband or not. This difference is likely to be occurred by following reason. Wife's satisfaction with her partner and with the marital relationship has been shown to be remarkably lower

than those of husband in Japan.[43] Indeed, we found that factors relating to social relationships were associated with frequency of laughter. This finding supports our hypothesis that wealthier people laugh more frequently than poorer people because they have more opportunities to come into contact with others.

Implications from this study for public health are twofold. First, given the multiple positive effects of laughing on certain aspects of health,[3-7, 9-18] income redistribution policies may have additional benefits for impoverished older people. That is, increased income may improve not only material conditions but also psychosocial health and cognitive ability. Second, while income redistribution policy reform may take a long time to implement, public health interventions that provide opportunities for more social interactions in local settings may help reduce the laughter deprivation among low-income populations.

To the best of our knowledge, this is the first study to report relationships among equivalized income, frequency of laughter, and factors relating to social relationships and family structure. However, there are several potential limitations that should be mentioned. First, the present study design was cross-sectional, and thus we cannot demonstrate causal relationships. However, longitudinal analyses of our cohort data can be used to address such issues in future research. Second, the use of self-reported questionnaires may have introduced reporting bias for income and frequency of laughter. For example, some participants may not know or accurately

remember their income or their laughter frequency. Third, we did not take the diversity of laughter into account: one study reported three different types of laughter: "laughter of pleasure," "laughter of social obligation," and "laughter as relief from tension".[44] "Laughter of pleasure" is an expression of pleasant emotions. "Laughter of social obligation" is a way of communicating in interaction with others; this laughter occurs consciously. "Laughter as relief from tension" occurs when strain dissipates or is removed. Further research is needed to consider these differences in laughter relative to equivalized income.

CONCLUSION

In this study, we demonstrated a relationship between equivalized income and frequency of laughter. Additionally, we found an association between frequency of laughter and factors relating to social relationships, particularly family structure and frequency of meeting friends. We suggest that people with a high income may improve their health through high frequency of laughter. Future research should foreground health improvements for older people.

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Conflict of Interest

This was not an industry supported study. The authors declare that they have no conflicts of interest.

Authors' contributions

Yurika Imai, Masato Nagai and Tetsuya Ohira contributed to the design of the study. Naoki Kondo, Kokoro Shirai and Katsunori Kondo participated in

data collection. Yurika Imai and Masato Nagai participated in data analysis. Yurika Imai, Masato Nagai and Tetsuya Ohira participated in writing the report. All authors participated in critical revision of the manuscript and approved the final version of the report for submission.

Ethical 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.

Data sharing

No additional data available.

REFERENCES

1. Cabinet Office. The Aging Society: Current Situation and Implementation Measures FY 2013. 2014. Available from: http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf_e.html.
2. Cabinet Office. The Status of Aging and Implementation of Measures for the Aging Society in FY 2003. 2004. Available from: http://www8.cao.go.jp/kourei/english/annualreport/2004/04wp-e.html.

3. Bennett MP, Lengacher C. Humor and Laughter May Influence Health: III. Laughter and Health Outcomes. *Evid Based Complement Alternat Med* 2008; 5: 37-40.

4. Sakai Y, Takayanagi K, Ohno M, et al. A trial of improvement of immunity in cancer patients by laughter therapy. *Jpn Hosp* 2013: 53-59.

5. Bennett MP, Zeller JM, Rosenberg L, et al. The effect of mirthful laughter on stress and natural killer cell activity. *Altern Ther Health Med* 2003; 9: 38-45.

6. Kimata H. Laughter counteracts enhancement of plasma neurotrophin levels and allergic skin wheal responses by mobile phone-mediated stress. *Behav Med* 2004; 29: 149-152.

7. Kimata H. Laughter elevates the levels of breast-milk melatonin. *J Psychosom Res* 2007; 62: 699-702.

8. Kimata H. Increase in dermcidin-derived peptides in sweat of patients with atopic eczema caused by a humorous video. *J Psychosom Res* 2007; 62: 57-59.

9. Bellert JL. Humor. *A therapeutic approach in oncology nursing. Cancer Nurs* 1989; 12: 65-70.

10. Erdman L. Laughter therapy for patients with cancer. *Oncol Nurs Forum* 1991; 18: 1359-1363.

11. Penson RT, Partridge RA, Rudd P, et al. Laughter: the best medicine? *Oncologist* 2005; 10: 651-660.

12. Saper B. The therapeutic use of humor for psychiatric disturbances of adolescents and adults. *Psychiatr Q* 1990; 61: 261-272.

13. Gelkopf M, Kreitler S, Sigal M. Laughter in a psychiatric ward. Somatic, emotional, social, and clinical influences on schizophrenic patients. *J Nerv Ment Dis* 1993; 181: 283-289.

14. van Alphen PJ. Humor as diagnostic and therapeutic tool in psychiatry. Laughter is healthy. *TVZ* 1997; 107: 674-677.

15. Kim SH, Kim YH, Kim HJ. Laughter and Stress Relief in Cancer Patients: A Pilot Study. *Evid Based Complement Alternat Med* 2015: 864739.

16. 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.

17. 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: 546-552.

18. Dolgoff-Kaspar R, Baldwin A, Johnson MS, et al. Effect of laughter yoga on mood and heart rate variability in patients awaiting organ transplantation: a pilot study. *Altern Ther Health Med* 2012; 18: 61-66.

19. Goodenough B, Low LF, Casey AN, et al. Study protocol for a randomized controlled trial of humor therapy in residential care: the Sydney Multisite Intervention of LaughterBosses and ElderClowns

(SMILE). *Int Psychogeriatr* 2012; 24: 2037-2044.

20. Low LF, Goodenough B, Fletcher J, et al. The effects of humor therapy on nursing home residents measured using observational methods: the SMILE cluster randomized trial. *J Am Med Dir Assoc* 2014; 15: 564-569.

21. Low LF, Brodaty H, Goodenough B, et al. The Sydney Multisite Intervention of LaughterBosses and ElderClowns (SMILE) study: cluster randomised trial of humour therapy in nursing homes. *BMJ Open* 2013: 3; e002072.

22. Kagamimori S, Gaina A, Nasermoaddeli A. Socioeconomic status and health in the Japanese population. *Soc Sci Me*d 2009; 68: 2152-2160.

23. 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: 127-135.

24. Kahneman D, Deaton A. High income improves evaluation of life but not emotional well-being. *Proc Natl Acad Sci U S A* 2010; 107: 16489-16493.

25. Kondo K. Kenkokakusasyakai nanigakenkowomushibamunoka. Igakusyoin; 2005 (in Japanese).

26. Smoskia M, Bachorowskia JA. Antiphonal laughter between friends and strangers. *Cognition and Emotion* 2010; 17: 327-340.

27. Lim LL, Kua EH. Living alone, loneliness, and psychological

well-being of older persons in singapore. *Curr Gerontol Geriatr Res* 2011: 673181.

28. 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: 934-942.

29. 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: 103-116.

30. Wada T, Ishine M, Kita T, et al. Depression screening of elderly community-dwelling Japanese. *J Am Geriatr Soc* 2003; 51: 1328-1329.

31. 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: 173-178.

32. 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* 2007; 14: 406-414.

33. 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.

34. Spiegelman D, Hertzmark E. Easy SAS calculations for risk or

prevalence ratios and differences. *Am J Epidemiol* 2005; 162: 199-200.

35. Navarro J, del Moral R, Alonso MF, et al. Validation of laughter for diagnosis and evaluation of depression. *J Affect Disord* 2014; 160: 43-49.

36. Quesnel-Vallee A, Taylor M. Socioeconomic pathways to depressive symptoms in adulthood: evidence from the National Longitudinal Survey of Youth 1979. *Soc Sci Med* 2012; 74: 734-743.

37. Oda T. Some Considerations about Friendship of Elderly Japanese Living in an Urban Area. *Bulletin of Graduate School of Human Development and Environment, Kobe University* 2003; 10: 491-502 (in Japanese).

38. 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.

39. Litwin H, Shiovitz-Ezra S. Social network type and subjective well-being in a national sample of older Americans. *Gerontologist* 2011; 51: 379-388.

40. Saito M, Kondo N, Kondo K, et al. Gender differences on the impacts of social exclusion on mortality among older Japanese: AGES cohort study. *Soc Sci Med* 2012; 75: 940-945.

