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## Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-024609
Article Type:	Research
Date Submitted by the Author:	05-Jun-2018
Complete List of Authors:	Amemiya, Airi; University of Tokyo School of Public Health, Department of Health Economics and Epidemiology Research Fujiwara, Takeo; Tokyo Medical and Dental University, Department of Global Health Promotion Shirai, Kokoro Kondo, Katsunori; Chiba University, Center for Preventive Medical Science Oksanen, Tuula; Finnish Institute of Occupational Health Pentti, Jaana; University of Turku, Department of Public Health Vahtera, Jussi; Työterveyslaitos
Keywords:	Adverse childhood experience, Life-course approach, International comparison study, Japan, Finland

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Manuscripts

**Title****Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland**

Airi Amemiya<sup>1</sup>, Takeo Fujiwara\*<sup>2</sup>, Kokoro Shirai<sup>3</sup>, Katsunori Kondo<sup>4,5,6</sup>, Tuula

Oksanen<sup>7</sup>, Jaana Pentti<sup>8</sup>, Jussi Vahtera<sup>8,9</sup>

1. Department of Social Medicine, National Research Institute for Child Health and Development, 2-10-1 Okura, Setagaya-ku, Tokyo 157-8535, Japan

2. Department of Global Health Promotion, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8510, Japan

3. Department of Human Sciences, School of Law and Letters, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Nakagami-gun, Okinawa 903-0213, Japan

4. Center for Preventive Medical Sciences, Chiba University, 1-8-1, Inohana, Chuo Ward, Chiba-shi, Chiba, 260-0856, Japan

5. Center for Well-being and Society, Nihon Fukushi University, Okuda, Mihama-cho, Chita-gun, Aichi 470-3295, Japan

6. Department of Gerontology and Evaluation Study, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, 7-430 Morioka-cho, Obu City,

1  
2  
3  
4  
5  
6 Aichi 474-8511, Japan  
7

8  
9 7. Finnish Institute of Occupational Health, FI-20032 TYÖTERVEYSLAITOS, Turku,  
10  
11 Finland  
12

13  
14 8. Department of Public Health, University of Turku, 20014 Turun yliopisto, Turku,  
15  
16 Finland  
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18  
19 9. Turku University Hospital, Kiinamyllynkatu 4–8, Turku, Finland  
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25  
26 **Corresponding author:**

27  
28 Takeo Fujiwara  
29

30  
31 Tel: +81-3-3417-2663  
32

33  
34 Email: [fujiwara.hlth@tmd.ac.jp](mailto:fujiwara.hlth@tmd.ac.jp)  
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40 **Word count: 2,433**  
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**ABSTRACT**

**Objective:** We aimed to examine associations between adverse childhood experiences (ACEs) and adult diseases in older adults in Japan and Finland.

**Design:** Cross-sectional comparative study.

**Setting:** Data were evaluated from a gerontological study in Japan and two public health studies in Finland.

**Participants:** A total of 13,123 adults from Japan (mean age, 69.5 years) and 10,353 adults (mean age, 64.4 years) were included in this study. Logistic regression was used to examine the associations of each, any, and the number of ACEs (parental divorce, fear in the family, and poverty in childhood) with poor self-rated health, cancer, heart disease or stroke, diabetes mellitus, smoking, and body mass index. Models were adjusted for sex, age, education, marital status, and working status.

**Results:** Half of the respondents in Japan and 37% of those in Finland reported having experienced at least one of the measured ACEs. Number of ACEs was associated with self-rated health in both countries, and the point estimates were similar (odds ratio [OR]: 1.35, 95% confidence interval [CI]: 1.25-1.46 in Japan; OR: 1.34, 95% CI: 1.27-1.41 in Finland). Number of ACEs was associated with the prevalence of cancer (OR: 1.20, 95% CI: 1.04-1.38 in Japan; OR: 1.13, 95% CI: 0.99-1.28 in Finland), heart

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6 disease or stroke (OR: 1.10, 95% CI: 1.01-1.20 in Japan; OR 1.11, 95% CI: 0.98-1.25:  
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8 in Finland), diabetes mellitus (OR: 1.08, 95% CI: 0.995-1.17 in Japan; OR 1.17, 95%  
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10 CI: 1.06-1.28 in Finland), current smoking (OR: 1.11, 95% CI: 1.02-1.22 in Japan; OR:  
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12 1.15, 95% CI: 1.06-1.26 in Finland), and an increase in body mass index in both  
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14 countries.  
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20 **Conclusions:** Associations between ACEs and self-rated health, adult diseases, and  
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22 health behaviours were similar in Japan and Finland. This suggests that the impact of  
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24 ACEs on health is noteworthy and consistent across cultural and social environments.  
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### 31 **Strength and limitations of this study**

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- 34 • This is an international comparative study that investigated the impact of adverse  
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36 childhood experiences on the health of older adults in Japan and Finland.
- 37 • We used data from the Japan Gerontological Evaluation Study from Japan, and the  
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39 Finnish Public Sector Study and Health and Social Support Study from Finland.
- 40 • The results suggest that ACEs have a remarkable impact on health, a finding that is  
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42 consistent across cultural and social environments.  
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## INTRODUCTION

Adverse childhood experiences (ACEs), including long-term financial difficulties, parental divorce, and fear of a family member,[1] are increasingly recognised as determinants of unhealthy behaviours (e.g., obesity,[1, 2] alcohol consumption, smoking, and lower levels of physical activity[1]), adult diseases (e.g., cardiovascular disease, diabetes,[1, 3] stroke, cancer,[1] and depression[1, 2]), and even early death.[4] However, it is not known whether the impact of ACEs on adult health varies by country, although the pathways linking childhood adversities with adult health likely depend on cultural or social environments.[5–7] Therefore, international comparisons of countries with different cultural and/or social environments in childhood but similar welfare state regimes may provide further understanding of the mechanisms underlying ACEs and adult health.

