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# BMJ Open

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

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

4  
5 **Running head:**

6 Association between laughter and income

7  
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9 Equivalized income, Japan, Laughter, Older people, Social relationships

10  
11 **Authors:**

12 Yurika Imai<sup>1</sup>, MD, Masato Nagai, PhD<sup>1, 2, 3</sup>, Tetsuya Ohira, MD, PhD<sup>1,4</sup>,  
13 Kokoro Shirai, PhD<sup>5</sup>, Naoki Kondo, MD, PhD<sup>6</sup>, Katsunori Kondo, MD, PhD<sup>7</sup>,

14 <sup>8</sup>

15  
16 <sup>1</sup> Department of Epidemiology, Fukushima Medical University School of  
17 Medicine, Fukushima, Japan

18 <sup>2</sup> Tohoku Medical Megabank Organization, Tohoku University, Sendai, Japan

19 <sup>3</sup> Graduate School of Medicine, Tohoku University, Sendai, Japan

20 <sup>4</sup> Radiation Medical Science Center for Fukushima Health Management  
21 Survey, Fukushima Medical University, Fukushima, Japan

22 <sup>5</sup> Department of Human Sciences, School of Law and Letters, University of  
23 the Ryukyus, Okinawa, Japan

24 <sup>6</sup> Department of Health and Social Behavior / Department of Health  
25 Education and Health Sociology, School of Public Health, The University of  
26 Tokyo, Tokyo, Japan

27 <sup>7</sup> Center for Preventive Medical Sciences, Chiba University, Chiba, Japan

28 <sup>8</sup> Department of Gerontological Evaluation, Center for Gerontology and  
29 Social Science, National Center for Geriatrics and Gerontology, Aichi, Japan

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### 44 **Corresponding author:**

45 Tetsuya Ohira

46 Department of Epidemiology, Fukushima Medical University School of

1  
2  
3  
4  
5 47 Medicine, Hikarigaoka 1, Fukushima, Fukushima 960-1295, Japan.

6  
7 48 Phone: +81-24-547-1344

8  
9 49 Fax: +81-24-547-1336

10  
11 50 E-mail: teohira@fmu.ac.jp.

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31  
32 59 **ABSTRACT**

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34 60 **Objective:** Laughter has positive and quantifiable effect on certain aspects of  
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36 61 health. Additionally, previous studies have suggested income influences the  
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38 62 emotion. In the present study, we examined the relationship between  
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40 63 equivalent income and frequency of laughter by a cross-sectional study.

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42 64 **Design:** Cross-sectional study and binomial regression analysis.

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44 65 **Setting:** Sampled from 30 municipalities in Japan.

45  
46 66 **Participants:** The 20,752 non-disabled Japanese individuals aged  $\geq 65$  years  
47  
48 67 using data from the Japan Gerontological Evaluation Study.

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50 68 **Primary outcome:** Frequency of laughter.

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52 69 **Results:** We found laughter increased significantly with an increase in  
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5 70 equivalent income (P for trend <.0001). After adjustment for age,  
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7 71 instrumental activity of daily living (IADL), depression, frequency of  
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9 72 meeting friends, number of social groups, and family structure, the PRs with  
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11 73 Q4 (men;  $\geq$  €24,420, women;  $\geq$  €21,154) were 1.21 (95% confidence interval:  
12  
13 74 1.13-1.30) among men and 1.14 (1.08-1.20) among women, as compared with  
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15 75 Q1 (men; < €12,041, women; < €9,518), respectively. After the exclusion of  
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17 76 participants with depression, the association was essentially unchanged.  
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19 77 Additionally, we found that inadequate social relationship or living alone  
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21 78 were associated with lower frequency of laughter. In comparison with the  
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23 79 lowest equivalent income with meeting friends less frequently and living  
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25 80 alone, the PRs of the highest equivalent income with meeting friends  
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27 81 frequently and living with someone were higher, respectively.  
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32 **Conclusions:** We demonstrated that there was significant relationship  
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34 83 between equivalent income and frequency of laughter. Social relationship  
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36 84 and family structure were also associated with frequency of laughter.  
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39 (237 words)  
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## 43 **Article summary**

### 44 **Article focus:**

- 45  
46 47 ● Present study described the association between equivalent income,  
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49 90 frequency of laughter and social relationship-related factor with 20,752  
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51 91 Japanese persons aged  $\geq$ 65 years who were randomly collected  
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54 92 throughout Japan  
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5 93 **Key message:**

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7 94 ● There was a positive relationship between equivalent income and  
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10 95 frequency of laughter.  
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12 96 ● Inadequate social relationship or living alone were associated with lower  
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14 97 frequency of laughter.  
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16 98 ● The positive association between income and health was explained partly  
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18 99 by frequency of laughter.  
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20  
21 100 ● Intervention for social relation instead of income might be possible to  
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23 101 improve laughter.  
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27 102

28 103 **Strengths and limitations of this study:**

- 29  
30 104 ● This is the first study to report relationships among equalized income,  
31  
32 105 frequency of laughter, and factors relating to social relationships and  
33  
34 106 family structure  
35  
36 107 ● The present study design was cross-sectional, and thus we cannot  
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38 108 demonstrate causal relationships.  
39  
40 109 ● The use of self-reported questionnaires may have introduced reporting  
41  
42 110 bias for income and frequency of laughter.  
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48 112 **INTRODUCTION**

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50 113 In most developed countries, the proportion of older people is growing faster  
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52 114 than any other age group. Of these countries, Japan is experiencing  
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54 115 population aging at the fastest pace (19.0% in 2003; 25.1% in 2013).<sup>1, 2</sup> The

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5 116 need for health promotion and disease prevention targeting older people is  
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7 117 increasing. Various health promotion strategies have been recommended for  
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9 118 older people, and laughter therapy has been introduced as an important  
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11 119 option.<sup>3</sup> Previous studies have suggested that laughter has positive and  
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13 120 quantifiable effects on certain aspects of health, such as immune function,<sup>4, 5</sup>  
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15 121 allergic dermatitis,<sup>6-8</sup> cancer,<sup>9-11</sup> psychiatric diseases,<sup>12-15</sup> dementia,<sup>16</sup> and  
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17 122 cardiovascular diseases.<sup>17, 18</sup> Additionally, laughter therapy improves aspects  
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19 123 of mental and physical function in older people,<sup>3</sup> and has therefore been  
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21 124 incorporated into complementary medicine. One example of this is a  
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23 125 randomized controlled trial of humor therapy in residential care: the Sydney  
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25 126 Multisite Intervention of LaughterBosses and ElderClowns (SMILE).<sup>3, 19</sup>  
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27 127 This trial has suggested that humor therapy decreases agitation and also  
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29 128 increases happiness.<sup>20, 21</sup>

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34 129 There is also growing interest in the influence of socioeconomic  
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36 130 status on health.<sup>22</sup> Previous studies have reported that socioeconomic status,  
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38 131 especially income, influences emotions.<sup>23, 24</sup> The threshold association  
39  
40 132 between income and positive emotion was observed.<sup>24</sup> Income has a positive  
41  
42 133 dose-response relationship with positive emotion up to \$75,000 per year,  
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44 134 while insufficient income is a significant predictor for depression.<sup>23</sup> Indeed,  
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46 135 the proportion of people with depression in the lowest income group is 15.8%  
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48 136 among men and 15.0% among women.<sup>25</sup> Depression is 6.9 times more  
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50 137 prevalent for men and 4.1 times more prevalent for women in this income  
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52 138 group than it is in the highest income group among Japanese aged 65–69  
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5 139 years. However, no studies have demonstrated a relationship between  
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7 140 income and frequency of laughter.  
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9 141 In the present study, therefore, we examined the relationship  
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11 142 between equivalized income and frequency of laughter among men and  
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13 143 women aged 65 years and older in Japan. Our hypothesis was that frequency  
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15 144 of laughter would be positively associated with equivalized income. We  
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17 145 further hypothesized that social relationships and family structure would  
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19 146 modify the association between laughter and income for older people,  
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21 147 because personal relationships have been associated with laughter,<sup>26</sup> and  
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23 148 living alone has been correlated with reduced psychological well-being.<sup>27</sup>  
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## 28 149 29 30 150 **METHODS**

### 31 151 **Study sample**

32 152 This study was a cross-sectional study using data from the Japan  
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34 153 Gerontological Evaluation Study (JAGES). The JAGES was designed to  
35  
36 154 describe the health status and social determinants of non-disabled people  
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38 155 aged 65 years and older, sampled from 30 municipalities in Japan. We used  
39  
40 156 the 2013 wave of JAGES, which was obtained from self-reported  
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42 157 questionnaires mailed to 195,290 community-dwelling individuals aged 65  
43  
44 158 years and older who were not eligible to receive benefits from public  
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46 159 long-term care insurance services. Of these, 138,293 individuals responded  
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48 160 to the survey (response rate = 70.8%). In addition to basic questions, there  
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50 161 were five modules in the survey covering different topics.<sup>28</sup> We used one of  
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5 162 these modules, which included questions about frequency of laughter.  
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7 163 Respondents to this module comprised 12,174 men and 14,194 women. We  
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9 164 analyzed a total of 20,006 participants (9,912 men and 10,094 women), after  
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11 165 excluding 6,362 participants with missing information on frequency of  
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13 166 laughter (n = 1,306), annual household income (n = 3,386), and number of  
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15 167 people living together (n = 1,670).  
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18 168 The JAGES protocol was reviewed and approved by the Ethics  
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20 169 Committee on Research of Human Subjects at Nihon Fukushi University  
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22 170 (Approval No. 10-05). Written informed consent was assumed with voluntary  
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24 171 return of the questionnaire.  
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### 30 173 **Laughter**

31  
32 174 The outcome variable was frequency of laughing. Laughter was assessed  
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34 175 through each participant's response to a question about how frequently they  
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36 176 laughed out loud during their daily life. The possible item answers were:  
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38 177 almost every day, 1–5 days/week, 1–3 days/month, and < 1 day/month. We  
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40 178 defined participants as laughing often if they answered “almost every day.”  
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### 45 180 **Equivalized income**