41. Larson R. Thirty years of research on the subjective well-being of older americans. *J Gerontol* 1978; 33: 109-125.

42. House JS. Social Support and Social Structure. *Sociological Forum*

1987; 2: 135-146.

43. Kashiwagi K, Hirayama J. Marital norm, reality and satisfaction in middle-aged couples: why are wives less satisfied than husbands?. *Shinrigaku Kenkyu* 2003; 74: 122-130 (in Japanese).

44. Shimizu A. Laughter, the brain, and psychiatric diseases. *Seishin Shinkeigaku Zasshi* 2001; 103: 895-903 (in Japanese).

Figure legend

Figure 1. Adjusted Prevalence Ratios (PRs) for laughing almost every day in each group according to equivalized income and frequency of meeting friends in men (a) and women (b) were calculated using binomial regression analysis. PRs are adjusted for age (5-year category), instrumental activity of daily living (IADL; independent, not independent, missing), depression (no depression, depression, missing). The lowest equivalized income and meeting friends less frequently category was set as the reference category.

Figure 2. Adjusted Prevalence Ratios (PRs) for laughing almost every day in each group according to equivalized income and number of social groups in men (a) and women (b) were calculated using binomial regression analysis. PRs are adjusted for age (5-year category), instrumental activity of daily living (IADL; independent, not independent,

missing), depression (no depression, depression, missing). The lowest equivalized income and non-participation in social group category was set as the reference category.

Figure 3. Adjusted Prevalence Ratios (PRs) for laughing almost every day in each group according to equivalized income and family structure in men (a) and women (b) were calculated using binomial regression analysis. PRs are adjusted for age (5-year category), instrumental activity of daily living (IADL; independent, not independent, missing), depression (no depression, depression, missing). The lowest equivalized income and living alone category was set as the reference category.