Japan and Finland are both members of the Organization for Economic Co-operation and Development (OECD), employ a universal healthcare system,[8, 9] and provide free education to those aged 6 to 15 years.[10] According to the World Happiness Report, the level of social support received (as measured by having someone to count on in times of trouble) is relatively high in both countries (92.3% and 94.8% in 2015, in Japan and Finland, respectively).[11] However, the two countries differ in

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6 terms of equality (e.g., the Gini coefficient was 0.33 in Japan [2012] and 0.26 in Finland  
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8 [2015]). Japan ranked 22<sup>th</sup> and Finland ranked 7<sup>th</sup>, in terms of equality, out of 37 OECD  
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10 countries in 2015.[12]  
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14 The purpose of this study was, therefore, to examine the associations and  
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16 related risk factors between ACEs and adult diseases in older adults in Japan and  
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18 Finland.  
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## 25 **METHODS**

### 26 **Sample**

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31 The data in this study were collected from surveys conducted among older individuals  
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33 in Finland and Japan. The Japanese data were from the Japan Gerontological Evaluation  
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35 Study (JAGES), which comprises community-dwelling individuals aged 65 years and  
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37 older from 30 municipalities (in 14 municipalities the entire population was surveyed,  
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39 whereas in the remaining 16 municipalities, random sampling was performed) who  
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41 were not eligible to receive benefits from public long-term care insurance services. The  
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43 data used in this study were from participants (n = 137,736, response rate = 71%) aged  
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45 ≥65 years, one-fifth of whom were questioned for information on adverse experiences  
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47 in childhood (n = 25,928) in 2013. Participants with missing data on age, sex, ACEs,  
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6 self-rated health (SRH), body mass index (BMI), and smoking were excluded.  
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9 The Finnish data were drawn from two prospective cohort studies: the Finnish  
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11 Public Sector (FPS) study and the Health and Social Support (HeSSup) study. The FPS  
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13 study included employees representing a wide range of occupations working in 10  
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15 towns and six hospital districts. The FPS data used in this study were derived from  
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17 employed and retired participants in the 2008/2009 survey, and included information on  
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19 self-reported ACEs (n = 42,877, response rate = 69%).<sup>[13]</sup> For this study, all FPS study  
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21 respondents aged  $\geq 60$  years (n = 7169) were selected. The HeSSup study targeted a  
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23 sample representative of the Finnish population in four age groups (20–24, 30–34, 40–  
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25 44, and 50–54 years), in 1998.<sup>[14]</sup> In the 2012 follow-up survey, information on  
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27 self-reported ACEs was obtained from 11,924 participants (response rate = 78%). Of  
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29 them, those in the oldest age group (64–68 years) were selected (n = 3184). The two  
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31 Finnish cohorts were pooled. The studies together included 13,123 (6,214 men and  
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33 6,909 women) participants from Japan and 10,353 (3,201 men and 7,152 women)  
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35 participants from Finland.  
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48 The JAGES was approved by the Ethics Committee for Research on Human  
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50 Subjects at Nihon Fukushi University, Japan (No. 10–05) and the Ethics Committee for  
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52 Medical Research at the University of Tokyo (No. 10555). The FPS study was approved  
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6 by the Ethics Committee of the Helsinki and Uusimaa Hospital District and HeSSup  
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9 study by the joint Ethics Committee of the University of Turku and the Turku  
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11 University Central Hospital.  
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### 17 **Measurement of adverse childhood experiences**

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20 The questions related to ACEs were somewhat different between the three studies, but  
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22 the variables were harmonised. In short, we assessed three ACEs: (1) parental divorce  
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24 (the FPS study, HeSSup study, and JAGES), (2) fear of a family member (FPS and  
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26 HeSSup studies)/witness of domestic violence or physical abuse (JAGES), and (3)  
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28 financial difficulties in the family (FPS study, HeSSup study, and JAGES).  
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34 In the JAGES, we assessed ACEs using four questions modified from Felitti's  
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36 original ACE study[1] and the World Mental Health survey in Japan.[15] Respondents  
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38 were asked if they had experienced the following adversities in their childhood (yes/no):  
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40 parents' divorce/separation, financial difficulties in the family, being witness to  
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42 domestic violence, or physical abuse. We categorised those who responded having  
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44 experienced "being witness to domestic violence" and/or "physical abuse" as having  
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46 "frequent fear in a family". These ACEs measures have been shown to predict the  
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48 number of remaining teeth[16] and higher functional limitation in Japan.[17] In the FPS  
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6 and HeSSup studies, we assessed ACEs using three survey questions modified from  
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8 Statistics Finland's Survey of Living Conditions.[18] Respondents were asked whether  
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10 they had experienced the following adversities: parent's divorce/separation, long-term  
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12 financial difficulties in the family, and frequent fear of a family member (the response  
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14 categories "no", "yes", and "cannot say" were coded as missing variables), and the  
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16 findings have been used in other studies to predict the presence of coronary heart  
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18 disease,[19] depression,[19] and non-adherence to statin therapy.[7]  
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25 For the present study, the three ACEs were analysed separately and also as a  
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27 summary variable (0 to 3). For the summary variable, missing data were coded as not  
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29 having that specific ACE.  
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### 37 **Measurement of adult health and health behaviours**