46  
47 181 Equivalized income was calculated by dividing the median value of the  
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49 182 multiple-choice annual household income by the square root of the number of  
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51 183 people living together. The annual household income question had 15  
52  
53 184 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,  
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5 185 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  $\geq 12.0$  million  
6  
7 186 Japanese yen). We used a purchasing power parity rate of EUR€1.00 =  
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9 187 JPN¥130 (as of July 2017). We divided the participants into quartiles  
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11 188 according to their equivalized income: Q1 (men  $< \text{€}12,041$ ; women  $< \text{€}9,518$ ),  
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13 189 Q2 (men  $\text{€}12,041\text{--}\text{€}15,543$ ; women  $\text{€}9,518\text{--}\text{€}14,957$ ), Q3 (men  $\text{€}15,544\text{--}$   
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15  $\text{€}24,426$ ; women  $\text{€}14,958\text{--}\text{€}21,153$ ), and Q4 (men  $\geq \text{€}24,420$ ; women  $\geq$   
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17  $\text{€}21,154$ ).  
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### 23 193 **Measures and definitions**

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25 194 Instrumental activity of daily living (IADL) was assessed using the Tokyo  
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27 195 Metropolitan Institute of Gerontology Index of Competence,<sup>29</sup> and the results  
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29 196 were classified as high IADL (5 points) or low IADL ( $\leq 4$  points). The  
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31 197 evaluation of depression was made using the Geriatric Depression Scale  
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33 198 (GDS).<sup>30</sup> GDS is a 15-item questionnaire, with a score range of 1–15.<sup>31</sup>  
34  
35 199 Following previous research,<sup>32, 33</sup> participants were classified into two  
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37 200 groups: not depressed (GDS  $< 5$ ) and depressed (GDS  $\geq 5$ ).  
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41 201 Frequency of meeting friends and acquaintances was measured with  
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43 202 a question comprising six categories ( $\geq 4$  days/week, 2–3 days/week, 1  
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45 203 day/week, 1–3 days/month, several times/year, and none). We divided the  
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47 204 respondents into three groups:  $< 2$  times/week,  $\geq 2$  times/week, or missing.  
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50 205 Participants were also presented with 14 different civic associations  
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52 206 and social groups, and asked with which ones they were regularly connected;  
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54 207 this provided a measurement, divided into six categories, for each type of  
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5 208 social group ( $\geq 4$  days/week, 2–3 days/week, 1 day/week, 1–3 days/month,  
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7 209 several times/year, no participation). The total number of types of groups in  
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9 210 which each respondent participated at least several times per year was  
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11 211 tallied, and respondents were divided into four groups: 0, 1 or 2,  $\geq 3$ , or  
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14 212 missing.

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16 213 Family structure was assessed through two questions: one regarding  
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18 214 the number of people living together, and the other regarding marital status.  
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20 215 The marital status question provided five answer categories (married,  
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22 216 bereaved, divorced, never married, and other). Based on answers to these  
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24 217 questions, we divided the participants into four groups: alone,  $\geq 2$  without  
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26 218 partner,  $\geq 2$  with partner, or  $\geq 2$  with no information about marital status.  
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### 32 220 **Statistical analysis**

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34 221 We used binomial regression analyses to derive prevalence ratios (PRs)  
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36 222 based on 95% confidence intervals (CIs) for “laughing almost every day”  
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38 223 according to equivalized income. Following recent statistical  
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40 224 recommendations, we calculated PRs rather than odds ratios because  
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42 225 prevalence of laughing almost every day was not rare ( $\geq 10\%$ ).<sup>34</sup> We used the  
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44 226 SAS version 9.4 statistical software package. In each model, the lowest  
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46 227 equivalized income category was set as the reference category. A “missing”  
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48 228 category was used in analysis to account for missing values in response to  
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50 229 questions. In Model 1, we controlled for age (65–69, 70–74, 75–79, 80–84,  $\geq$   
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52 230 85), IADL (high IADL, low IADL, or missing), and depression (no depression,  
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5 231 depression, or missing). Model 2 was adjusted for the covariates in Model 1  
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7 232 plus social relationship-related factor such as frequency of meeting friends (<  
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9 233 2 times/week,  $\geq 2$  times/week, or missing) and number of social groups (0, 1  
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11 234 or 2,  $\geq 3$ , or missing), and family structure (alone,  $\geq 2$  without partner,  $\geq 2$   
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13 235 with partner, or  $\geq 2$  with no information about marital status). Additionally,  
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15 236 to confirm the robustness of our results we also carried out the same series of  
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17 237 analysis using the sample excluding subjects with depression ( $GDS \geq 5$ ) and  
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19 238 missing information about depression. There might be bias due to depression  
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21 239 because people with depression might seldom laugh and depression  
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23 240 influences employment and income.

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27 241 To assess whether the prevalence of laughter associated with  
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29 242 equivalized income differed between social relationships (frequency of  
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31 243 meeting friends or number of social groups) or family structure, we  
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33 244 conducted a sub-analysis in which participants were cross-classified into  
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35 245 groups according to their equivalized income; the lowest equivalized income  
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37 246 group was treated with each inadequate social relationship (meeting friends  
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39 247 less frequently or non-participation in an organization) or living alone as the  
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41 248 reference categories. The  $p$  value for the trend was calculated by categorical  
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43 249 variables. All  $p$  values were two-tailed, and differences of  $< 0.05$  were  
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45 250 accepted as statistically significant.

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## 51 52 252 **RESULTS**

### 53 54 253 **Baseline characteristic by equivalized income**

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5 254 Table 1 shows the baseline characteristics of the study participants  
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7 255 according to the categories of equivalized income. The proportions for  
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9 256 laughing almost every day were 37.2% for men and 47.6% for women; these  
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11 257 proportions increased as equivalized income increased for both men and  
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14 258 women. The proportion of respondents who reported laughing < 1  
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16 259 time/month was 9.7% for men and 5.3% for women. The mean age was  
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18 260 highest in the lowest equivalized income group for both men and women. The  
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21 261 proportion of low IADL and depression decreased as equivalized income  
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23 262 increased. Meeting friends and participating in social groups increased with  
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25 263 a rise in equivalized income. The proportion of people co-habiting was  
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27 264 highest in Q2 for men and in Q3 for women.  
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Table 1. Baseline characteristics by categories of household income

	Equivalentized income <sup>a</sup>				P value <sup>b</sup>
	Q1	Q2	Q3	Q4	
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 <sup>c</sup> )	74.3 (6.0)	73.3 (5.8)	73.2 (6.0)	72.8 (6.1)	<0.0001
IADL <sup>c</sup> (%)					
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	2.6	0.6	0.3	0.3	
about marital status					
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)

	Equivalent income				P value
	Q1	Q2	Q3	Q4	
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	

<sup>a</sup> 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).

<sup>b</sup> P values were calculated by chi-squared test (categorical variables), or ANOVA (continuous variables).

266 <sup>c</sup> SD, standard deviation; IADL, instrumental activity of daily living.



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5 267 **Equivalized income and frequency of laughter**

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7 268 Table 2 shows the results of our binomial regression models for frequency of  
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9 269 laughter according to equivalized income. Equivalized income was  
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11 270 significantly associated with frequency of laughter among both men and  
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13 271 women. The PRs tended to amplify as equivalized income increased.  
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15 272 Compared with those in the lowest equivalized income group, the  
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17 273 age-adjusted PRs of laughing almost every day for participants in the  
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19 274 highest equivalized income group were greater: 1.43 (95% CI, 1.33–1.54) for  
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21 275 men, and 1.30 (1.23–1.38) for women. After adjusting for age, IADL,  
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23 276 depression, frequency of meeting friends, number of social groups, and  
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25 277 family structure, the PRs decreased to 1.21 for men and 1.14 for women in  
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28 278 this group; however, the association was essentially unchanged.  
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Table 2. Prevalence Ratios and 95% confidence intervals of frequency of laughing according to equivalized income.

	Equivalized income <sup>a</sup>				P for trend <sup>b</sup>
	Q1	Q2	Q3	Q4	
<b>Men</b>					
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 <sup>c</sup>	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 <sup>d</sup>	reference	1.03(0.96-1.11)	1.12(1.05-1.21)	1.21(1.13-1.30)	<0.0001
<b>Women</b>					
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 <sup>c</sup>	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 <sup>d</sup>	reference	0.98(0.92-1.05)	1.06(1.00-1.12)	1.14(1.08-1.20)	<0.0001

<sup>a</sup> 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).

<sup>b</sup> P for trend was calculated by categorical variables.

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

<sup>d</sup> 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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5 280 Table 3 shows the results of our binomial regression models for  
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7 281 frequency of laughter according to equivalized income, using a sample that  
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9 282 excluded participants with depression ( $GDS \geq 5$ ) and missing information  
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11 283 about depression. The associations remained unchanged after these  
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14 284 exclusions. The PRs of laughing almost every day for men and women with  
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16 285 the highest equivalized income were 1.23 (95% CI, 1.13–1.34) and 1.10 (1.04–  
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18 286 1.17), respectively.  
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Table 3. Prevalence Ratios and 95% confidence intervals of frequency of laughing according to equivalized income for no depression people.

		Equivalized income <sup>a</sup>				P for trend <sup>b</sup>
		Q1	Q2	Q3	Q4	
<b>Men</b>						
	No. of participants with no depression	1296	1587	1958	1943	
	No. of participants laughing almost everyday	499	634	875	945	
	Multi-adjusted <sup>c</sup>	reference	1.01(0.93-1.11)	1.15(1.06-1.25)	1.23(1.13-1.34)	<0.0001
<b>Women</b>						
	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

<sup>a</sup> 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).

<sup>b</sup> P for trend was calculated by categorical variables.