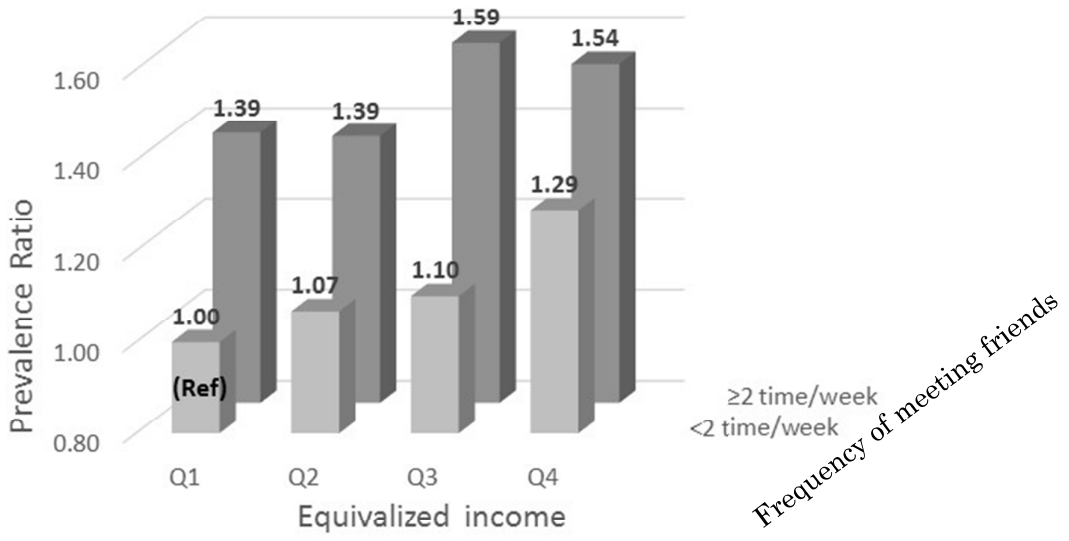

Figure1-a

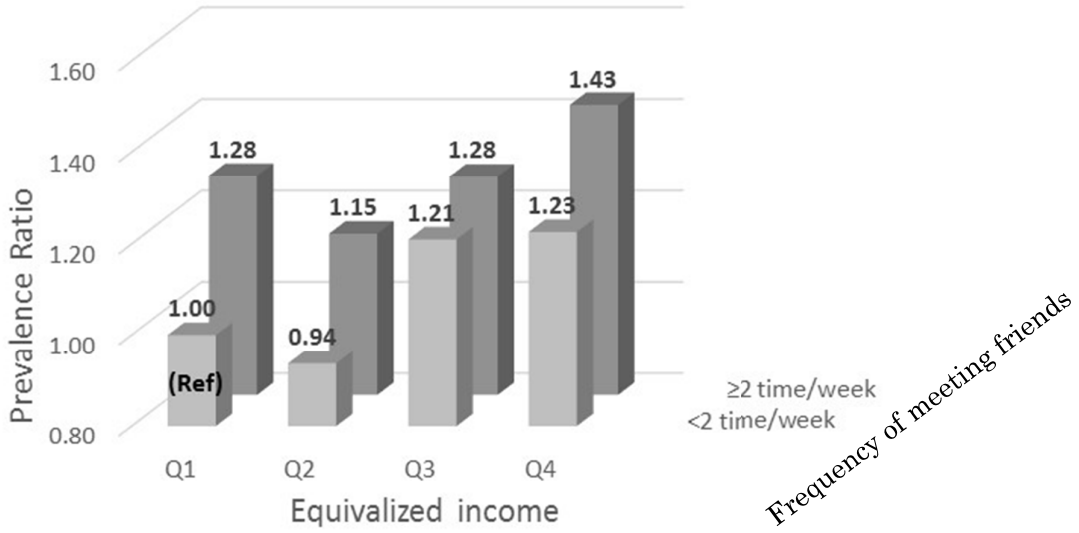

Figure1-b

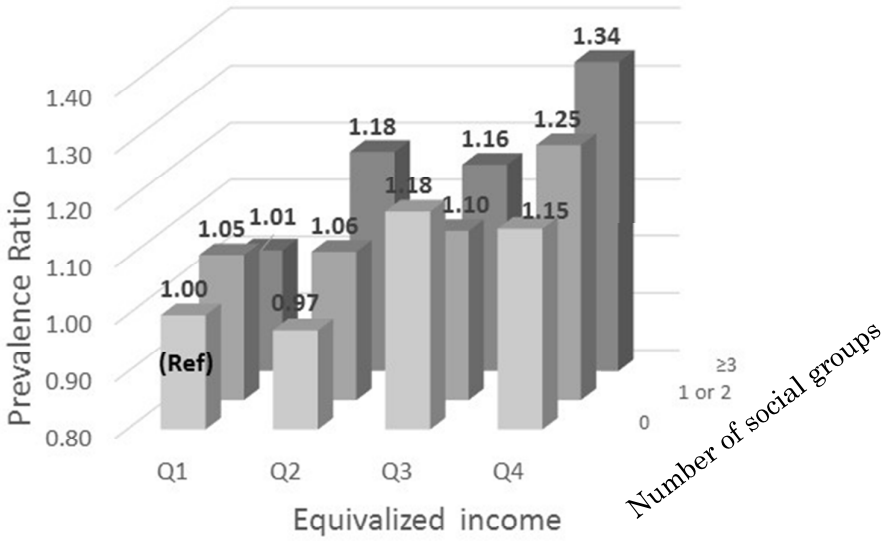

Figure2-a

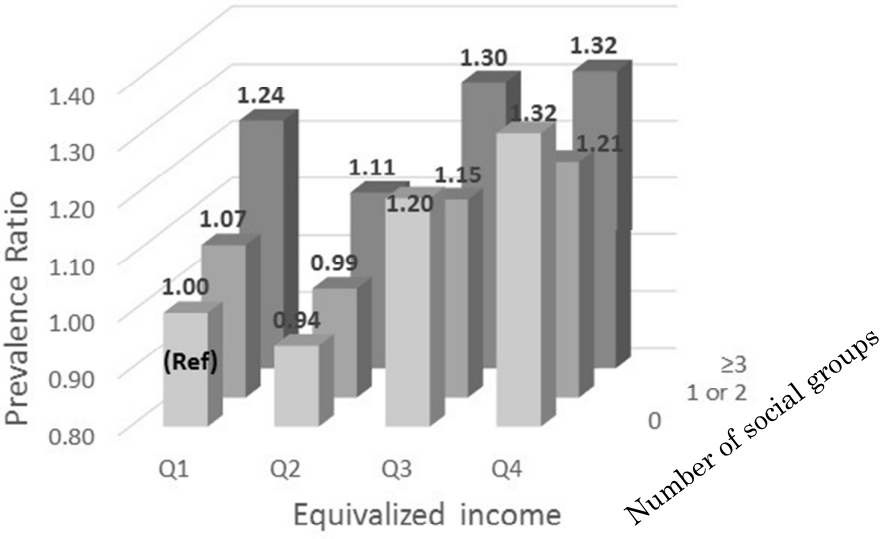

Figure2-b

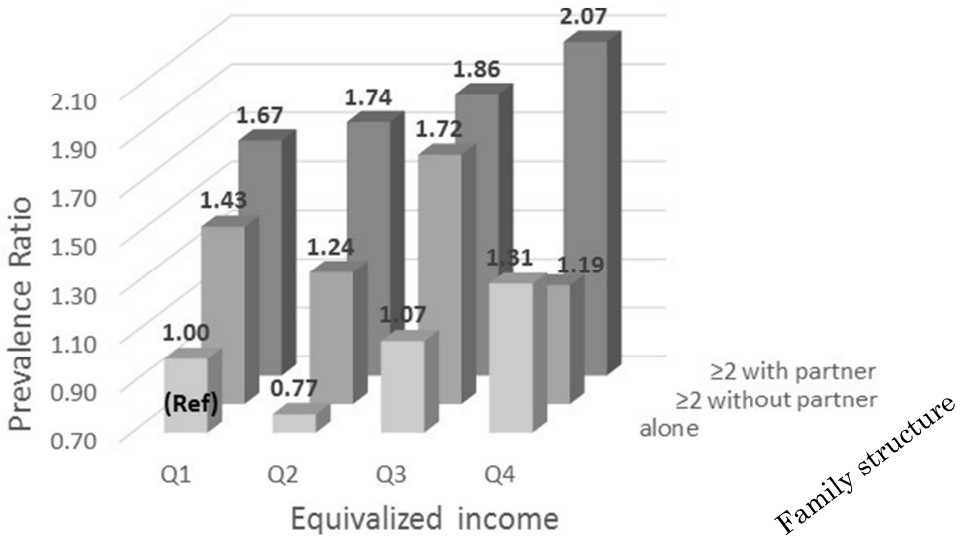

Figure3-a

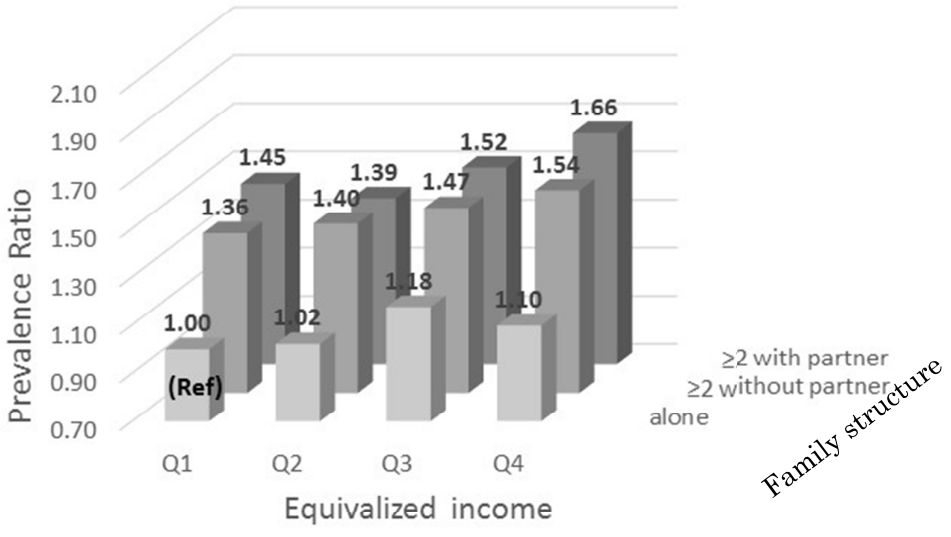

Figure3-b

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	10-11
Study size	10	Explain how the study size was arrived at	10-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-11
		(b) Indicate number of participants with missing data for each variable of interest	12-13
Outcome data	15*	Report numbers of outcome events or summary measures	12-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	15
		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	17-19
Discussion			
Key results	18	Summarise key results with reference to study objectives	19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-22
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The impact of social relationships on income-laughter relationships among older people: The JAGES cross-sectional study

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Secondary Subject Heading:	Epidemiology, Mental health
Keywords:	Japan, Laughter,, Older people, Social relationships, Equivalised income

Research

The impact of social relationships on income-laughter relationships among older people: The JAGES cross-sectional study

Running head:

The impact of social relationships on income-laughter relationships

Keywords:

Equivalised income, Japan, Laughter, Older people, Social relationships

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ABSTRACT

Objectives: Laughter has a positive and quantifiable effect on certain aspects of health, and previous studies have suggested that income influences the emotion. However, it is unknown whether social relationship-related factors modify the association between equivalised income and laughter among older people. In the present study, we examined the relationship between equivalised income and the frequency of laughter. In addition, we examined the impact of social relationship-related factors on the association between equivalised income and frequency of laughter using a cross-sectional study design.

Design: Cross-sectional study and binomial regression analysis.

Setting: We sampled from 30 municipalities in Japan.

Participants: We examined 20,752 non-disabled Japanese individuals aged ≥ 65 years using data from the Japan Gerontological Evaluation Study.

Primary outcome; Frequency of laughter.

Results: Laughter increased significantly with an increase in equivalent income (P for trend < .0001). Prevalence ratios (PRs) for laughing almost every day were calculated according to quartile equivalised income (quartile) after adjusting for age, instrumental activities of daily living (IADL), depression, frequency of meeting friends, number of social groups, and family structure. The results revealed that PRs in Q4 (men; ≥ €24,420, women; ≥ €21,154) were 1.21 (95% confidence interval: 1.13-1.30) among men and 1.14 (1.08-1.20) among women, as compared with Q1 (men; < €12,041, women; < €9,518), respectively. After excluding participants with depression, the association remained significant. In addition, we found inadequate social relationships and living alone were associated with a lower frequency of laughter. In comparison with the lowest equivalent income with meeting friends less frequently and living alone, the PRs of the highest equivalent income with meeting friends frequently and living with someone were higher, respectively.

Conclusions: The results revealed a significant relationship between equivalent income and the frequency of laughter. Social relationships and family structure were also associated with the frequency of laughter.

(300 words)

Strengths and limitations of this study:

- This is the first study to investigate relationships among equivalised income and frequency of laughter, and to examine the impact of social relationship-related factors on this association.
- The present study design was cross-sectional, and thus we cannot demonstrate causal relationships.
- The use of self-reported questionnaires may have introduced reporting bias regarding income and the frequency of laughter.

INTRODUCTION

In most developed countries, the proportion of older people is growing faster than any other age group. Among these countries, Japan is experiencing the most rapidly aging population (19.0% in 2003; 26.7% in 2015).[1 2] The need for health promotion and disease prevention targeting older people is increasing. Various health promotion strategies have been recommended for older people, and laughter therapy has been introduced as a potentially important option.[3-5] Previous studies have suggested that laughter has positive and quantifiable effects on certain aspects of health, including immune function,[6] allergic dermatitis,[7-9] cancer,[10 11] psychiatric diseases,[12] dementia,[13] and cardiovascular diseases.[14] In addition, laughter therapy has been found to improve various aspects of mental and physical function in older people, [3-5] and has been incorporated into complementary medicine. For example, a

randomized controlled trial of humor therapy in residential care called the Sydney Multisite Intervention of LaughterBosses and ElderClowns (SMILE)[15] suggested that humor therapy decreased agitation and increased happiness.[16 17]

Laughter is reported to occur most frequently during casual conversation.[18] Surprise is an important element in humor because laughter usually occurs when one encounters a meaningful interpretation of some stimulus or event that differs from the meaning that was initially assumed.[19] An individual's emotions are influenced by their character and social background, and previous studies have reported that socioeconomic status, particularly income, influences emotions.[20 21] In addition, the threshold association between income and positive emotion (emotional well-being) has been reported.[21] In another study, income was found to have a positive dose-response relationship with positive emotion, up to an annual income of $75,000, whereas insufficient income was a significant predictor for depression.[20] The proportion of people with depression in the lowest income group is 15.8% among men and 15.0% among women,[22] and depression is 6.9 times more prevalent for men and 4.1 times more prevalent for women in this income group than it is in the highest income group among people in Japan aged 65–69 years. Although these findings suggest that emotion varies according to socioeconomic status, no previous studies have demonstrated a relationship between income and the frequency of laughter.