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39 Questions on adult health and health behaviours were somewhat different between the  
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41 countries. In the JAGES, SRH was measured using the question: "How do you feel  
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43 about your current health status: excellent, good, fair, or poor?" Responses were  
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45 recoded into dichotomous response variables (fair/poor as 0, and excellent/good as 1). A  
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47 history of being diagnosed with cancer, heart diseases or stroke, or diabetes mellitus was  
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49 self-reported (response categories: "yes" and "no"). BMI was calculated as participants'  
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6 self-reported weight in kilograms divided by height in meters squared. The smoking  
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8 status (current, former, or never) was based on replies to survey questionnaires.  
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11 In the FPS and HeSSup studies, SRH was measured through the question:  
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13 “How is your current health status?” with five response categories (from 1 [poor] to 5  
14 [excellent]). The responses “moderate”, “good”, and “excellent” were categorised as  
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16 good (1), and the other response options as poor (0). Information on cancer was derived  
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18 from the National Cancer Registry, and prevalent cardiovascular disease (heart disease  
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20 or stroke) and diabetes mellitus were defined based on the special reimbursement for the  
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22 medication for these diseases, as obtained from the Social Insurance Institution of  
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24 Finland.[20] BMI was calculated from self-reported weight and height. The smoking  
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26 status (current, former, and never) was based on survey responses.  
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#### 40 **Covariates**

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42 Education was divided into three levels: (i) 9 years or less, referring to a comprehensive  
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44 school education in Finland and junior high school education in Japan, (ii) 9–12 years,  
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46 describing post-compulsory secondary general academic and vocational education in  
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48 Finland and high school or technical college education in Japan, and (iii) 12 years or  
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50 more, referring to a university degree in both countries. Marital status was divided into  
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6 four categories: (i) single, never married and non-cohabiting, (ii) widowed, (iii)  
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8 divorced, and (iv) married or cohabiting with a partner. Working status was divided into  
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10 two categories: (i) working and (ii) retired or never worked (Japan). Missing values  
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12 were treated as dummy variables.  
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### 20 **Statistical analysis**

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22 Logistic regression analysis was performed to examine the association of each ACE,  
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24 any ACE, and the total number of ACEs with health outcomes. Linear regression  
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26 analysis was used for BMI. Multinomial logistic regression was used for smoking status.  
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28 Model 1 was adjusted for age and sex. Model 2 was further adjusted for education,  
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30 marital status, and working status.  
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37 The odds ratios (ORs) and their 95% confidence intervals (95% CIs) were  
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39 calculated. Statistical analysis was performed using Stata (ver. 13.1; StataCorp, College  
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41 Station, TX, USA).  
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### 48 **RESULTS**

49  
50 Table 1 shows the distribution of the variables for each country. The prevalence rates of  
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52 parental divorce, fear in the family, and childhood poverty were 3%, 9%, and 47%,  
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6 respectively, in Japan. In Finland, these proportions were 9%, 13%, and 29%,  
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9 respectively. Half of the respondents in Japan and 37% of those in Finland reported  
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12 having experienced at least one ACE. The mean age of the participants and the  
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15 proportion of men were higher in Japan than in Finland.  
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19 Table 1. Characteristics of the study participants  
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	Japan (JAGES) (N = 13,123)		Finland (pooled FPS and HeSSup studies) (N = 10,353)	
	N or mean	% or SD	N or mean	% or SD
21 Parental divorce		336 2.6	958	9.3
22 Fear in family		1195 9.1	1348	13.0
23 Childhood poverty		6135 46.8	3013	29.1
24 Any adverse childhood experience		6561 50.0	3852	37.2
25 Total number of adverse childhood experiences	0	6562 50.0	6501	62.8
26	1	5517 42.0	2634	25.4
27	2	983 7.5	969	9.4
28	3	61 0.5	249	2.4
29 Age		69.5 2.8	64.4	2.9
30 Sex	male	6214 47.4	3201	30.9
31	female	6909 52.7	7152	69.1
32 SRH	poor/fair	1770 13.5	3780	36.5
33 Cancer		460 3.5	388	3.8
34	missing		54	0.5

Heart disease or stroke		1353	10.3	466	4.5
	missing			54	0.5
Diabetes mellitus		1738	13.2	714	6.9
	missing			54	0.5
BMI mean		23.0	3.1	26.7	4.4
Smoking	never	9221	70.3	6973	67.4
	former	2221	16.9	2444	23.6
	current	1681	12.8	936	9.0
Education	<9 years	4395	33.5	1868	18.0
	10-12 years	5476	41.7	3168	30.6
	12+ years	3103	23.7	5234	50.6
	missing	149	1.1	83	0.8
Marital status	single	326	2.5	574	5.5
	divorced	535	4.1	1414	13.7
	widowed	1606	12.2	741	7.2
	married/cohabit	10441	79.6	7557	73.0
	missing	215	1.6	67	0.7
Working status	not working	8604	65.6	3092	29.9
	working	4062	31.0	7230	69.8
	missing	457	3.5	31	0.3