<sup>c</sup> 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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5 289 **Frequency of laughter according to equivalized income, by social**  
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7 290 **relationships and family structures**  
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9 291 Figure 1, 2, and 3 shows the results of a sub-analysis, which examined  
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11 292 interactions between income and laughing almost every day, by social  
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13 293 relationships and family structure. While we observed no significant  
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15 294 interactions ( $p$  for interaction: frequency of meeting friends = 0.73 for men;  
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17 295 number of social groups = 0.20 for men, 0.11 for women; family structure =  
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19 296 0.86 for men, 0.52 for women) without frequency of meeting friends in  
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21 297 women, we found that inadequate social relationships (particularly meeting  
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23 298 friends less frequently or living alone) were associated with lower frequency  
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25 299 of laughter. The PR for men in the lowest equivalized income group who met  
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27 300 more often with friends was 1.39 (95% CI: 1.24–1.56), while for men in the  
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29 301 highest equivalent income group who met less frequently with friends, the  
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31 302 PR was 1.29 (1.17–1.42). The PR for women in the lowest equivalized income  
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33 303 group who met more often with friends was 1.28 (1.17–1.40), while for  
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35 304 women in the highest equivalized income group who met with friends less  
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37 305 frequently, the PR was 1.23 (1.13–1.33). In family structure, the PR for men  
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39 306 in the lowest equivalized income group who lives  $\geq 2$  with partner was 1.67  
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41 307 (95% CI: 1.28–2.17), while for men in the highest equivalent income group  
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43 308 who lives alone, the PR was 1.31 (0.92–1.87). The PR for women in the lowest  
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45 309 equivalized income group who met more often with friends was 1.45 (1.25–  
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47 310 1.68), while for women in the highest equivalized income group who met with  
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49 311 friends less frequently, the PR was 1.10 (0.90–1.34). Among women but not  
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5 312 men, we observed statistically significant associations between equivalized  
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7 313 income and frequency of laughter if there were inadequate social  
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9 314 relationships such as meeting friends less frequently or non-participation in  
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11 315 organizations. However, we observed no statistically significant associations  
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13 316 between equivalized income and frequency of laughter if the women had  
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15 317 richer social relationships such as meeting friends more frequently or  
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17 318 participating in more social groups.  
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## 321 **DISCUSSION**

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

332 While the present study showed an association between equivalized  
333 income and frequency of laughter, previous studies have shown that  
334 depression decreases frequency of laughter,<sup>35</sup> and that household income

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5 335 influences mental health.<sup>36</sup> Recognizing that our results may have reflected  
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7 336 bias because of participant depression, we conducted further analyses after  
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9 337 excluding participants with depression. Nevertheless, the tendency did not  
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11 338 change. We believe that this result supports the original design of this study,  
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14 339 which posited that frequency of laughter is associated with income  
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16 340 regardless of depression.

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18 341 Previous studies, however, have indicated that people who had more  
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20 342 money had more opportunity to come in contact with others.<sup>37</sup> Coming in  
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22 343 contact with others, moreover, is considered important to subjective  
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24 344 well-being.<sup>38</sup> It is possible, then, that wealthier people laugh more frequently  
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26 345 because they have more opportunities to meet others. Therefore, we  
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28 346 examined the influence of social relationship factors and family structure on  
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30 347 the relationship between equivalized income and frequency of laughter.

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34 348 In a cross-classification analysis of equivalized income and frequency  
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36 349 of meeting friends, we found that meeting friends was associated with  
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38 350 frequency of laughter for both men and women. A study of older Japanese  
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40 351 people indicated that friendship was important for subjective well-being;<sup>38</sup>  
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42 352 friendship decreases loneliness and anxiety, and increases happiness.<sup>39</sup>  
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44 353 These findings suggest that meeting friends leads to increasing  
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46 354 opportunities for laughter.

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50 355 In a cross-classification analysis of equivalized income and number of  
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52 356 social groups, we observed no significant associations between participating  
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54 357 in social groups and frequency of laughter among men in Q1–3; however, the

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5 358 PRs of men in Q4 tended to amplify as their number of social groups  
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7 359 increased. Previous research has suggested that relative poverty might be a  
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9 360 risk factor for poor emotional well-being among older men;<sup>40</sup> for an older man,  
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11 361 relative poverty had a bigger impact on well-being than social isolation. In  
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13 362 the present study, relatively poor men (Q1–3) laughed less frequently  
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15 363 regardless of the number of social groups in which they participated. By  
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17 364 contrast, the PRs were higher for women in wealthier groups (Q3 and Q4)  
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19 365 and/or those participating in three or more social groups. For older women,  
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21 366 interpersonal relationships might have a strong protective or buffering effect  
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23 367 for psychosocial stress.<sup>40</sup> In the present study, they laughed frequently even  
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25 368 if they had a low equivalized income. Larson reviewed research from the past  
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27 369 30 years about subjective well-being of older Americans,<sup>41</sup> and found a  
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29 370 positive correlation between social activity and well-being.  
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34 371 In our cross-classification analysis on equivalized income and family  
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36 372 structure, we found positive association between number of family members  
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38 373 and frequency of laughter for both men and women. However, for men  
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40 374 without a partner, no association was evident. Particularly for men, a spouse  
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42 375 has a bigger influence than someone else.<sup>42</sup> The present study showed that  
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44 376 poor men living with a wife laughed more frequently than wealthy men  
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46 377 without a wife. For women, however, living with someone was important for  
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48 378 laughter, whether that partner was their husband or not. This difference is  
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50 379 likely to be occurred by following reason. Wife's satisfaction with her partner  
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52 380 and with the marital relationship has been shown to be remarkably lower  
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5 381 than those of husband in Japan.<sup>43</sup> Indeed, we found that factors relating to  
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7 382 social relationships were associated with frequency of laughter. This finding  
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9 383 supports our hypothesis that wealthier people laugh more frequently than  
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11 384 poorer people because they have more opportunities to come into contact  
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14 385 with others.  
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16 386 Implications from this study for public health are twofold. First, given  
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18 387 the multiple positive effects of laughing on certain aspects of health,<sup>3-7, 9-18</sup>  
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20 388 income redistribution policies may have additional benefits for impoverished  
21  
22 389 older people. That is, increased income may improve not only material  
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24 390 conditions but also psychosocial health and cognitive ability. Second, while  
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26 391 income redistribution policy reform may take a long time to implement,  
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28 392 public health interventions that provide opportunities for more social  
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30 393 interactions in local settings may help reduce the laughter deprivation  
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32 394 among low-income populations.  
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36 395 To the best of our knowledge, this is the first study to report  
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38 396 relationships among equivalized income, frequency of laughter, and factors  
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40 397 relating to social relationships and family structure. However, there are  
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42 398 several potential limitations that should be mentioned. First, the present  
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44 399 study design was cross-sectional, and thus we cannot demonstrate causal  
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46 400 relationships. However, longitudinal analyses of our cohort data can be used  
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48 401 to address such issues in future research. Second, the use of self-reported  
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50 402 questionnaires may have introduced reporting bias for income and frequency  
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52 403 of laughter. For example, some participants may not know or accurately  
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5 404 remember their income or their laughter frequency. Third, we did not take  
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7 405 the diversity of laughter into account: one study reported three different  
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9 406 types of laughter: “laughter of pleasure,” “laughter of social obligation,” and  
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11 407 “laughter as relief from tension”.<sup>44</sup> “Laughter of pleasure” is an expression of  
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13 408 pleasant emotions. “Laughter of social obligation” is a way of communicating  
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15 409 in interaction with others; this laughter occurs consciously. “Laughter as  
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17 410 relief from tension” occurs when strain dissipates or is removed. Further  
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19 411 research is needed to consider these differences in laughter relative to  
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21 412 equivalized income.  
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## 414 **CONCLUSION**

415 In this study, we demonstrated a relationship between equivalized income  
416 and frequency of laughter. Additionally, we found an association between  
417 frequency of laughter and factors relating to social relationships,  
418 particularly family structure and frequency of meeting friends. We suggest  
419 that people with a high income may improve their health through high  
420 frequency of laughter. Future research should foreground health  
421 improvements for older people.  
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#### 41 443 **Conflict of Interest**

42  
43 444 This was not an industry supported study. The authors declare that they  
44  
45 445 have no conflicts of interest.

#### 46 47 446 48 49 447 **Authors' contributions**

50  
51 448 Yurika Imai, Masato Nagai and Tetsuya Ohira contributed to the design of  
52  
53 449 the study. Naoki Kondo, Kokoro Shirai and Katsunori Kondo participated in  
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5 450 data collection. Yurika Imai and Masato Nagai participated in data analysis.  
6  
7 451 Yurika Imai, Masato Nagai and Tetsuya Ohira participated in writing the  
8  
9 452 report. All authors participated in critical revision of the manuscript and  
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11 453 approved the final version of the report for submission.  
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#### 15 16 455 **Ethical approval**

17  
18 456 The JAGES protocol was reviewed and approved by the Ethics Committee on  
19  
20 457 Research of Human Subjects at Nihon Fukushi University (Approval No.  
21  
22 458 10-05). Written informed consent was assumed with voluntary return of the  
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24 459 questionnaire.  
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#### 28 29 30 461 **Data sharing**

31  
32 462 No additional data available.  
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23 596 **Figure legend**

24  
25 597 Figure 1. Adjusted Prevalence Ratios (PRs) for laughing almost every day  
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27 598 in each group according to equivalized income and frequency of meeting  
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29 599 friends in men (a) and women (b) were calculated using binomial  
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31 600 regression analysis. PRs are adjusted for age (5-year category),  
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33 601 instrumental activity of daily living (IADL; independent, not independent,  
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35 602 missing), depression (no depression, depression, missing). The lowest  
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37 603 equivalized income and meeting friends less frequently category was set  
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39 604 as the reference category.