In the current study, we hypothesized that the frequency of laughter

would be positively associated with equivalised income. We further hypothesized that social relationships and family structure would modify the association between equivalised income and laughter for older people. Closer personal relationships are associated with more frequent laughter,[23] and living alone has been correlated with reduced psychological well-being.[24] Laughter is not only involved in the expression of emotion, but also in the maintenance of social bonds.[25] In the present study, therefore, we examined the relationship between equivalised income and frequency of laughter. In addition, we examined the impact of social relationship-related factors on this relationship association among men and women aged 65 years and older in Japan.

METHODS

Study sample

The present study had a cross-sectional design, using data from the Japan Gerontological Evaluation Study (JAGES). The JAGES was designed to describe the health status and social determinants of non-disabled people aged 65 years and older, sampled from 30 municipalities in Japan. We used the 2013 wave of JAGES, which was obtained from self-reported questionnaires mailed to a source population of 195,290 community-dwelling individuals between 1 October and 2 December 2013. These individuals were 65 years and older, and were not eligible to receive benefits from public long-term care insurance services. Of this sample, 138,293 individuals

responded to the survey (response rate = 70.8%). In addition to basic questions, there were five modules in the survey covering different topics[26] —module A: nursing care, medical care, and lifestyles; module B: oral hygiene, optimism, subjective health; module C: social capital, history of abuse; module D: subjective quality of life, sleep, cognitive function; and module E: physical activity. We examined data from module B, which included questions about laughter. Of the 138,293 respondents, the current study examined the data of 26,368 individuals who responded to the JAGES basic questions as well as module B, including questions about the frequency of laughter. The final analysis involved 20,006 participants (9,912 men and 10,094 women), after excluding 6,362 participants with missing information about the frequency of laughter (n = 1,306), annual household income (n = 3,386), or the number of people living together (n = 1,670).

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.

Laughter

The outcome variable was the frequency of laughing. Laughter was assessed through each participant's response to a question about how frequently they laughed out loud during their daily life. The possible item answers were: almost every day, 1–5 days/week, 1–3 days/month, and < 1 day/month. Based

on a previous study[14], we defined participants as laughing often if they answered "almost every day."

Equivalised income

Equivalised income was calculated by dividing the median value of the multiple-choice annual household income by the square root of the number of people living together. The annual household income question had 15 categories (< 0.5, 0.5–1.0, 1.0–1.5, 1.5–2.0, 2.0–2.5, 2.5–3.0, 3.0–4.0, 4.0–5.0, 5.0–6.0, 6.0–7.0, 7.0–8.0, 8.0–9.0, 9.0–10.0, 10.0–12.0, and ≥ 12.0 million Japanese yen). We used a purchasing power parity rate of EUR€1.00 = JPN¥130 (as of July 2017). We divided the participants into quartiles according to their equivalised income: Q1 (men < €12,041; women < €9,518), Q2 (men €12,041–€15,543; women €9,518–€14,957), Q3 (men €15,544–€24,426; women €14,958–€21,153), and Q4 (men ≥ €24,420; women ≥ €21,154).

Measures and definitions

Instrumental activities of daily living (IADL) were assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence,[27] and the results were classified as high IADL (5 points) or low IADL (≤ 4 points). The evaluation of depression was made using the Geriatric Depression Scale (GDS).[28] The GDS is a 15-item questionnaire, with a score range of 1–15.[29] In accord with previous studies,[30 31] participants were classified into two

groups: not depressed (GDS < 5) and depressed (GDS ≥ 5).

The frequency of meeting friends and acquaintances was measured with a question comprising six categories (≥ 4 days/week, 2–3 days/week, 1 day/week, 1–3 days/month, several times/year, and none). We divided the respondents into three groups: < 2 times/week, ≥ 2 times/week, or missing.

Participants were also presented with 14 different civic associations and social groups, and asked which ones they were regularly involved with. This provided a measurement, divided into six categories, for each type of social group (≥ 4 days/week, 2–3 days/week, 1 day/week, 1–3 days/month, several times/year, no participation). The total number of types of groups in which each respondent participated at least several times per year was tallied, and respondents were divided into four groups: 0, 1 or 2, ≥ 3, or missing.

Family structure was assessed through two questions: one regarding the number of people living together, and the other regarding marital status. The marital status question provided five answer categories (married, bereaved, divorced, never married, and other). Based on the responses to these questions, we divided participants into four groups: alone, ≥ 2 without partner, ≥ 2 with partner, or ≥ 2 with no information about marital status.

Statistical analysis

We used binomial regression analyses to derive prevalence ratios (PRs) based on 95% confidence intervals (CIs) for "laughing almost every day"

according to equivalised income. In accord with recent statistical recommendations, we calculated PRs rather than odds ratios because the prevalence of laughing almost every day was not rare (≥ 10%).[32] We used the SAS version 9.4 statistical software package. In each model, the lowest equivalised income category was set as the reference category. A "missing" category was used in analysis to account for missing values in response to questions. In Model 1, we controlled for age (65–69, 70–74, 75–79, 80–84, ≥ 85 years), IADL (high IADL, low IADL, or missing), and depression (no depression, depression, or missing). Model 2 was adjusted for the covariates in Model 1 plus social relationship-related factors such as the frequency of meeting friends (< 2 times/week, ≥ 2 times/week, or missing) and number of social groups (0, 1 or 2, ≥ 3, or missing), and family structure (alone, ≥ 2 without partner, ≥ 2 with partner, or ≥ 2 with n6o information about marital status). Additionally, to confirm the robustness of our results we also carried out the same series of analyses using the sample excluding subjects with depression (GDS ≥ 5) and missing information about depression. It should be noted that the results in this study design may be affected by bias related to depression because people with depression might seldom laugh and depression influences employment and income.

To assess whether the prevalence of laughter associated with equivalised income differed between social relationships (frequency of meeting friends or number of social groups) or family structure, we conducted an analysis in which participants were cross-classified into groups

according to their equivalised income. The lowest equivalised income group was treated with each inadequate social relationship (meeting friends less frequently or non-participation in an organization) or living alone as reference categories. The *p* value for the trend was calculated by categorical variables conducted from binomial regression model adjusting above covariates. All *p* values were two-tailed, and differences of < 0.05 were accepted as statistically significant.

RESULTS

Baseline characteristics by equivalised income

Table 1 shows the baseline characteristics of the study participants according to the categories of equivalised income. The proportions for laughing almost every day were 37.2% for men and 47.6% for women; these proportions increased as equivalised income increased for both men and women. The proportion of respondents who reported laughing < 1 time/month was 9.7% for men and 5.3% for women. The mean age was highest in the lowest equivalised income group for both men and women. The proportion of low IADL and depression decreased as equivalised income increased. Meeting friends and participating in social groups increased with a rise in equivalised income. The proportion of people co-habiting was highest in Q2 for men and in Q3 for women.