JAGES; Japan Gerontological Evaluation Study, FPS; Finnish Public Sector, HeSSup; Health and Social Support, SD; standard deviation, SRH; self-rated health, BMI; body mass index

As for SRH, the rate of “poor or fair” was higher in Finland than in Japan (37%

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6 and 14%, respectively). The prevalence of cancer was similar in both countries;  
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9 however, that of heart disease or stroke and diabetes mellitus was higher in Japan. As  
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11 for BMI, the mean BMI was higher in Finland than in Japan. The distribution of  
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14 smoking status was similar. In the case of socioeconomic status, 50% of the people in  
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17 Finland and a quarter of those in Japan were educated for 12 years or more. Two-thirds  
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20 of the participants in Finland were currently working, whereas two-thirds of those in  
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23 Japan were currently not working.

24  
25 Table 2 shows the association between ACEs and SRH, and diseases (e.g.,  
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28 cancer, heart disease or stroke, and diabetes mellitus). SRH was associated with each  
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31 type of ACE and the number of ACEs, for both countries. Interestingly, the point  
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34 estimates were similar. For example, the OR of the number of ACEs for poor/fair SRH  
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37 was 1.35 (95% CI: 1.25-1.46) in Japan and 1.34 (95% CI: 1.27-1.41) in Finland, after  
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40 adjusting the covariates (Model 2). The ORs of the number of ACEs for cancer, heart  
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43 disease or stroke, and diabetes mellitus were also similar in both studies in Model 2.  
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Table 2. Association between adverse childhood experiences and self-rated health and diseases

		Japan				Finland			
		Model 1		Model 2		Model 1		Model 2	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
SRH (poor/fair)	Parental divorce	<b>1.40</b>	<b>1.05 - 1.86</b>	<b>1.34</b>	<b>1.004 - 1.80</b>	<b>1.37</b>	<b>1.20 - 1.57</b>	<b>1.30</b>	<b>1.13 - 1.49</b>
	Fear in family	<b>1.77</b>	<b>1.52 - 2.05</b>	<b>1.70</b>	<b>1.46 - 1.98</b>	<b>1.65</b>	<b>1.47 - 1.85</b>	<b>1.56</b>	<b>1.39 - 1.76</b>
	Childhood poverty	<b>1.46</b>	<b>1.32 - 1.62</b>	<b>1.32</b>	<b>1.19 - 1.47</b>	<b>1.68</b>	<b>1.54 - 1.83</b>	<b>1.60</b>	<b>1.46 - 1.75</b>
	Any ACE	<b>1.50</b>	<b>1.36 - 1.67</b>	<b>1.37</b>	<b>1.23 - 1.52</b>	<b>1.66</b>	<b>1.53 - 1.80</b>	<b>1.60</b>	<b>1.47 - 1.74</b>
	Number of ACEs	<b>1.43</b>	<b>1.33 - 1.54</b>	<b>1.35</b>	<b>1.25 - 1.46</b>	<b>1.39</b>	<b>1.32 - 1.46</b>	<b>1.34</b>	<b>1.27 - 1.41</b>
Cancer	Parental divorce	1.32	0.78 - 2.24	1.40	0.82 - 2.38	1.16	0.82 - 1.62	1.19	0.84 - 1.67
	Fear in family	0.99	0.72 - 1.37	1.01	0.73 - 1.40	<b>1.36</b>	<b>1.03 - 1.80</b>	<b>1.40</b>	<b>1.06 - 1.85</b>
	Childhood poverty	<b>1.26</b>	<b>1.04 - 1.52</b>	<b>1.31</b>	<b>1.08 - 1.59</b>	1.05	0.84 - 1.32	1.07	0.86 - 1.35
	Any ACE	<b>1.26</b>	<b>1.04 - 1.52</b>	<b>1.31</b>	<b>1.08 - 1.59</b>	1.11	0.90 - 1.36	1.13	0.91 - 1.39
	Number of ACEs	<b>1.16</b>	<b>1.008 - 1.33</b>	<b>1.20</b>	<b>1.04 - 1.38</b>	1.11	0.97 - 1.26	1.13	0.99 - 1.28
Heart disease or stroke	Parental divorce	1.30	0.94 - 1.81	1.26	0.91 - 1.76	0.93	0.66 - 1.32	0.90	0.63 - 1.27
	Fear in family	1.13	0.94 - 1.37	1.10	0.91 - 1.32	1.16	0.88 - 1.54	1.11	0.84 - 1.48
	Childhood poverty	<b>1.16</b>	<b>1.03 - 1.30</b>	1.11	0.99 - 1.25	<b>1.35</b>	<b>1.10 - 1.64</b>	<b>1.30</b>	<b>1.07 - 1.59</b>
	Any ACE	<b>1.15</b>	<b>1.02 - 1.29</b>	1.10	0.97 - 1.24	<b>1.32</b>	<b>1.09 - 1.59</b>	<b>1.28</b>	<b>1.05 - 1.55</b>