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44 606 Figure 2. Adjusted Prevalence Ratios (PRs) for laughing almost every day  
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46 607 in each group according to equivalized income and number of social  
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48 608 groups in men (a) and women (b) were calculated using binomial  
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50 609 regression analysis. PRs are adjusted for age (5-year category),  
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52 610 instrumental activity of daily living (IADL; independent, not independent,  
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5 611 missing), depression (no depression, depression, missing). The lowest  
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7 612 equivalized income and non-participation in social group category was set  
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13  
14 615 Figure 3. Adjusted Prevalence Ratios (PRs) for laughing almost every day in  
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16 616 each group according to equivalized income and family structure in men (a)  
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18 617 and women (b) were calculated using binomial regression analysis. PRs are  
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20 618 adjusted for age (5-year category), instrumental activity of daily living  
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22 619 (IADL; independent, not independent, missing), depression (no depression,  
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24 620 depression, missing). The lowest equivalized income and living alone  
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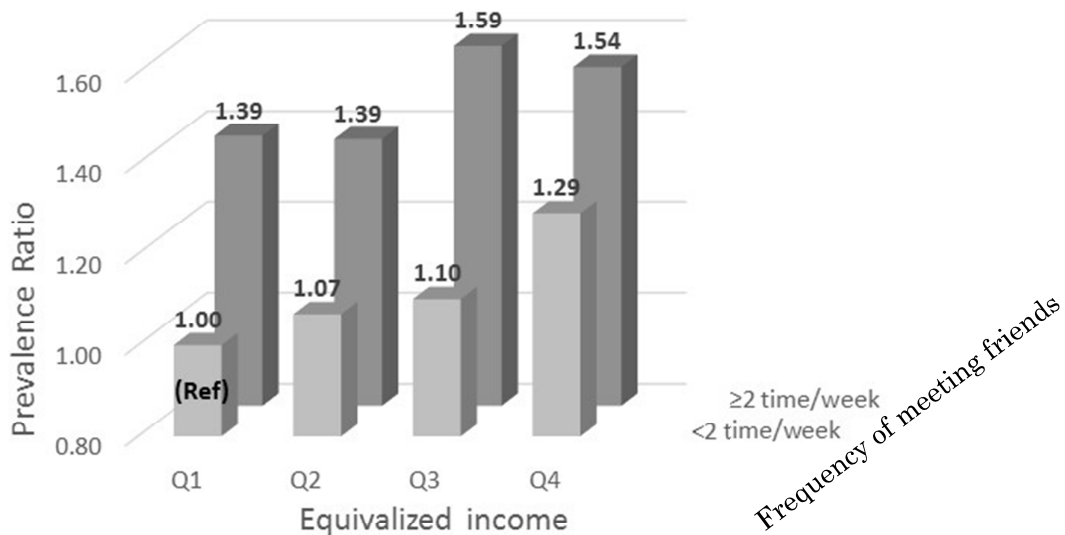


Figure1-a

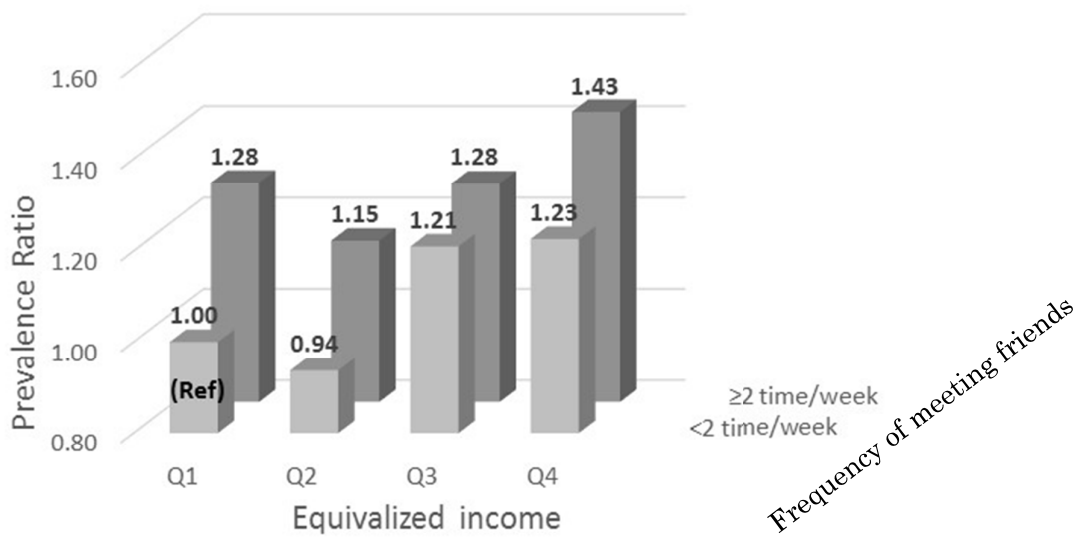


Figure1-b

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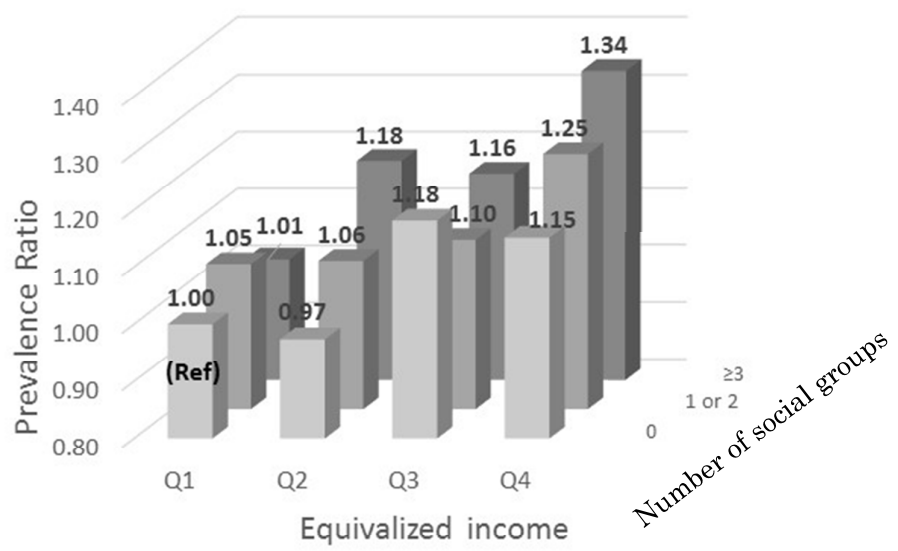


Figure2-a

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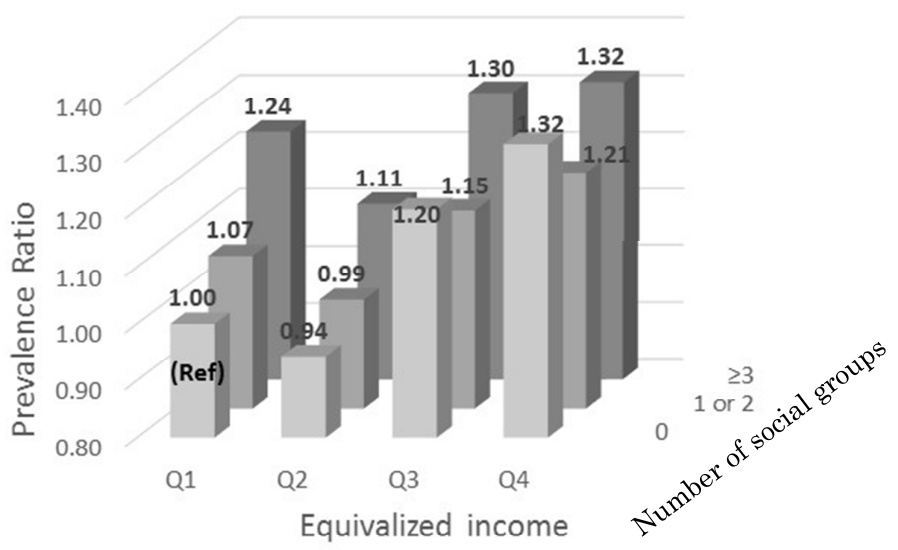


Figure2-b

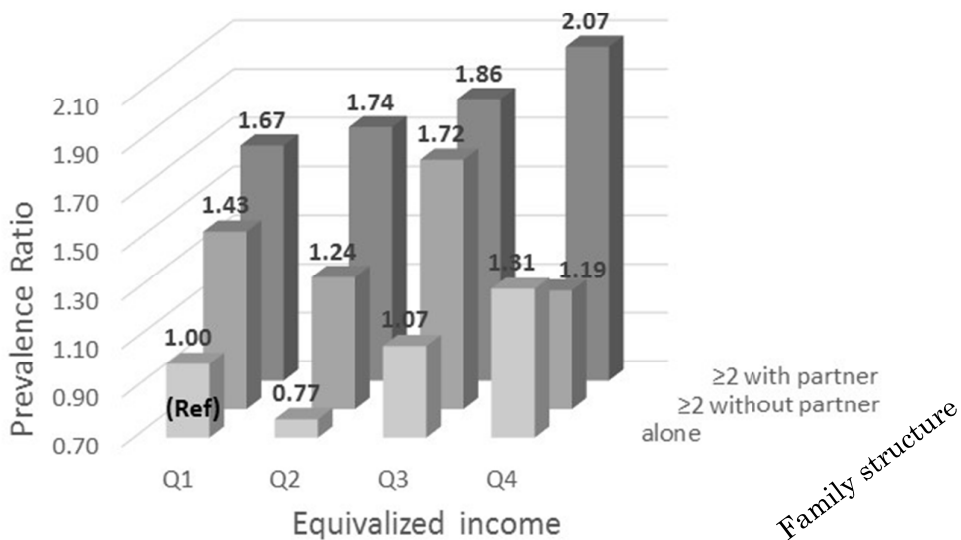


Figure3-a

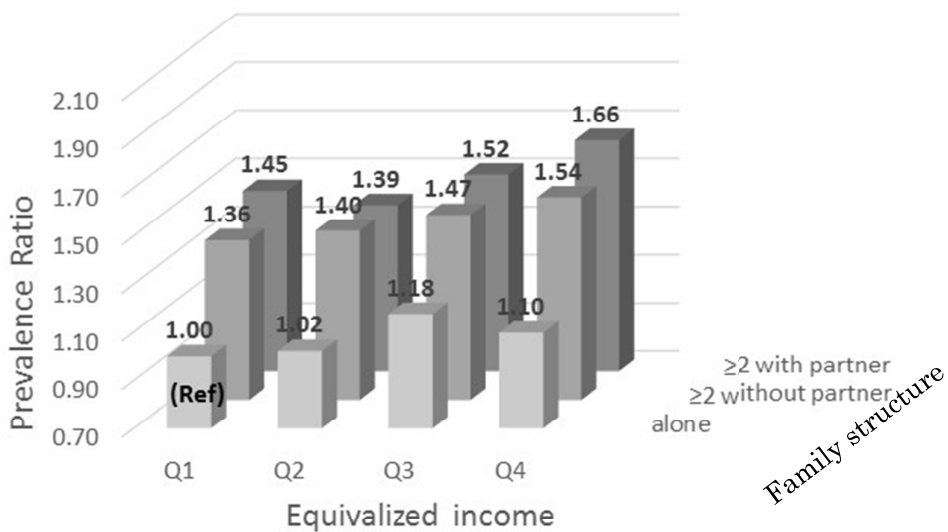


Figure3-b

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

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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	
<b>Other information</b>			
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](http://www.strobe-statement.org).