Table 1. Baseline characteristics by categories of household income

	Equivalised income*				
	Q1	Q2	Q3	Q4	*p* value†

Men					
Number of participants	2628	2454	2739	2480	
Frequency of laughing (%)					
Almost everyday	30.9	35.3	38.7	44.2	<0.0001
1-5 times/week	37.6	38.7	39.0	37.4	
1-3 times/month	16.7	16.5	14.3	12.0	
<1 time/month	14.8	9.6	8.0	6.4	
Age (years) (%)					
65-69	24.5	30.2	32.3	36.8	<0.0001
70-74	29.9	31.3	31.0	28.9	
75-80	25.5	23.4	19.8	17.8	
80-85	14.3	10.8	12.0	11.4	
≥85	5.9	4.3	5.0	5.1	
Mean age (years) (SD‡)	74.3 (6.0)	73.3 (5.8)	73.2 (6.0)	72.8 (6.1)	<0.0001
IADL‡ (%)					
High IADL	64.7	74.0	77.1	77.6	<0.0001
Low IADL	30.0	22.9	20.0	20.5	
Missing	5.4	3.1	2.9	1.9	
Frequency of meeting friends (%)					
<2 time/week	67.2	68.3	68.2	62.8	<0.0001
≥2 time/week	27.6	28.0	28.7	34.5	
Missing	5.3	3.8	3.2	2.7	
Number of social groups (%)					
0	29.0	22.9	21.1	19.1	<0.0001
1 or 2	25.3	27.4	29.5	28.1	
≥3	30.2	36.8	38.8	42.6	
Missing	15.5	12.9	10.7	10.2	
Family structure (%)					
Alone	10.5	6.4	8.9	6.7	<0.0001
≥2 without partner	7.5	4.7	4.1	4.9	
≥2 with partner	79.5	88.2	86.7	88.1	
≥2 with no information about marital status	2.6	0.6	0.3	0.3	
Depression (%)					
No depression	49.3	64.7	71.5	78.4	<0.0001
Depression	35.8	24.5	19.5	13.5	
Missing	14.9	10.9	9.0	8.2	

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(Cont Table 1)

	Equivalised income				
	Q1	Q2	Q3	Q4	*p* value

Women					
Number of participants	2688	2169	2863	2731	
Frequency of laughing (%)					
Almost everyday	41.9	40.5	51.1	55.2	<0.0001
1-5 times/week	38.0	41.0	37.9	35.1	
1-3 times/month	11.4	12.2	7.7	6.6	
<1 time/month	8.7	6.3	3.4	3.1	
Age (years) (%)					
65-69	23.0	28.3	33.7	34.5	<0.0001
70-74	30.4	31.2	32.3	29.6	
75-80	25.3	21.5	20.8	17.7	
80-85	14.5	13.1	9.4	12.5	
≥85	6.9	5.9	3.8	5.8	
Mean age (years) (SD)	74.6(6.1)	73.8(6.0)	72.8(5.7)	73.2(6.3)	<0.0001
IADL (%)					
High IADL	80.7	86.7	90.3	88.4	<0.0001
Low IADL	15.1	10.5	7.7	9.0	
Missing	4.3	2.8	2.0	2.7	
Frequency of meeting friends (%)					
<2 time/week	53.5	55.2	54.4	54.0	<0.0001
≥2 time/week	40.0	40.6	42.3	43.4	
Missing	6.5	4.2	3.3	2.7	
Number of social groups (%)					
0	26.1	23.1	18.6	19.4	<0.0001
1 or 2	25.7	26.1	28.9	26.9	
≥3	25.6	34.1	38.8	41.8	
Missing	22.7	16.7	13.7	11.9	
Family structure (%)					
Alone	17.6	39.5	9.8	11.4	<0.0001
≥2 without partner	27.1	12.3	15.3	22.6	
≥2 with partner	51.8	47.2	74.2	65.4	
≥2 with no information about marital status	3.5	1.1	0.7	0.6	
Depression (%)					
No depression	52.0	57.3	68.2	73.0	<0.0001
Depression	28.1	24.9	17.5	13.6	
Missing	19.9	17.9	14.3	13.5	

* Q1 (men; <€12,041, women; <€9,518), Q2 (men; €12,041-€15,543, women; €9,518-€14,957), Q3 (men; €15,544-€24,426, women; €14,958-€21,153), Q4 (men; ≥€24,427, women; ≥€21,154).

† *p* values were calculated by chi-squared test (categorical variables), or ANOVA (continuous variables).
‡ SD, standard deviation; IADL, instrumental activities of daily living.

Equivalised income and frequency of laughter

Table 2 shows the results of our binomial regression models for frequency of

laughter according to equivalised income. Equivalised income was significantly associated with frequency of laughter among both men and women. The PRs tended to become greater as equivalised income increased. Compared with those in the lowest equivalised income group, the age-adjusted PRs for laughing almost every day for participants in the highest equivalised income group were greater: 1.43 (95% CI, 1.33–1.54) for men, and 1.30 (1.23–1.38) for women. After adjusting for age, IADL, depression, frequency of meeting friends, number of social groups, and family structure, the PRs decreased to 1.21 for men and 1.14 for women in this group; however, the association remained significant.

Table 2. Prevalence ratios and 95% confidence intervals of frequency of laughing according to equivalised income.

	Equivalised income*				
	Q1	Q2	Q3	Q4	*p* for trend†
Men					
No. of participants	2628	2454	2739	2480	
No. of participants laughing almost everyday	812	866	1060	1096	
Crude	reference	1.14(1.06-1.24)	1.25(1.16-1.35)	1.43(1.33-1.54)	<0.0001
Age-adjusted	reference	1.13(1.05-1.22)	1.25(1.16-1.34)	1.43(1.33-1.54)	<0.0001
Multi-adjusted Model 1‡	reference	1.04(0.96-1.13)	1.12(1.04-1.21)	1.24(1.16-1.34)	<0.0001
Multi-adjusted Model 2§	reference	1.03(0.96-1.11)	1.12(1.05-1.21)	1.21(1.13-1.30)	<0.0001
Women					
No. of participants	2688	2169	2863	2731	
No. of participants laughing almost everyday	1126	879	1462	1507	
Crude	reference	0.97(0.90-1.04)	1.22(1.15-1.29)	1.32(1.25-1.39)	<0.0001
Age-adjusted	reference	0.96(0.89-1.02)	1.19(1.13-1.26)	1.30(1.23-1.38)	<0.0001
Multi-adjusted Model 1	reference	0.92(0.86-0.99)	1.09(1.03-1.15)	1.16(1.10-1.23)	<0.0001
Multi-adjusted Model 2	reference	0.98(0.92-1.05)	1.06(1.00-1.12)	1.14(1.08-1.20)	<0.0001

* Q1 (men; <€12,041, women; <€9,518), Q2 (men; €12,041-€15,543, women; €9,518-€14,957), Q3 (men; €15,544-€24,426, women; €14,958-€21,153), Q4 (men; ≥€24,427, women; ≥€21,154).

† *p* for trend was calculated by categorical variables.

‡ Model 1 is adjusted for age (5-years category), instrumental activities of daily living (independent, not independent, missing), depression (no depression , depression, missing).

§ Model 2 is adjusted for the covariates in Model 1 plus frequency of meeting friends (<2 time/week, ≥2 time/week, missing), number of social groups (0, 1 or 2, ≥3, missing), family structure (alone, ≥2 without partner, ≥2 with partner, missing).

Table 3 shows the results of our binomial regression models for frequency of laughter according to equivalised income, using a sample that excluded participants with depression (GDS ≥ 5) and those for whom information about depression was missing. The associations remained unchanged after excluding these participants. The PRs of laughing almost every day for men and women with the highest equivalised income were 1.23 (95% CI, 1.13–1.34) and 1.10 (1.04–1.17), respectively.

Table 3. Prevalence ratios and 95% confidence intervals of frequency of laughing according to equivalised income without depression.

	Equivalised income*				
	Q1	Q2	Q3	Q4	*p* for trend†
Men					
No. of participants with no depression	1296	1587	1958	1943	
No. of participants laughing almost everyday	499	634	875	945	
Multi-adjusted‡	reference	1.01(0.93-1.11)	1.15(1.06-1.25)	1.23(1.13-1.34)	<0.0001
Women					
No. of participants with no depression	1398	1242	1953	1993	
No. of participants laughing almost everyday	755	602	1122	1209	
Multi-adjusted	reference	0.94(0.87-1.01)	1.03(0.97-1.09)	1.10(1.04-1.17)	<0.0001

* Q1 (men; <€12,041, women; <€9,518), Q2 (men; €12,041-€15,543, women; €9,518-€14,957), Q3 (men; €15,544-€24,426, women; €14,958-€21,153), Q4 (men; ≥€24,427, women; ≥€21,154).

† *p* for trend was calculated by categorical variables.

‡ Prevalence ratios were adjusted for age (5-years category), instrumental activities of daily living (independent, not independent, missing), frequency of meeting friends (<2 time/week, ≥2 time/week, missing), number of social groups (0, 1 or 2, ≥3, missing), family structure (alone, ≥2 without partner, ≥2 with partner, missing).