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	Number of ACEs	<b>1.14</b>	<b>1.04 - 1.24</b>	<b>1.10</b>	<b>1.01 - 1.20</b>	<b>1.14</b>	<b>1.01 - 1.28</b>	1.11	0.98 - 1.25
Diabetes mellitus	Parental divorce	1.29	0.96 - 1.73	1.30	0.97 - 1.74	<b>1.37</b>	<b>1.07 - 1.75</b>	<b>1.34</b>	<b>1.05 - 1.72</b>
	Fear in family	1.11	0.94 - 1.32	1.12	0.95 - 1.33	<b>1.46</b>	<b>1.18 - 1.80</b>	<b>1.42</b>	<b>1.15 - 1.76</b>
	Childhood poverty	1.07	0.97 - 1.19	1.06	0.95 - 1.18	1.15	0.97 - 1.35	1.12	0.95 - 1.32
	Any ACE	<b>1.12</b>	<b>1.01 - 1.24</b>	<b>1.11</b>	<b>1.001 - 1.24</b>	<b>1.21</b>	<b>1.04 - 1.42</b>	<b>1.19</b>	<b>1.02 - 1.39</b>
	Number of ACEs	<b>1.08</b>	<b>1.001 - 1.17</b>	1.08	0.995 - 1.17	<b>1.18</b>	<b>1.08 - 1.30</b>	<b>1.17</b>	<b>1.06 - 1.28</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, OR; odds ratio, CI; confidence interval; SRH, self-rated health

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Odds ratios (95% confidence intervals) were derived from logistic regression models.

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4 Table 3 shows the associations between ACEs and smoking. Former smoking and  
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6 current smoking were positively associated with the number of ACEs for both countries, and  
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8 the ORs were similar. Table 4 shows the association between ACEs and BMI. BMI was  
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10 positively associated with each type of ACE, and the number of ACEs in Finland. This  
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12 association was also observed in Japan; however, the coefficients in Japan were lower than in  
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18 Finland.  
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Table 3. Association between adverse childhood experiences and smoking

		Japan				Finland			
		Model 1		Model 2		Model 1		Model 2	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Former smoking (ref: never)	Parental divorce	1.13	0.82 - 1.57	1.12	0.81 - 1.56	<b>1.54</b>	<b>1.31 - 1.81</b>	<b>1.48</b>	<b>1.26 - 1.74</b>
	Fear in family	1.14	0.96 - 1.36	1.11	0.93 - 1.32	<b>1.45</b>	<b>1.26 - 1.67</b>	<b>1.38</b>	<b>1.20 - 1.60</b>
	Childhood poverty	<b>1.14</b>	<b>1.02 - 1.26</b>	<b>1.13</b>	<b>1.02 - 1.26</b>	<b>1.42</b>	<b>1.28 - 1.57</b>	<b>1.37</b>	<b>1.24 - 1.53</b>
	Any ACE	<b>1.13</b>	<b>1.02 - 1.26</b>	<b>1.12</b>	<b>1.01 - 1.25</b>	<b>1.45</b>	<b>1.31 - 1.60</b>	<b>1.40</b>	<b>1.27 - 1.55</b>
	Number of ACEs	<b>1.11</b>	<b>1.03 - 1.21</b>	<b>1.11</b>	<b>1.02 - 1.20</b>	<b>1.30</b>	<b>1.22 - 1.38</b>	<b>1.26</b>	<b>1.19 - 1.35</b>
Current smoking (ref: never)	Parental divorce	<b>1.46</b>	<b>1.06 - 2.01</b>	1.32	0.95 - 1.82	<b>1.64</b>	<b>1.32 - 2.03</b>	<b>1.49</b>	<b>1.20 - 1.85</b>
	Fear in family	<b>1.29</b>	<b>1.07 - 1.55</b>	1.16	0.96 - 1.40	<b>1.45</b>	<b>1.19 - 1.76</b>	<b>1.32</b>	<b>1.09 - 1.61</b>
	Childhood poverty	<b>1.20</b>	<b>1.07 - 1.35</b>	1.10	0.98 - 1.24	1.15	0.99 - 1.40	1.07	0.92 - 1.25
	Any ACE	<b>1.24</b>	<b>1.10 - 1.39</b>	<b>1.13</b>	<b>1.01 - 1.27</b>	<b>1.33</b>	<b>1.16 - 1.53</b>	<b>1.24</b>	<b>1.08 - 1.43</b>
	Number of ACEs	<b>1.20</b>	<b>1.10 - 1.31</b>	<b>1.11</b>	<b>1.02 - 1.22</b>	<b>1.22</b>	<b>1.12 - 1.33</b>	<b>1.15</b>	<b>1.06 - 1.26</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, RR; Relative risk ratio, CI; confidence interval; ref, reference

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Relative risk ratios (95% confidence intervals) were derived from multinomial logistic regression models.

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Table 4. Association between adverse childhood experiences and body mass index

	Japan				Finland			
	Model 1		Model 2		Model 1		Model 2	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Parental divorce	0.18	-0.15 - 0.52	0.18	-0.15 - 0.51	<b>0.60</b>	<b>0.31 - 0.89</b>	<b>0.52</b>	<b>0.23 - 0.81</b>
Fear in family	<b>0.22</b>	<b>0.03 - 0.40</b>	<b>0.20</b>	<b>0.02 - 0.39</b>	<b>0.49</b>	<b>0.24 - 0.75</b>	<b>0.40</b>	<b>0.15 - 0.65</b>
Childhood poverty	<b>0.15</b>	<b>0.04 - 0.25</b>	0.07	-0.03 - 0.18	<b>0.49</b>	<b>0.30 - 0.67</b>	<b>0.40</b>	<b>0.22 - 0.59</b>
Any ACE	<b>0.14</b>	<b>0.03 - 0.24</b>	0.07	-0.04 - 0.18	<b>0.40</b>	<b>0.23 - 0.57</b>	<b>0.33</b>	<b>0.15 - 0.50</b>
Number of ACEs	<b>0.14</b>	<b>0.06 - 0.22</b>	<b>0.09</b>	<b>0.01 - 0.18</b>	<b>0.36</b>	<b>0.25 - 0.47</b>	<b>0.30</b>	<b>0.19 - 0.41</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, Coef.; coefficient, CI; confidence interval; BMI, body mass index.