# BMJ Open

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

Journal:	<i>BMJ Open</i>
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<b>Primary Subject Heading</b>:	Complementary medicine
Secondary Subject Heading:	Epidemiology, Mental health
Keywords:	Japan, Laughter,, Older people, Social relationships, Equivalised income

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Manuscripts

1 **Research**

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

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5 **Running head:**

6 The impact of social relationships on income-laughter relationships

7  
8 **Keywords:**

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

10  
11 **Authors:**

12 Yurika Imai<sup>1</sup>, MD, Masato Nagai, PhD<sup>1, 2, 3</sup>, Tetsuya Ohira, MD, PhD<sup>1,4</sup>,  
13 Kokoro Shirai, PhD<sup>5</sup>, Naoki Kondo, MD, PhD<sup>6</sup>, Katsunori Kondo, MD, PhD<sup>7</sup>,

14 <sup>8</sup>

15  
16 <sup>1</sup> Department of Epidemiology, Fukushima Medical University School of  
17 Medicine, Fukushima, Japan

18 <sup>2</sup> Tohoku Medical Megabank Organization, Tohoku University, Sendai, Japan

19 <sup>3</sup> Graduate School of Medicine, Tohoku University, Sendai, Japan

20 <sup>4</sup> Radiation Medical Science Center for Fukushima Health Management  
21 Survey, Fukushima Medical University, Fukushima, Japan

22 <sup>5</sup> Department of Human Sciences, School of Law and Letters, University of  
23 the Ryukyus, Okinawa, Japan

24 <sup>6</sup> Department of Health and Social Behavior / Department of Health  
25 Education and Health Sociology, School of Public Health, The University of  
26 Tokyo, Tokyo, Japan

27 <sup>7</sup> Center for Preventive Medical Sciences, Chiba University, Chiba, Japan

28 <sup>8</sup> Department of Gerontological Evaluation, Center for Gerontology and  
29 Social Science, National Center for Geriatrics and Gerontology, Aichi, Japan

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### 44 **Corresponding author:**

45 Tetsuya Ohira

46 Department of Epidemiology, Fukushima Medical University School of

1  
2  
3  
4  
5 47 Medicine, Hikarigaoka 1, Fukushima, Fukushima 960-1295, Japan.

6  
7 48 Phone: +81-24-547-1344

8  
9 49 Fax: +81-24-547-1336

10  
11 50 E-mail: teohira@fmu.ac.jp.

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32 59 **ABSTRACT**

33  
34 60 **Objectives:** Laughter has a positive and quantifiable effect on certain aspects  
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36 61 of health, and previous studies have suggested that income influences the  
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38 62 emotion. However, it is unknown whether social relationship-related factors  
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40 63 modify the association between equivalised income and laughter among  
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42 64 older people. In the present study, we examined the relationship between  
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44 65 equivalised income and the frequency of laughter. In addition, we examined  
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46 66 the impact of social relationship-related factors on the association between  
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48 67 equivalised income and frequency of laughter using a cross-sectional study  
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50 68 design.

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53 69 **Design:** Cross-sectional study and binomial regression analysis.  
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5 70 **Setting:** We sampled from 30 municipalities in Japan.

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7 71 **Participants:** We examined 20,752 non-disabled Japanese individuals aged  $\geq$   
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9 72 65 years using data from the Japan Gerontological Evaluation Study.

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11 73 **Primary outcome:** Frequency of laughter.

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13 74 **Results:** Laughter increased significantly with an increase in equivalent  
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15 75 income (P for trend  $< .0001$ ). Prevalence ratios (PRs) for laughing almost  
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17 76 every day were calculated according to quartile equivalised income (quartile)  
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19 77 after adjusting for age, instrumental activities of daily living (IADL),  
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21 78 depression, frequency of meeting friends, number of social groups, and  
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23 79 family structure. The results revealed that PRs in Q4 (men;  $\geq$  €24,420,  
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25 80 women;  $\geq$  €21,154) were 1.21 (95% confidence interval: 1.13-1.30) among men  
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27 81 and 1.14 (1.08-1.20) among women, as compared with Q1 (men;  $<$  €12,041,  
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29 82 women;  $<$  €9,518), respectively. After excluding participants with depression,  
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31 83 the association remained significant. In addition, we found inadequate social  
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33 84 relationships and living alone were associated with a lower frequency of  
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35 85 laughter. In comparison with the lowest equivalent income with meeting  
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37 86 friends less frequently and living alone, the PRs of the highest equivalent  
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39 87 income with meeting friends frequently and living with someone were higher,  
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41 88 respectively.  
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47 89 **Conclusions:** The results revealed a significant relationship between  
48  
49 90 equivalent income and the frequency of laughter. Social relationships and  
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51 91 family structure were also associated with the frequency of laughter.

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54 92 (300 words)

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**94 Strengths and limitations of this study:**

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

102

**103 INTRODUCTION**

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

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5 116 randomized controlled trial of humor therapy in residential care called the  
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7 117 Sydney Multisite Intervention of Laughter Bosses and Elder Clowns  
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9 118 (SMILE)<sup>15</sup> suggested that humor therapy decreased agitation and increased  
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11 119 happiness.<sup>16 17</sup>

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13  
14 120 Laughter is reported to occur most frequently during casual  
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16 121 conversation.<sup>18</sup> Surprise is an important element in humor because laughter  
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18 122 usually occurs when one encounters a meaningful interpretation of some  
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20 123 stimulus or event that differs from the meaning that was initially assumed.<sup>19</sup>  
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22  
23 124 An individual's emotions are influenced by their character and social  
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25 125 background, and previous studies have reported that socioeconomic status,  
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27 126 particularly income, influences emotions.<sup>20 21</sup> In addition, the threshold  
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29 127 association between income and positive emotion (emotional well-being) has  
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31 128 been reported.<sup>21</sup> In another study, income was found to have a positive  
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33 129 dose-response relationship with positive emotion, up to an annual income of  
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35 130 \$75,000, whereas insufficient income was a significant predictor for  
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37 131 depression.<sup>20</sup> The proportion of people with depression in the lowest income  
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39 132 group is 15.8% among men and 15.0% among women,<sup>22</sup> and depression is 6.9  
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41 133 times more prevalent for men and 4.1 times more prevalent for women in  
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43 134 this income group than it is in the highest income group among people in  
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45 135 Japan aged 65–69 years. Although these findings suggest that emotion  
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47 136 varies according to socioeconomic status, no previous studies have  
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49 137 demonstrated a relationship between income and the frequency of laughter.  
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54 138 In the current study, we hypothesized that the frequency of laughter  
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5 139 would be positively associated with equivalised income. We further  
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7 140 hypothesized that social relationships and family structure would modify the  
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9 141 association between equivalised income and laughter for older people. Closer  
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11 142 personal relationships are associated with more frequent laughter,<sup>23</sup> and  
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13 143 living alone has been correlated with reduced psychological well-being.<sup>24</sup>  
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15 144 Laughter is not only involved in the expression of emotion, but also in the  
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17 145 maintenance of social bonds.<sup>25</sup> In the present study, therefore, we examined  
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19 146 the relationship between equivalised income and frequency of laughter. In  
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21 147 addition, we examined the impact of social relationship-related factors on  
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23 148 this relationship association among men and women aged 65 years and older  
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25 149 in Japan.  
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## 30 150 31 32 151 **METHODS**

### 33 34 152 **Study sample**

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36 153 The present study had a cross-sectional design, using data from the Japan  
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38 154 Gerontological Evaluation Study (JAGES). The JAGES was designed to  
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40 155 describe the health status and social determinants of non-disabled people  
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42 156 aged 65 years and older, sampled from 30 municipalities in Japan. We used  
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44 157 the 2013 wave of JAGES, which was obtained from self-reported  
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46 158 questionnaires mailed to a source population of 195,290 community-dwelling  
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48 159 individuals between 1 October and 2 December 2013. These individuals were  
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50 160 65 years and older, and were not eligible to receive benefits from public  
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52 161 long-term care insurance services. Of this sample, 138,293 individuals  
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5 162 responded to the survey (response rate = 70.8%). In addition to basic  
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7 163 questions, there were five modules in the survey covering different topics<sup>26</sup>  
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9 164 —module A: nursing care, medical care, and lifestyles; module B: oral  
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11 165 hygiene, optimism, subjective health; module C: social capital, history of  
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13 166 abuse; module D: subjective quality of life, sleep, cognitive function; and  
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15 167 module E: physical activity. We examined data from module B, which  
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17 168 included questions about laughter. Of the 138,293 respondents, the current  
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19 169 study examined the data of 26,368 individuals who responded to the JAGES  
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21 170 basic questions as well as module B, including questions about the frequency  
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23 171 of laughter. The final analysis involved 20,006 participants (9,912 men and  
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25 172 10,094 women), after excluding 6,362 participants with missing information  
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27 173 about the frequency of laughter (n = 1,306), annual household income (n =  
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29 174 3,386), or the number of people living together (n = 1,670).