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Frequency of laughter according to equivalised income, by social relationships and family structures

Figure 1, 2, and 3 show the results of the interactions between income and laughing almost every day, by social relationships and family structure. While we observed no significant interactions (*p* for interaction: frequency of meeting friends = 0.73 for men; number of social groups = 0.20 for men, 0.11 for women; family structure = 0.86 for men, 0.52 for women) without frequency of meeting friends in women, we found that inadequate social relationships (particularly when indicated by meeting friends less frequently or living alone) were associated with a lower frequency of laughter. The PR for men in the lowest equivalised income group who met more often with friends was 1.39 (95% CI: 1.24–1.56), while for men in the highest equivalent income group who met less frequently with friends, the PR was 1.29 (1.17–1.42). The PR for women in the lowest equivalised income group who met more often with friends was 1.28 (1.17–1.40), while for women in the highest equivalised income group who met with friends less frequently, the PR was 1.23 (1.13–1.33). In terms of family structure, the PR for men in the lowest equivalised income group who lived with ≥2 people with a partner was 1.67 (95% CI: 1.28–2.17), while for men in the highest equivalent income group who lived alone, the PR was 1.31 (0.92–1.87). The PR for women in the lowest equivalised income group who lived with ≥2 people with a partner was 1.45 (1.25–1.68), while for women in the highest equivalised income group who lived alone, the PR was 1.10 (0.90–1.34). Among women, but not men,

we observed significant associations between equivalised income and the frequency of laughter if the participant had inadequate social relationships, indicated by meeting friends less frequently or non-participation in organizations. However, we observed no statistically significant associations between equivalised income and frequency of laughter if the women had richer social relationships, indicated by meeting friends more frequently or participating in more social groups.

DISCUSSION

The current study examined and described the relationship between equivalised income and the frequency of laughter. In addition, we examined the impact of social relationship-related factors on the association between equivalised income and the frequency of laughter. We found a positive association between equivalised income and frequency of laughter among both men and women. Importantly, this association differed depending on family structure and the frequency of meeting friends. Among women participants, this association was weaker if they met friends frequently or participated in more social groups. However, we did not find a similar trend among participating men. Therefore, social relationships and family structure may modify the association between equivalised income and the frequency of laughter.

The present study showed an association between equivalised

income and the frequency of laughter, while previous studies have shown that depression decreases the frequency of laughter[33] and that household income influences mental health.[34] Because our results could potentially have reflected bias related to participant depression, we conducted further analyses after excluding participants with depression. However, this did not change the tendency exhibited in the results. We believe that this result supports the original prediction of this study that the frequency of laughter would be associated with income, regardless of depression.

Previous studies, however, have indicated that people with more income tend to have more opportunity to come into contact with others.[35] Laughter has been found to occur most frequently during casual conversation.[18] Coming into contact with others is considered to be important to subjective well-being.[36] Thus, it is possible that wealthier people laugh more frequently because they have more opportunities to meet others. Therefore, we examined the influence of social relationship factors and family structure on the relationship between equivalised income and the frequency of laughter.

In a cross-classification analysis of equivalised income and frequency of meeting friends, we found that meeting friends was associated with frequency of laughter for both men and women. A previous study of older Japanese participants indicated that friendship was important for subjective well-being,[36] in accord with the notion that friendship decreases loneliness and anxiety, and increases happiness.[37] These findings suggest that meeting

friends leads to more opportunities for laughter.

In a cross-classification analysis of equivalised income and number of social groups, we observed no significant associations between participating in social groups and the frequency of laughter among men in Q1–3; however, the PRs of men in Q4 tended to become greater as their number of social groups increased. Previous research has suggested that relative poverty might be a risk factor for poor emotional well-being among older men;[38] for an older man, relative poverty had a bigger impact on well-being than social isolation. In the present study, relatively poor men (Q1–3) laughed less frequently regardless of the number of social groups in which they participated. In contrast, PRs were higher for women in wealthier groups (Q3 and Q4) and/or those participating in three or more social groups. For older women, interpersonal relationships might have a strong protective or buffering effect for psychosocial stress.[38] The current results revealed that women with three or more social groups laughed frequently even if they had a low equivalised income. In the evolution of human societies, laughing is thought to function as an essential behavioral mechanism not only for expression of emotion, but also for the maintenance of social bonds.[25] Larson reviewed research from the past 30 years examining the subjective well-being of older Americans,[39] and found a positive correlation between social activity and well-being.

In our cross-classification analysis on equivalised income and family structure, we found a positive association between the number of family

members and the frequency of laughter for both men and women. However, for men without a partner, this association was not evident. Particularly for men, the presence of a partner has been found to have a stronger influence than other relationships.[40] The present results revealed that low-income men living with a partner laughed more frequently than unmarried wealthy men. For women, however, living with another person was important for laughter, whether that person was their partner or not. This difference may be related to the finding that women's satisfaction with their partner and their marital relationship is markedly lower than the partner- and marital relationship-related satisfaction of men in Japan.[41] Indeed, we found that factors relating to social relationships were associated with the frequency of laughter. This finding supports our hypothesis that wealthier people laugh more frequently than poorer people because they have more opportunities to come into contact with others.

The current findings have two main implications for public health. First, given the multiple positive effects of laughing on certain aspects of health, [6-8 10 13-14] income redistribution policies may have additional benefits for impoverished older people. That is, increased income may improve not only material conditions but also psychosocial health and cognitive ability. Second, while income redistribution policy reform may take a long time to implement, public health interventions that provide opportunities for more social interactions in local settings may help reduce the deprivation of laughter among low-income populations.

To the best of our knowledge, this is the first study to report significant relationships among equivalised income, factors relating to social relationships and family structure, and the frequency of laughter. However, there are several potential limitations that should be considered. First, because the present study design was cross-sectional, we could not demonstrate causal relationships. However, longitudinal analyses of our cohort data can be used to address these issues in future research. Second, the results may have been affected by residual confounders such as the rates of watching television, reading books, or other potential confounding factors for which we did not collect data. Third, it might be that people might not remember frequency of laughter correctly. However, the item of laughter has been used in previous epidemiological studies in Japan.[14 26] The 1-year test–retest reliability of the item was assessed in a previous study in 2,680 men and women aged 30–74 years, though the lowest category in frequency of laughter is different between that study (almost never) and current study (<1 day/month). The Spearman correlation coefficient was found to be 0.61 ($p < 0.001$).[42] Forth, the use of self-reported questionnaires may have introduced reporting bias regarding income and the frequency of laughter. For example, some participants may not know or accurately remember their income or their frequency of laughter. We consider these biases to represent cases of non-differential misclassification, which would not be expected to be dependent upon each other. However, this misclassification weakens the true association, biasing the data towards the null hypothesis. Fifth, we did not

take the diversity of types of laughter into account. There are many different types of laughter (e.g., laughter related to joy, taunting, or tickling), each of which are thought to play distinct roles in social cognition.[43 44] One study reported three different types of laughter: "laughter of pleasure," "laughter of social obligation," and "laughter as relief from tension".[45] "Laughter of pleasure" is an expression of pleasant emotions. "Laughter of social obligation" occurs consciously, and is a way of communicating in interaction with others. "Laughter as relief from tension" occurs when strain dissipates or is removed. Further research is required to consider these differences in laughter relative to equivalised income.

CONCLUSION

In this study, we demonstrated a relationship between equivalised income and the frequency of laughter. Additionally, we found an association between frequency of laughter and factors relating to social relationships, particularly family structure and frequency of meeting friends. We suggest that people with higher incomes may experience improved health through a higher frequency of laughter. Future research should examine laughter-related health improvements among older people.

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Conflict of Interest

This was not an industry supported study. The authors declare that they have no conflicts of interest.

Authors' contributions

Yurika Imai, Masato Nagai and Tetsuya Ohira contributed to the design of

the study. Naoki Kondo, Kokoro Shirai and Katsunori Kondo participated in data collection. Yurika Imai and Masato Nagai participated in data analysis. Yurika Imai, Masato Nagai and Tetsuya Ohira participated in writing the report. All authors participated in critical revision of the manuscript and approved the final version of the report for submission.

Ethical 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.

Data sharing

No additional data are available.

REFERENCES

1. Cabinet Office. The Status of Aging and Implementation of Measures for the Aging Society in FFY 2003. 2004. Available from: http://www8.cao.go.jp/kourei/english/annualreport/2004/04wp-e.html. Accessed 4 March 2016.
2. Cabinet Office. The State of Aging and Implementation of the Measures for an Aging Society in FY2015 2016 [Available from:

http://www8.cao.go.jp/kourei/english/annualreport/2016/2016pdf_e.html. accessed Accessed 17 January 2018.