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Coefficients (95% confidence intervals) were derived from regression models.

## 1 DISCUSSION

2 This study showed that elderly individuals in Japan and Finland who had experienced ACEs  
3 had worse health profiles (sub-optimal SRH and presence of chronic diseases) and more often  
4 had biological and behavioural risk factors (high BMI and smoking) than those with no ACEs.  
5 The strength of these associations was also similar. The only exception was BMI, which  
6 showed a more robust association in the Finnish cohorts than in the Japanese cohort.

7 Our finding, highlighting the association between ACEs and worse adult health, is  
8 consistent with those of other studies.[1, 21, 22] Importantly, the consistency of our results in  
9 harmonised cohorts from two different countries suggests that childhood adversities affect  
10 health similarly in these two societies. These associations were observed in older adults from  
11 the two countries, born during or soon after World War II (WWII). Although both Japan and  
12 Finland were among the countries that lost WWII, Finland, in contrast to Japan, was not  
13 occupied and suffered less damage than Japan, during and after the war. Thus, the adversities  
14 experienced by elderly Japanese adults in their childhood are likely to have been more severe  
15 than those experienced by elderly Finnish adults. In spite of the differences in these histories,  
16 as well as the cultural and social environments of older adults in these countries,[23, 24] it is  
17 interesting to note that the associations observed were similar. A potential explanation could  
18 be the presence of universal healthcare systems in these countries, which offer adequate  
19 medical treatment for diseases over one's life span, and likely lead to the attenuation of the

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4 20 impact of ACEs on health later in life. In addition, the presence of equal free educational  
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7 21 opportunities in both countries may explain the similar impact of ACEs on adult health, as  
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10 22 educational attainment can attenuate the impact of ACEs on later health.[25] The presence of  
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12 23 high social support in both countries may also attenuate the impact of ACEs on later  
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15 24 health.[26] The effect of ACEs on health, in different educational or healthcare systems,  
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18 25 requires further study.

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20 26 Similarly, ACEs were associated with smoking, which is consistent with the findings  
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23 27 of a previously conducted international comparison research in eight eastern European  
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26 28 countries[5] and other studies in the United States (US),[1, 27] United Kingdom (UK),[28]  
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29 29 and Finland.[29] The eastern European comparison study reported that ACEs were associated  
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32 30 with smoking among adults aged 14–66 years.[5] The relationships between ACEs and  
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35 31 smoking have predominantly been investigated among adults towards middle age; however,  
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38 32 few studies have examined these relationships using large community samples of older adults.  
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41 33 The current study showed that ACEs had an effect on smoking among older individuals, even  
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44 34 though the association may have been underestimated because of early death due to smoking  
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47 35 and ACEs (e.g., survival bias). Our results suggest that ACEs have a consistent long-term  
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50 36 effect on smoking among older adults despite differences in the price of cigarettes or smoking  
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53 37 advertisements, between the countries.

54 38 ACEs were associated with an increase in BMI in both countries; however, the  
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4 39 impact of ACEs was higher in Finland. This association was consistent with that observed in a  
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7 40 previously conducted study, which showed that ACEs elevated the risk of obesity in the US,[1,  
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10 41 2] UK,[28] and Finland.[30] The obesity rate among older individuals was higher in Finland  
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12 42 than in Japan in the current study; thus, we used continuous BMI as an outcome. The presence  
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15 43 of sampling bias in the current study may also have led to the lower impact of ACEs on BMI  
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18 44 in Japan, as the JAGES includes only individuals without nursing care.

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20 45       There are several limitations to this study. First, this was a cross-sectional study  
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23 46 conducted among older adults; thus, differential recall and selection bias cannot be ruled out,  
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26 47 especially if those with a disease were more likely to recall ACEs or if those with the most  
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29 48 difficult ACEs did not participate. Second, these results, although based on harmonised  
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32 49 measures, were derived from highly developed countries. Third, we did not assess other ACEs  
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35 50 such as sexual abuse, neglect, or childhood neighbourhood deprivation. Further studies are  
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38 51 warranted to investigate the association between other ACEs and adult disease in different  
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41 52 cultural settings, and in low- and middle-income countries.

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43 53       In conclusion, we observed that ACEs were associated in a similar manner with SRH,  
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46 54 diseases, and smoking, in both Japan and Finland. The impact of ACEs on BMI was stronger  
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49 55 in Finland than in Japan. These results suggest that the association between ACEs and health  
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52 56 is noteworthy, and is consistent even in countries with different historical and cultural  
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55 57 heritages.