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34 175 The JAGES protocol was reviewed and approved by the Ethics  
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36 176 Committee on Research of Human Subjects at Nihon Fukushi University  
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38 177 (Approval No. 10-05). Written informed consent was assumed with voluntary  
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40 178 return of the questionnaire.  
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## 45 180 **Laughter**

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47 181 The outcome variable was the frequency of laughing. Laughter was assessed  
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49 182 through each participant's response to a question about how frequently they  
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51 183 laughed out loud during their daily life. The possible item answers were:  
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53 184 almost every day, 1–5 days/week, 1–3 days/month, and < 1 day/month. Based  
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5 185 on a previous study<sup>14</sup>, we defined participants as laughing often if they  
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7 186 answered “almost every day.”  
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### 11 188 **Equivalised income**

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14 189 Equivalised income was calculated by dividing the median value of the  
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16 190 multiple-choice annual household income by the square root of the number of  
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18 191 people living together. The annual household income question had 15  
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20 192 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,  
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22 193 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  
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24 194 Japanese yen). We used a purchasing power parity rate of EUR€1.00 =  
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26 195 JPN¥130 (as of July 2017). We divided the participants into quartiles  
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28 196 according to their equivalised income: Q1 (men < €12,041; women < €9,518),  
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30 197 Q2 (men €12,041–€15,543; women €9,518–€14,957), Q3 (men €15,544–  
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32 198 €24,426; women €14,958–€21,153), and Q4 (men ≥ €24,420; women ≥  
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34 199 €21,154).  
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### 40 201 **Measures and definitions**

41  
42 202 Instrumental activities of daily living (IADL) were assessed using the Tokyo  
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44 203 Metropolitan Institute of Gerontology Index of Competence,<sup>27</sup> and the results  
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46 204 were classified as high IADL (5 points) or low IADL (≤ 4 points). The  
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48 205 evaluation of depression was made using the Geriatric Depression Scale  
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50 206 (GDS).<sup>28</sup> The GDS is a 15-item questionnaire, with a score range of 1–15.<sup>29</sup> In  
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52 207 accord with previous studies,<sup>30 31</sup> participants were classified into two  
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5 208 groups: not depressed (GDS < 5) and depressed (GDS ≥ 5).  
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7 209 The frequency of meeting friends and acquaintances was measured  
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9 210 with a question comprising six categories (≥ 4 days/week, 2–3 days/week, 1  
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11 211 day/week, 1–3 days/month, several times/year, and none). We divided the  
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14 212 respondents into three groups: < 2 times/week, ≥ 2 times/week, or missing.  
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16 213 Participants were also presented with 14 different civic associations  
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18 214 and social groups, and asked which ones they were regularly involved with.  
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20 215 This provided a measurement, divided into six categories, for each type of  
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22 216 social group (≥ 4 days/week, 2–3 days/week, 1 day/week, 1–3 days/month,  
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24 217 several times/year, no participation). The total number of types of groups in  
25  
26 218 which each respondent participated at least several times per year was  
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28 219 tallied, and respondents were divided into four groups: 0, 1 or 2, ≥ 3, or  
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30 220 missing.  
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34 221 Family structure was assessed through two questions: one regarding  
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36 222 the number of people living together, and the other regarding marital status.  
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38 223 The marital status question provided five answer categories (married,  
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40 224 bereaved, divorced, never married, and other). Based on the responses to  
41  
42 225 these questions, we divided participants into four groups: alone, ≥ 2 without  
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44 226 partner, ≥ 2 with partner, or ≥ 2 with no information about marital status.  
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## 49 228 **Statistical analysis**

50  
51 229 We used binomial regression analyses to derive prevalence ratios (PRs)  
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53 230 based on 95% confidence intervals (CIs) for “laughing almost every day”  
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5 231 according to equivalised income. In accord with recent statistical  
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7 232 recommendations, we calculated PRs rather than odds ratios because the  
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9 233 prevalence of laughing almost every day was not rare ( $\geq 10\%$ ).<sup>32</sup> We used the  
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11 234 SAS version 9.4 statistical software package. In each model, the lowest  
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14 235 equivalised income category was set as the reference category. A “missing”  
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16 236 category was used in analysis to account for missing values in response to  
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18 237 questions. In Model 1, we controlled for age (65–69, 70–74, 75–79, 80–84,  $\geq$   
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20 238 85 years), IADL (high IADL, low IADL, or missing), and depression (no  
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22 239 depression, depression, or missing). Model 2 was adjusted for the covariates  
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25 240 in Model 1 plus social relationship-related factors such as the frequency of  
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27 241 meeting friends (< 2 times/week,  $\geq 2$  times/week, or missing) and number of  
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29 242 social groups (0, 1 or 2,  $\geq 3$ , or missing), and family structure (alone,  $\geq 2$   
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31 243 without partner,  $\geq 2$  with partner, or  $\geq 2$  with n60 information about marital  
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33 244 status). Additionally, to confirm the robustness of our results we also carried  
34  
35 245 out the same series of analyses using the sample excluding subjects with  
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37 246 depression (GDS  $\geq 5$ ) and missing information about depression. It should be  
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39 247 noted that the results in this study design may be affected by bias related to  
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41 248 depression because people with depression might seldom laugh and  
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43 249 depression influences employment and income.  
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48 250 To assess whether the prevalence of laughter associated with  
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50 251 equivalised income differed between social relationships (frequency of  
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52 252 meeting friends or number of social groups) or family structure, we  
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54 253 conducted an analysis in which participants were cross-classified into groups  
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254 according to their equivalised income. The lowest equivalised income group  
 255 was treated with each inadequate social relationship (meeting friends less  
 256 frequently or non-participation in an organization) or living alone as  
 257 reference categories. The *p* value for the trend was calculated by categorical  
 258 variables conducted from binomial regression model adjusting above  
 259 covariates. All *p* values were two-tailed, and differences of < 0.05 were  
 260 accepted as statistically significant.

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## 262 RESULTS

### 263 Baseline characteristics by equivalised income

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

Table 1. Baseline characteristics by categories of household income

	Equivalised income*				<i>p</i> value <sup>†</sup>
	Q1	Q2	Q3	Q4	

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 <sup>‡</sup> )	74.3 (6.0)	73.3 (5.8)	73.2 (6.0)	72.8 (6.1)	<0.0001
IADL <sup>‡</sup> (%)					
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	

275

(Cont Table 1)

Equivalised income

Q1	Q2	Q3	Q4	<i>p</i> value
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5	Women					
6	Number of participants	2688	2169	2863	2731	
7	Frequency of laughing (%)					
8	Almost everyday	41.9	40.5	51.1	55.2	<0.0001
9	1-5 times/week	38.0	41.0	37.9	35.1	
10	1-3 times/month	11.4	12.2	7.7	6.6	
11	<1 time/month	8.7	6.3	3.4	3.1	
12	Age (years) (%)					
13	65-69	23.0	28.3	33.7	34.5	<0.0001
14	70-74	30.4	31.2	32.3	29.6	
15	75-80	25.3	21.5	20.8	17.7	
16	80-85	14.5	13.1	9.4	12.5	
17	≥85	6.9	5.9	3.8	5.8	
18	Mean age (years) (SD)	74.6(6.1)	73.8(6.0)	72.8(5.7)	73.2(6.3)	<0.0001
19	IADL (%)					
20	High IADL	80.7	86.7	90.3	88.4	<0.0001
21	Low IADL	15.1	10.5	7.7	9.0	
22	Missing	4.3	2.8	2.0	2.7	
23	Frequency of meeting friends (%)					
24	<2 time/week	53.5	55.2	54.4	54.0	<0.0001
25	≥2 time/week	40.0	40.6	42.3	43.4	
26	Missing	6.5	4.2	3.3	2.7	
27	Number of social groups (%)					
28	0	26.1	23.1	18.6	19.4	<0.0001
29	1 or 2	25.7	26.1	28.9	26.9	
30	≥3	25.6	34.1	38.8	41.8	
31	Missing	22.7	16.7	13.7	11.9	
32	Family structure (%)					
33	Alone	17.6	39.5	9.8	11.4	<0.0001
34	≥2 without partner	27.1	12.3	15.3	22.6	
35	≥2 with partner	51.8	47.2	74.2	65.4	
36	≥2 with no information about marital status	3.5	1.1	0.7	0.6	
37	Depression (%)					
38	No depression	52.0	57.3	68.2	73.0	<0.0001
39	Depression	28.1	24.9	17.5	13.6	
40	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.

## 276 **Equivalised income and frequency of laughter**

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

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5 278 laughter according to equivalised income. Equivalised income was  
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7 279 significantly associated with frequency of laughter among both men and  
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9 280 women. The PRs tended to become greater as equivalised income increased.  
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11 281 Compared with those in the lowest equivalised income group, the  
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13 282 age-adjusted PRs for laughing almost every day for participants in the  
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15 283 highest equivalised income group were greater: 1.43 (95% CI, 1.33–1.54) for  
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17 284 men, and 1.30 (1.23–1.38) for women. After adjusting for age, IADL,  
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19 285 depression, frequency of meeting friends, number of social groups, and  
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21 286 family structure, the PRs decreased to 1.21 for men and 1.14 for women in  
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23 287 this group; however, the association remained significant.  
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Table 2. Prevalence ratios and 95% confidence intervals of frequency of laughing according to equivalised income.

	Equivalised income*				<i>p</i> for trend <sup>†</sup>
	Q1	Q2	Q3	Q4	
<b>Men</b>					
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 <sup>‡</sup>	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 <sup>§</sup>	reference	1.03(0.96-1.11)	1.12(1.05-1.21)	1.21(1.13-1.30)	<0.0001
<b>Women</b>					
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).

<sup>†</sup> *p* for trend was calculated by categorical variables.

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

<sup>§</sup> 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).

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5 288 Table 3 shows the results of our binomial regression models for  
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7 289 frequency of laughter according to equivalised income, using a sample that  
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9 290 excluded participants with depression ( $GDS \geq 5$ ) and those for whom  
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11 291 information about depression was missing. The associations remained  
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14 292 unchanged after excluding these participants. The PRs of laughing almost  
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16 293 every day for men and women with the highest equivalised income were 1.23  
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18 294 (95% CI, 1.13–1.34) and 1.10 (1.04–1.17), respectively.  
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Table 3. Prevalence ratios and 95% confidence intervals of frequency of laughing according to equivalised income without depression.

	Equivalised income <sup>*</sup>				<i>p</i> for trend <sup>†</sup>
	Q1	Q2	Q3	Q4	
<b>Men</b>					
No. of participants with no depression	1296	1587	1958	1943	
No. of participants laughing almost everyday	499	634	875	945	
Multi-adjusted <sup>‡</sup>	reference	1.01(0.93-1.11)	1.15(1.06-1.25)	1.23(1.13-1.34)	<0.0001
<b>Women</b>					
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

<sup>\*</sup> 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).

<sup>†</sup> *p* for trend was calculated by categorical variables.

<sup>‡</sup> 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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5 296 **Frequency of laughter according to equivalised income, by social**  
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7 297 **relationships and family structures**  
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9 298 Figure 1, 2, and 3 show the results of the interactions between income and  
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11 299 laughing almost every day, by social relationships and family structure.