3. 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: 322-327.

4. Hasan H, Hasan TF. Laugh yourself into a healthier person: a cross cultural analysis of the effects of varying levels of laughter on health. Int *J Med Sci* 2009; 6: 200-211.

5. Ko HJ, Youn CH. Effects of laughter therapy on depression, cognition and sleep among the community-dwelling elderly. *Geriatr Gerontol Int* 2011; 11: 267-274.

6. Sakai Y, Takayanagi K, Ohno M, et al. A trial of improvement of immunity in cancer patients by laughter therapy. *Jpn Hosp* 2013: 53-59.

7. Kimata H. Laughter counteracts enhancement of plasma neurotrophin levels and allergic skin wheal responses by mobile phone-mediated stress. *Behav Med* 2004; 29: 149-152.

8. Kimata H. Laughter elevates the levels of breast-milk melatonin. *J Psychosom Res* 2007; 62: 699-702.

9. Kimata H. Increase in dermcidin-derived peptides in sweat of patients with atopic eczema caused by a humorous video. *J Psychosom Res* 2007; 62: 57-59.

10. Penson RT, Partridge RA, Rudd P, et al. Laughter: the best medicine? *Oncologist* 2005; 10: 651-660.

11. Noji S, Takayanagi K. A case of laughter therapy that helped improve advanced gastric cancer. *Jpn Hosp* 2010: 59-64.

12. Gelkopf M, Gonen B, Kurs R, et al. The effect of humorous movies on inpatients with chronic schizophrenia. *J Nerv Ment Dis* 2006; 194: 880-883.

13. 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.

14. 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: 546-552.

15. Goodenough B, Low LF, Casey AN, et al. Study protocol for a randomized controlled trial of humor therapy in residential care: the Sydney Multisite Intervention of LaughterBosses and ElderClowns (SMILE). *Int Psychogeriatr* 2012; 24: 2037-2044.

16. Low LF, Goodenough B, Fletcher J, et al. The effects of humor therapy on nursing home residents measured using observational methods: the SMILE cluster randomized trial. *J Am Med Dir Assoc* 2014; 15: 564-569.

17. Low LF, Brodaty H, Goodenough B, et al. The Sydney Multisite Intervention of LaughterBosses and ElderClowns (SMILE) study: cluster randomised trial of humour therapy in nursing homes. *BMJ Open* 2013: 3; e002072.

18. Provine RR. Laughter Punctuates Speech: Linguistic, Social and Gender

549 Contexts of Laughter. *Etholog* 1993; 95: 291-298.

550 19. Weems S. Ha!: The Science of When We Laugh and Why. New York, NY:

551 Basic Books 2014.

552 20. Ahmed D, El Shair IH, Taher E, et al.. Prevalence and predictors of

553 depression and anxiety among the elderly population living in geriatric

554 homes in Cairo, Egypt. *J Egypt Public Health Assoc* 2014; 89: 127-135.

555 21. Kahneman D, Deaton A. High income improves evaluation of life but not

556 emotional well-being. *Proc Natl Acad Sci U S A* 2010; 107: 16489-16493.

557 22. Kondo K. Kenkokakusasyakai nanigakenkowomushibamunoka.

558 Igakusyoin; 2005 (in Japanese).

559 23. Smoski M, Bachorowskia JA. Antiphonal laughter between friends and

560 strangers. *Cognition and Emotion* 2010; 17: 327-340.

561 24. Lim LL, Kua EH. Living alone, loneliness, and psychological well-being

562 of older persons in singapore. *Curr Gerontol Geriatr Res* 2011: 673181.

563 25. Navarro J, del Moral R, Pedro C. Marijuán. Laughing bonds: A

564 multidisciplinary inquiry into the social information processes of human

565 laughter. *Kybernetes* 2016; 45: 1292-307.

566 26. Hayashi K, Kawachi I, Ohira T, et al. Laughter and Subjective Health

567 Among Community-Dwelling Older People in Japan: Cross-Sectional

568 Analysis of the Japan Gerontological Evaluation Study Cohort Data. *J*

569 *Nerv Ment Dis* 2015; 203: 934-942.

570 27. Koyano W, Shibata H, Nakazato K, et al.. Measurement of competence:

571 reliability and validity of the TMIG Index of Competence. *Arch Gerontol*

Geriatr 1991; 13: 103-116.

28. Wada T, Ishine M, Kita T, et al. Depression screening of elderly community-dwelling Japanese. *J Am Geriatr Soc* 2003; 51: 1328-1329.

29. 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: 173-178.

30. 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* 2007; 14: 406-414.

31. 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.

32. Spiegelman D, Hertzmark E. Easy SAS calculations for risk or prevalence ratios and differences. *Am J Epidemiol* 2005; 162: 199-200.

33. Navarro J, del Moral R, Alonso MF, et al. Validation of laughter for diagnosis and evaluation of depression. *J Affect Disord* 2014; 160: 43-49.

34. Quesnel-Vallee A, Taylor M. Socioeconomic pathways to depressive symptoms in adulthood: evidence from the National Longitudinal Survey of Youth 1979. *Soc Sci Med* 2012; 74: 734-743.

35. Oda T. Some Considerations about Friendship of Elderly Japanese Living in an Urban Area. *Bulletin of Graduate School of Human Development*

and Environment, Kobe University 2003; 10: 491-502 (in Japanese).

36. 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.

37. Litwin H, Shiovitz-Ezra S. Social network type and subjective well-being in a national sample of older Americans. *Gerontologist* 2011; 51: 379-388.

38. Saito M, Kondo N, Kondo K, et al. Gender differences on the impacts of social exclusion on mortality among older Japanese: AGES cohort study. *Soc Sci Med* 2012; 75: 940-945.

39. Larson R. Thirty years of research on the subjective well-being of older americans. *J Gerontol* 1978; 33: 109-125.

40. House JS. Social Support and Social Structure. *Sociological Forum* 1987; 2: 135-146.

41. Kashiwagi K, Hirayama J. Marital norm, reality and satisfaction in middle-aged couples: why are wives less satisfied than husbands?. *Shinrigaku Kenkyu* 2003; 74: 122-130 (in Japanese).

42. 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* 2017; Epub ahead of print.

43. Wildgruber D, Szameitat DP, Ethofer T, et al. Different types of laughter modulate connectivity within distinct parts of the laughter perception network. *PLoS One* 2013; 8: e63441.

44. Szameitat DP, Kreifelts B, Alter K, et al. It is not always tickling: distinct cerebral responses during perception of different laughter types. *Neuroimage* 2010; 53: 1264-1271.

45. Shimizu A. Laughter, the brain, and psychiatric diseases. *Seishin Shinkeigaku Zasshi* 2001; 103: 895-903 (in Japanese).

Figure legend

Figure 1. Adjusted prevalence ratios (PRs) for laughing almost every day in each group according to equivalised income and frequency of meeting friends in men (a) and women (b) were calculated using binomial regression analysis. PRs were adjusted for age (5-year category), instrumental activities of daily living (IADL; independent, not independent, missing), and depression (no depression, depression, missing). The lowest equivalised income and meeting friends less frequently category was set as the reference category.

Figure 2. Adjusted prevalence ratios (PRs) for laughing almost every day in each group according to equivalised income and the number of social groups in men (a) and women (b) were calculated using binomial regression analysis. PRs were adjusted for age (5-year category), instrumental activities of daily living (IADL; independent, not independent, missing), and depression (no depression, depression,

missing). The lowest equivalised income and non-participation in social group category was set as the reference category.

Figure 3. Adjusted prevalence ratios (PRs) for laughing almost every day in each group according to equivalised income and family structure in men (a) and women (b) were calculated using binomial regression analysis. PRs were adjusted for age (5-year category), instrumental activities of daily living (IADL; independent, not independent, missing), and depression (no depression, depression, missing). The lowest equivalised income and living alone category was set as the reference category.