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7 59 **Competing interests:** The authors declare that they have no conflict of interest.  
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12 61 **Funding:** This work was supported by the Japan Society for the Promotion of Science's  
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14  
15 62 KAKENHI Grants (grant number JP15H01972 and JP16K16633), Health Labour Sciences  
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17 63 Research Grants (grant number H28-Choju-Ippan-002), Research and Development Grants  
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19  
20 64 for Longevity Science from the Japan Agency for Medical Research and Development  
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23 65 (AMED), Personal Health Record Utilization Project from AMED, Research Funding for  
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25  
26 66 Longevity Sciences from the National Center for Geriatrics and Gerontology (grant number  
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29 67 29-42), and the World Health Organization Centre for Health Development (WHO Kobe  
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32 68 Centre) (WHO APW 2017/713981). Jussi Vahtera was supported by NordForsk (Nordic  
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35 69 Research Program on Health and Welfare). Tuula Oksanen received funding from the Finnish  
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37 70 Work Environment Fund (grant number 117094).  
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43 72 **Authors' contribution:** TF conceived the design of the work. KK and JV obtained the data.  
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46 73 TF and JP analysed data. All authors interpret the findings. AA wrote the first draft of the  
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49 74 manuscript. TF, JV and TO revised it critically for important intellectual content. All authors  
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51 75 approved the final version of the manuscript.  
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## 77 References

- 78 1. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and  
79 household dysfunction to many of the leading causes of death in adults. The Adverse  
80 Childhood Experiences (ACE) Study. *Am J Prev Med* 1998;14:245–8.  
81 [https://doi.org/10.1016/s0749-3797\(98\)00017-8](https://doi.org/10.1016/s0749-3797(98)00017-8)
- 82 2. Anda RF, Felitti VJ, Bremner JD, et al. The enduring effects of abuse and related  
83 adverse experiences in childhood. a convergence of evidence from neurobiology and  
84 epidemiology. *Eur Arch Psychiatry Clin Neurosci* 2006;256:174–86.  
85 [https://doi.org/10.1111/j.1365-2214.2006.00614\\_2.x](https://doi.org/10.1111/j.1365-2214.2006.00614_2.x)
- 86 3. Nandi A, Glymour MM, Kawachi I, VanderWeele TJ. Using marginal structural  
87 models to estimate the direct effect of adverse childhood social conditions on onset of heart  
88 disease, diabetes, and stroke. *Epidemiology* 2012;23:223–32.  
89 <https://doi.org/10.1097/ede.0b013e31824570bd>
- 90 4. Brown DW, Anda RF, Tiemeier H, et al. Adverse childhood experiences and the risk  
91 of premature mortality. *Am J Prev Med* 2009;37:389–96.  
92 <https://doi.org/10.1016/j.amepre.2009.06.021>
- 93 5. Bellis MA, Hughes K, Leckenby N, et al. Adverse childhood experiences and  
94 associations with health-harming behaviours in young adults: surveys in eight eastern  
95 European countries. *Bull World Health Organ* 2014;92:641–55.

- 1  
2  
3  
4 96 <https://doi.org/10.2471/blt.13.129247>  
5  
6  
7 97 6. Anda RF, Butchart A, Felitti VJ, Brown DW. Building a framework for global  
8  
9 98 surveillance of the public health implications of adverse childhood experiences. *Am J Prev*  
10  
11  
12 99 *Med* 2010;39:93–8. <https://doi.org/10.1016/j.amepre.2010.03.015>  
13  
14  
15 100 7. Halonen JI, Stenholm S, Pentti J, et al. Childhood psychosocial adversity and adult  
16  
17 101 neighborhood disadvantage as predictors of cardiovascular disease: A cohort study.  
18  
19  
20 102 *Circulation* 2015;132:371–9. <https://doi.org/10.1161/circulationaha.115.015392>  
21  
22  
23 103 8. Shibuya K, Hashimoto H, Ikegami N, et al. Future of Japan's system of good health  
24  
25 104 at low cost with equity: beyond universal coverage. *Lancet* 2011;378:1265–73.  
26  
27  
28 105 [https://doi.org/10.1016/s0140-6736\(11\)61098-2](https://doi.org/10.1016/s0140-6736(11)61098-2)  
29  
30  
31 106 9. Vuorenkoski L, Mladovsky P, Mossialos E. Finland: Health system review. *Health*  
32  
33 107 *Syst Transit* 2008;10:1–168.  
34  
35  
36  
37 108 10. Cummings WK. Education and equality in Japan. Princeton: Princeton University  
38  
39 109 Press; 2014.  
40  
41  
42  
43 110 11. John Helliwell, Richard Layard, Sachs J. The World Happiness Report: New York:  
44  
45 111 Sustainable Development Solutions Network. 2016. <http://worldhappiness.report/>. Accessed  
46  
47 112 18 Nov 2016.  
48  
49  
50  
51 113 12. OECD: OECD Income Distribution Database (IDD): Gini, poverty, income, methods  
52  
53 114 and concepts. 2016. <http://www.oecd.org/social/income-distribution-database.htm>. Accessed

1  
2  
3  
4 115 18 Jul 2017.