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14 300 While we observed no significant interactions ( $p$  for interaction: frequency of  
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16 301 meeting friends = 0.73 for men; number of social groups = 0.20 for men, 0.11  
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18 302 for women; family structure = 0.86 for men, 0.52 for women) without  
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21 303 frequency of meeting friends in women, we found that inadequate social  
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23 304 relationships (particularly when indicated by meeting friends less frequently  
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25 305 or living alone) were associated with a lower frequency of laughter. The PR  
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27 306 for men in the lowest equivalised income group who met more often with  
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29 307 friends was 1.39 (95% CI: 1.24–1.56), while for men in the highest equivalent  
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31 308 income group who met less frequently with friends, the PR was 1.29 (1.17–  
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33 309 1.42). The PR for women in the lowest equivalised income group who met  
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35 310 more often with friends was 1.28 (1.17–1.40), while for women in the highest  
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37 311 equivalised income group who met with friends less frequently, the PR was  
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39 312 1.23 (1.13–1.33). In terms of family structure, the PR for men in the lowest  
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41 313 equivalised income group who lived with  $\geq 2$  people with a partner was 1.67  
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43 314 (95% CI: 1.28–2.17), while for men in the highest equivalent income group  
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45 315 who lived alone, the PR was 1.31 (0.92–1.87). The PR for women in the  
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47 316 lowest equivalised income group who lived with  $\geq 2$  people with a partner was  
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49 317 1.45 (1.25–1.68), while for women in the highest equivalised income group  
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51 318 who lived alone, the PR was 1.10 (0.90–1.34). Among women, but not men,  
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5 319 we observed significant associations between equivalised income and the  
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7 320 frequency of laughter if the participant had inadequate social relationships,  
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9 321 indicated by meeting friends less frequently or non-participation in  
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11 322 organizations. However, we observed no statistically significant associations  
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13 323 between equivalised income and frequency of laughter if the women had  
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15 324 richer social relationships, indicated by meeting friends more frequently or  
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17 325 participating in more social groups.  
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## 25 328 **DISCUSSION**

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27 329 The current study examined and described the relationship between  
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29 330 equivalised income and the frequency of laughter. In addition, we examined the  
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31 331 impact of social relationship-related factors on the association between  
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33 332 equivalised income and the frequency of laughter. We found a positive  
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35 333 association between equivalised income and frequency of laughter among  
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37 334 both men and women. Importantly, this association differed depending on  
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39 335 family structure and the frequency of meeting friends. Among women  
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41 336 participants, this association was weaker if they met friends frequently or  
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43 337 participated in more social groups. However, we did not find a similar trend  
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45 338 among participating men. Therefore, social relationships and family  
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47 339 structure may modify the association between equivalised income and the  
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49 340 frequency of laughter.  
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54 341 The present study showed an association between equivalised  
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5 342 income and the frequency of laughter, while previous studies have shown  
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7 343 that depression decreases the frequency of laughter<sup>33</sup> and that household  
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9 344 income influences mental health.<sup>34</sup> Because our results could potentially  
10  
11 345 have reflected bias related to participant depression, we conducted further  
12  
13 346 analyses after excluding participants with depression. However, this did not  
14  
15 347 change the tendency exhibited in the results. We believe that this result  
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17 348 supports the original prediction of this study that the frequency of laughter  
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19 349 would be associated with income, regardless of depression.  
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23 350 Previous studies, however, have indicated that people with more  
24  
25 351 income tend to have more opportunity to come into contact with others.<sup>35</sup>  
26  
27 352 Laughter has been found to occur most frequently during casual  
28  
29 353 conversation.<sup>18</sup> Coming into contact with others is considered to be important  
30  
31 354 to subjective well-being.<sup>36</sup> Thus, it is possible that wealthier people laugh  
32  
33 355 more frequently because they have more opportunities to meet others.  
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35 356 Therefore, we examined the influence of social relationship factors and  
36  
37 357 family structure on the relationship between equivalised income and the  
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39 358 frequency of laughter.  
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43 359 In a cross-classification analysis of equivalised income and frequency  
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45 360 of meeting friends, we found that meeting friends was associated with  
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47 361 frequency of laughter for both men and women. A previous study of older  
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49 362 Japanese participants indicated that friendship was important for subjective  
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51 363 well-being,<sup>36</sup> in accord with the notion that friendship decreases loneliness  
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53 364 and anxiety, and increases happiness.<sup>37</sup> These findings suggest that meeting  
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5 365 friends leads to more opportunities for laughter.  
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7 366 In a cross-classification analysis of equivalised income and number of  
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9 367 social groups, we observed no significant associations between participating  
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11 368 in social groups and the frequency of laughter among men in Q1–3; however,  
12  
13 369 the PRs of men in Q4 tended to become greater as their number of social  
14  
15 370 groups increased. Previous research has suggested that relative poverty  
16  
17 371 might be a risk factor for poor emotional well-being among older men;<sup>38</sup> for  
18  
19 372 an older man, relative poverty had a bigger impact on well-being than social  
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21 373 isolation. In the present study, relatively poor men (Q1–3) laughed less  
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23 374 frequently regardless of the number of social groups in which they  
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25 375 participated. In contrast, PRs were higher for women in wealthier groups  
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27 376 (Q3 and Q4) and/or those participating in three or more social groups. For  
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29 377 older women, interpersonal relationships might have a strong protective or  
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31 378 buffering effect for psychosocial stress.<sup>38</sup> The current results revealed that  
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33 379 women with three or more social groups laughed frequently even if they had  
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35 380 a low equivalised income. In the evolution of human societies, laughing is  
36  
37 381 thought to function as an essential behavioral mechanism not only for  
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39 382 expression of emotion, but also for the maintenance of social bonds.<sup>25</sup> Larson  
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41 383 reviewed research from the past 30 years examining the subjective  
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43 384 well-being of older Americans,<sup>39</sup> and found a positive correlation between  
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45 385 social activity and well-being.  
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52 386 In our cross-classification analysis on equivalised income and family  
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54 387 structure, we found a positive association between the number of family  
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5 388 members and the frequency of laughter for both men and women. However,  
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7 389 for men without a partner, this association was not evident. Particularly for  
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9 390 men, the presence of a partner has been found to have a stronger influence  
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11 391 than other relationships.<sup>40</sup> The present results revealed that low-income  
12  
13 392 men living with a partner laughed more frequently than unmarried wealthy  
14  
15 393 men. For women, however, living with another person was important for  
16  
17 394 laughter, whether that person was their partner or not. This difference may  
18  
19 395 be related to the finding that women's satisfaction with their partner and  
20  
21 396 their marital relationship is markedly lower than the partner- and marital  
22  
23 397 relationship-related satisfaction of men in Japan.<sup>41</sup> Indeed, we found that  
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25 398 factors relating to social relationships were associated with the frequency of  
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27 399 laughter. This finding supports our hypothesis that wealthier people laugh  
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29 400 more frequently than poorer people because they have more opportunities to  
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31 401 come into contact with others.  
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36 402 The current findings have two main implications for public health.  
37  
38 403 First, given the multiple positive effects of laughing on certain aspects of  
39  
40 404 health,<sup>6-8 10 13-14</sup> income redistribution policies may have additional benefits  
41  
42 405 for impoverished older people. That is, increased income may improve not  
43  
44 406 only material conditions but also psychosocial health and cognitive ability.  
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46 407 Second, while income redistribution policy reform may take a long time to  
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48 408 implement, public health interventions that provide opportunities for more  
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50 409 social interactions in local settings may help reduce the deprivation of  
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52 410 laughter among low-income populations.  
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5 411 To the best of our knowledge, this is the first study to report significant  
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7 412 relationships among equivalised income, factors relating to social  
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9 413 relationships and family structure, and the frequency of laughter. However,  
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11 414 there are several potential limitations that should be considered. First,  
12  
13 415 because the present study design was cross-sectional, we could not  
14  
15 416 demonstrate causal relationships. However, longitudinal analyses of our  
16  
17 417 cohort data can be used to address these issues in future research. Second,  
18  
19 418 the results may have been affected by residual confounders such as the rates  
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21 419 of watching television, reading books, or other potential confounding factors  
22  
23 420 for which we did not collect data. Third, it might be that people might not  
24  
25 421 remember frequency of laughter correctly. However, the item of laughter has  
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27 422 been used in previous epidemiological studies in Japan.<sup>14 26</sup> The 1-year test–  
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29 423 retest reliability of the item was assessed in a previous study in 2,680 men  
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31 424 and women aged 30–74 years, though the lowest category in frequency of  
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33 425 laughter is different between that study (almost never) and current study  
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35 426 (<1 day/month). The Spearman correlation coefficient was found to be 0.61 ( $p$   
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37 427 < 0.001).<sup>42</sup> Forth, the use of self-reported questionnaires may have  
38  
39 428 introduced reporting bias regarding income and the frequency of laughter.  
40  
41 429 For example, some participants may not know or accurately remember their  
42  
43 430 income or their frequency of laughter. We consider these biases to represent  
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45 431 cases of non-differential misclassification, which would not be expected to be  
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47 432 dependent upon each other. However, this misclassification weakens the true  
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49 433 association, biasing the data towards the null hypothesis. Fifth, we did not  
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5 434 take the diversity of types of laughter into account. There are many different  
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7 435 types of laughter (e.g., laughter related to joy, taunting, or tickling), each of  
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9 436 which are thought to play distinct roles in social cognition.<sup>43 44</sup> One study  
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11 437 reported three different types of laughter: “laughter of pleasure,” “laughter of  
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13 438 social obligation,” and “laughter as relief from tension”.<sup>45</sup> “Laughter of  
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15 439 pleasure” is an expression of pleasant emotions. “Laughter of social  
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17 440 obligation” occurs consciously, and is a way of communicating in interaction  
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19 441 with others. “Laughter as relief from tension” occurs when strain dissipates  
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21 442 or is removed. Further research is required to consider these differences in  
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23 443 laughter relative to equivalised income.  
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## 30 445 **CONCLUSION**

31  
32 446 In this study, we demonstrated a relationship between equivalised income  
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34 447 and the frequency of laughter. Additionally, we found an association between  
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36 448 frequency of laughter and factors relating to social relationships,  
37  
38 449 particularly family structure and frequency of meeting friends. We suggest  
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40 450 that people with higher incomes may experience improved health through a  
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42 451 higher frequency of laughter. Future research should examine  
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44 452 laughter-related health improvements among older people.  
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#### 41 474 **Conflict of Interest**