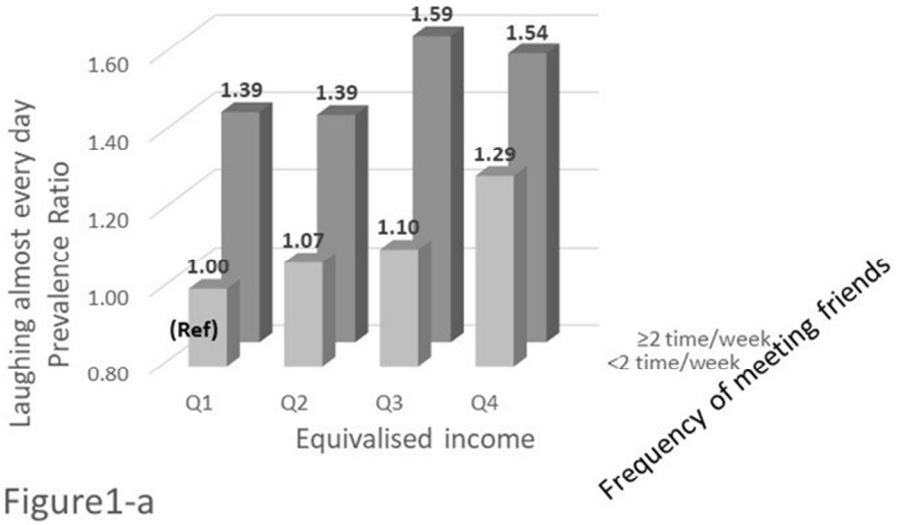

Figure1-a

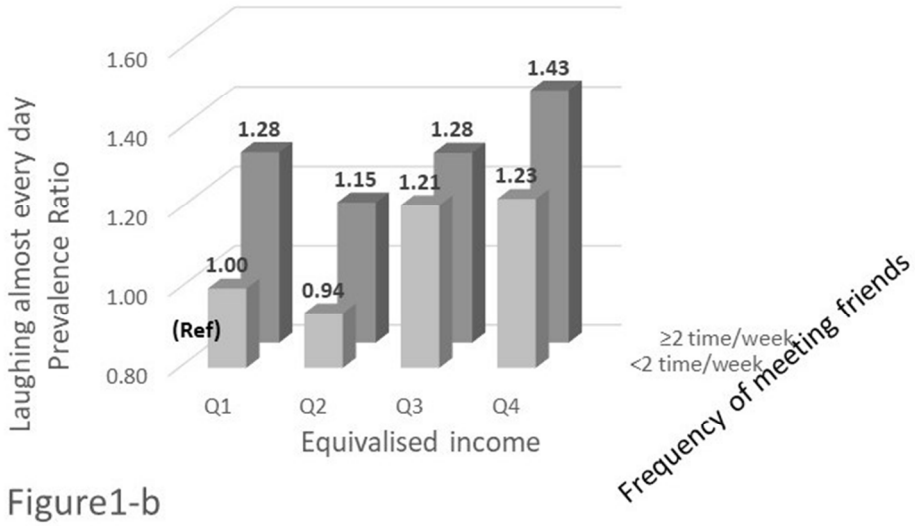

Figure1-b

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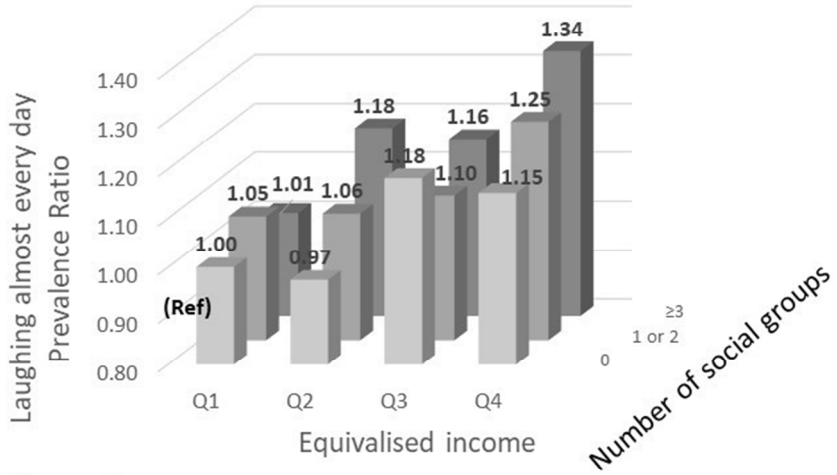

Figure2-a

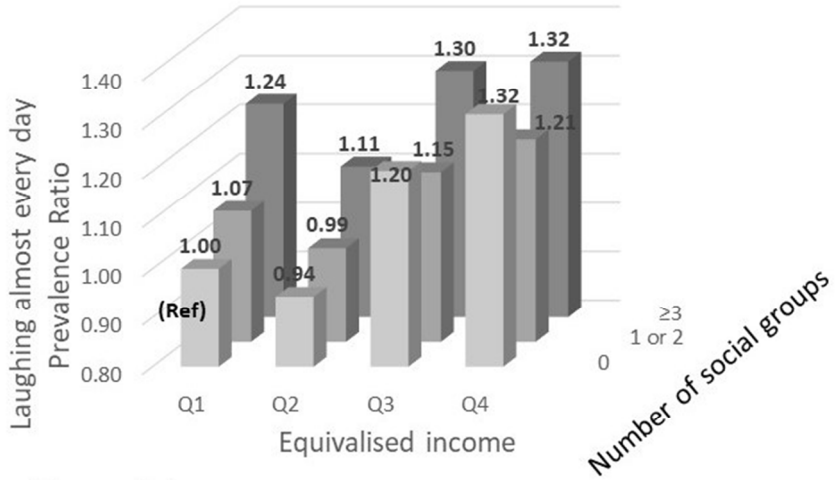

Figure2-b

60x76mm (300 x 300 DPI)

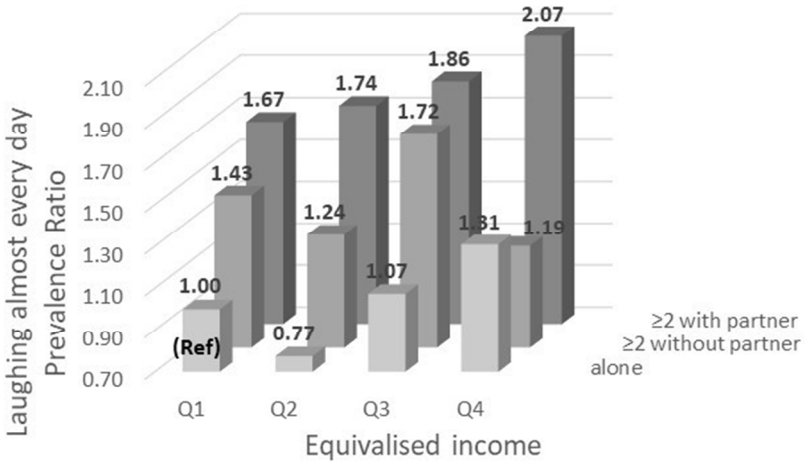

Figure3-a

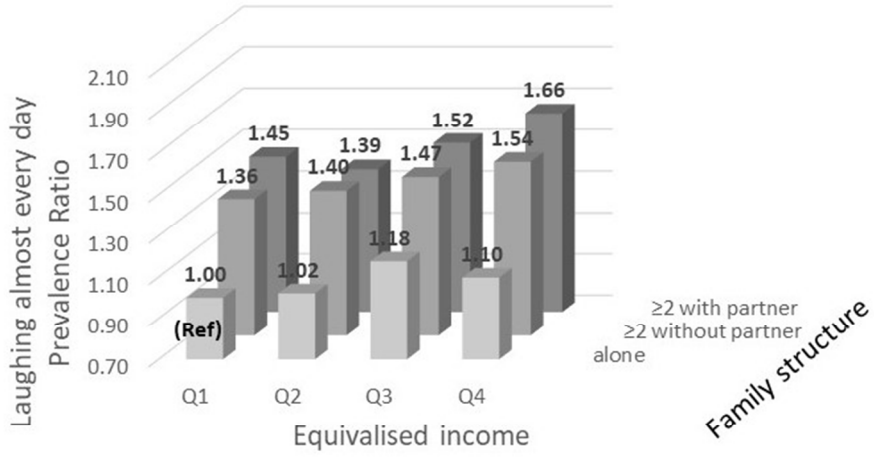

Figure3-b

63x76mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	10-11
Study size	10	Explain how the study size was arrived at	10-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-11
		(b) Indicate number of participants with missing data for each variable of interest	12-13
Outcome data	15*	Report numbers of outcome events or summary measures	12-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	15
		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	17-19
Discussion			
Key results	18	Summarise key results with reference to study objectives	19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-22
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.