42  
43 475 This was not an industry supported study. The authors declare that they  
44  
45 476 have no conflicts of interest.  
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48 477

#### 49 478 **Authors' contributions**

50  
51 479 Yurika Imai, Masato Nagai and Tetsuya Ohira contributed to the design of  
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5 480 the study. Naoki Kondo, Kokoro Shirai and Katsunori Kondo participated in  
6  
7 481 data collection. Yurika Imai and Masato Nagai participated in data analysis.  
8  
9 482 Yurika Imai, Masato Nagai and Tetsuya Ohira participated in writing the  
10  
11 483 report. All authors participated in critical revision of the manuscript and  
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13  
14 484 approved the final version of the report for submission.  
15

485

#### 486 **Ethical approval**

487 The JAGES protocol was reviewed and approved by the Ethics Committee on  
488 Research of Human Subjects at Nihon Fukushi University (Approval No.  
489 10-05). Written informed consent was assumed with voluntary return of the  
490 questionnaire.  
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#### 492 **Data sharing**

493 No additional data are available.  
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625 **Figure legend**

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

634

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

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5 641 missing). The lowest equivalised income and non-participation in social  
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7 642 group category was set as the reference category.  
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11  
12 644 Figure 3. Adjusted prevalence ratios (PRs) for laughing almost every day in  
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14 645 each group according to equivalised income and family structure in men (a)  
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16 646 and women (b) were calculated using binomial regression analysis. PRs were  
17  
18 647 adjusted for age (5-year category), instrumental activities of daily living  
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20 648 (IADL; independent, not independent, missing), and depression (no  
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22 649 depression, depression, missing). The lowest equivalised income and living  
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24 650 alone category was set as the reference category.  
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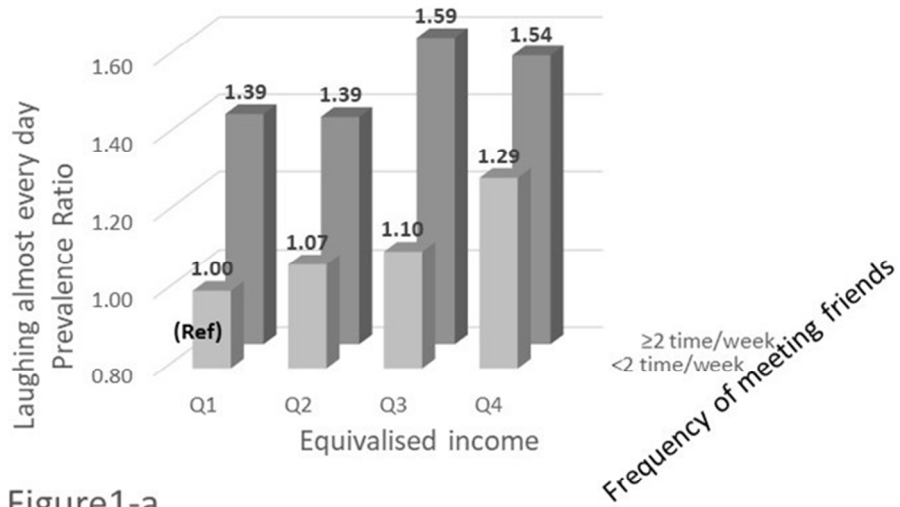


Figure1-a

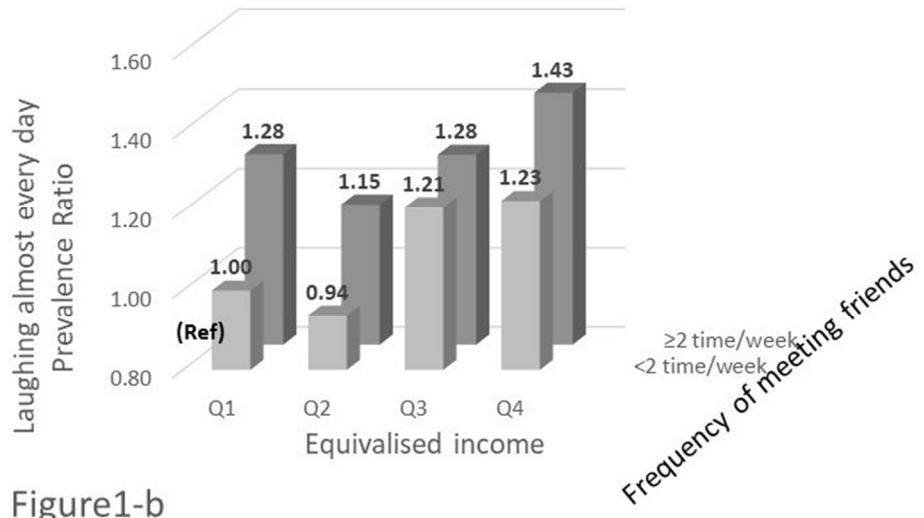


Figure1-b

62x75mm (300 x 300 DPI)

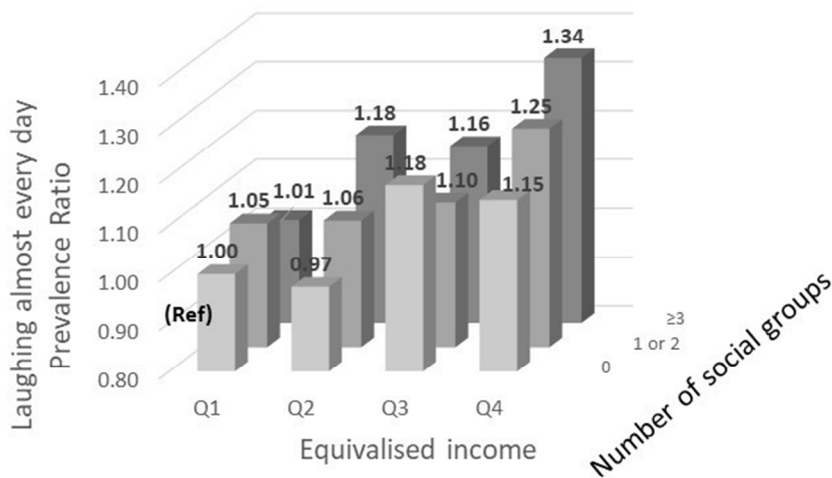


Figure2-a

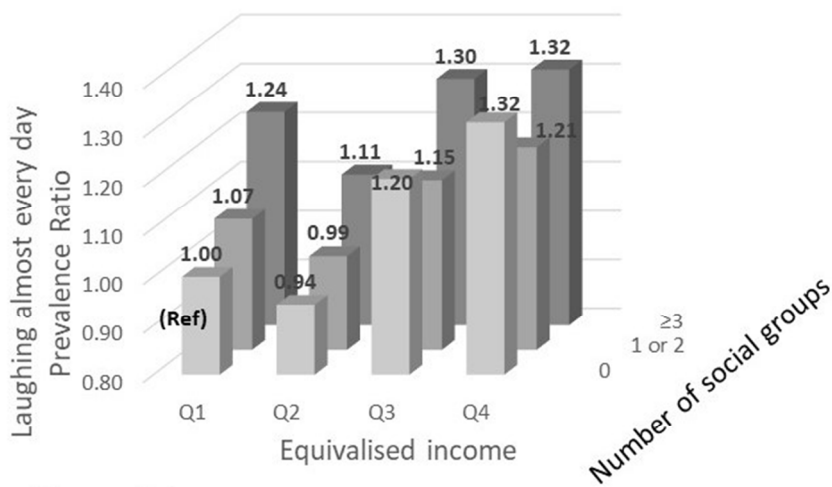


Figure2-b

60x76mm (300 x 300 DPI)

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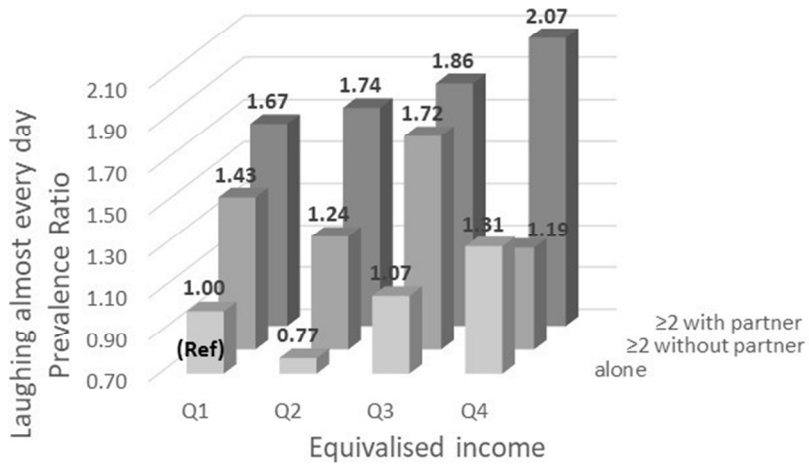


Figure3-a

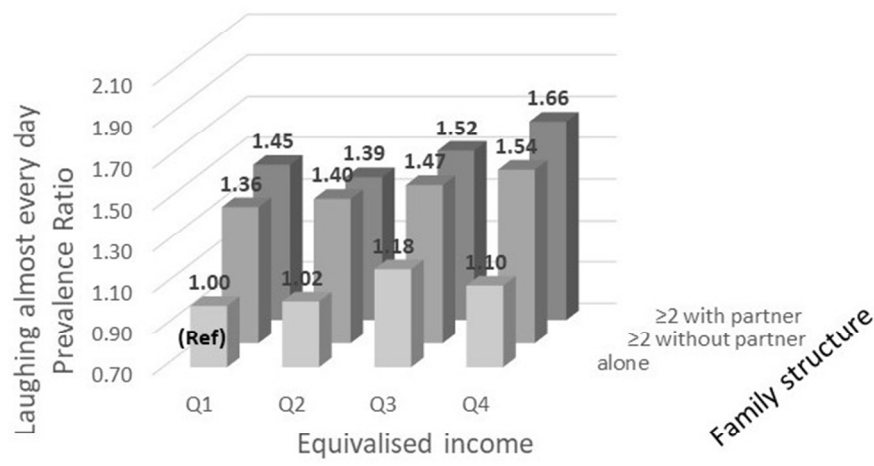


Figure3-b

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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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	
<b>Other information</b>			
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](http://www.strobe-statement.org).