5  
6 116 13. Laaksonen E, Martikainen P, Lahelma E, et al. Socioeconomic circumstances and  
7  
8  
9 117 common mental disorders among Finnish and British public sector employees: evidence from  
10  
11  
12 118 the Helsinki Health Study and the Whitehall II Study. *Int J Epidemiol* 2007;36:776–86.  
13  
14  
15 119 <https://doi.org/10.1093/ije/dym074>

16  
17 120 14. Feldt T, Lintula H, Suominen S, Koskenvuo M, Vahtera J, Kivimaki M. Structural  
18  
19  
20 121 validity and temporal stability of the 13-item sense of coherence scale: prospective evidence  
21  
22  
23 122 from the population-based HeSSup study. *Qual Life Res* 2007;16:483–93.  
24  
25  
26 123 <https://doi.org/10.1007/s11136-006-9130-z>

27  
28  
29 124 15. Fujiwara T, Kawakami N. Association of childhood adversities with the first onset of  
30  
31  
32 125 mental disorders in Japan: results from the World Mental Health Japan, 2002-2004. *J*  
33  
34  
35 126 *Psychiatr Res* 2011;45:481–7. <https://doi.org/10.1016/j.jpsychires.2010.08.002>

36  
37 127 16. Matsuyama Y, Fujiwara T, Aida J, et al. Experience of childhood abuse and later  
38  
39  
40 128 number of remaining teeth in older Japanese: a life-course study from Japan Gerontological  
41  
42  
43 129 Evaluation Study project. *Community Dent Oral Epidemiol* 2016;44:531–9.  
44  
45  
46 130 <https://doi.org/10.1111/cdoe.12246>

47  
48  
49 131 17. Amemiya A, Fujiwara T, Murayama H, Tani Y, Kondo K. Adverse childhood  
50  
51  
52 132 experiences and higher-level functional limitations among older Japanese people: results from  
53  
54  
55 133 the JAGES study. *J Gerontol A Biol Sci Med Sci* 2017;2:261-6.

1  
2  
3  
4 134 <https://doi.org/10.1093/gerona/glx097>.

5  
6 135 18. Rahkonen O, Lahelma E, Huuhka M. Past or present? Childhood living conditions  
7  
8  
9 136 and current socioeconomic status as determinants of adult health. *Soc Sci Med* 1997;44:327–  
10  
11  
12 137 36. [https://doi.org/10.1016/s0277-9536\(96\)00102-5](https://doi.org/10.1016/s0277-9536(96)00102-5)

13  
14  
15 138 19. Korkeila J, Vahtera J, Korkeila K, et al. Childhood adversities as predictors of  
16  
17  
18 139 incident coronary heart disease and cerebrovascular disease. *Heart* 2010;96:298–303.  
19  
20  
21 140 <https://doi.org/10.1136/hrt.2009.188250>

22  
23 141 20. Korhonen MJ, Halonen JI, Brookhart MA, et al. Childhood adversity as a predictor  
24  
25  
26 142 of non-adherence to statin therapy in adulthood. *PloS One* 2015;10:e0127638.  
27  
28  
29 143 <https://doi.org/10.1371/journal.pone.0127638>

30  
31 144 21. Furu K, Wettermark B, Andersen M, Martikainen JE, Almarsdottir AB, Sorensen HT.  
32  
33  
34 145 The Nordic countries as a cohort for pharmacoepidemiological research. *Basic Clin*  
35  
36  
37 146 *Pharmacol Toxicol* 2010;106:86–94. <https://doi.org/10.1111/j.1742-7843.2009.00494.x>

38  
39  
40 147 22. Boynton-Jarrett R, Ryan LM, Berkman LF, Wright RJ. Cumulative violence exposure  
41  
42  
43 148 and self-rated health: longitudinal study of adolescents in the United States. *Pediatrics*  
44  
45  
46 149 2008;122:961–70. <https://doi.org/10.1542/peds.2007-3063>

47  
48  
49 150 23. Chartier MJ, Walker JR, Naimark B. Separate and cumulative effects of adverse  
50  
51  
52 151 childhood experiences in predicting adult health and health care utilization. *Child Abuse Negl*  
53  
54  
55 152 2010;34:454–64. <https://doi.org/10.1016/j.chiabu.2009.09.020>

- 1  
2  
3  
4 153 24. Fujiwara T, Kondo K, Shirai K, Suzuki K, Kawachi I. Associations of childhood  
5  
6 154 socioeconomic status and adulthood height with functional limitations among Japanese older  
7  
8  
9 155 people: results from the JAGES 2010 Project. *J Gerontol A Biol Sci Med Sci* 2014; 7:852–9.  
10  
11  
12 156 <https://doi.org/10.1093/gerona/glt189>  
13  
14  
15 157 25. Tani Y, Fujiwara T, Kondo N, Noma H, Sasaki Y, Kondo K. Childhood  
16  
17 158 socioeconomic status and onset of depression among Japanese older adults: The JAGES  
18  
19  
20 159 Prospective Cohort Study. *Am J Geriatr Psychiatry* 2016;24:717–26.  
21  
22  
23 160 <https://doi.org/10.1016/j.jagp.2016.06.001>  
24  
25  
26 161 26. Kuh D, Shlomo YB, Ezra S. A life course approach to chronic disease epidemiology.  
27  
28 162 Oxford: Oxford University Press; 2004.  
29  
30  
31 163 27. Runsten S, Korkeila K, Koskenvuo M, Rautava P, Vainio O, Korkeila J. Can social  
32  
33 164 support alleviate inflammation associated with childhood adversities? *Nord J Psychiatry*  
34  
35 165 2014;68:137–44. <https://doi.org/10.3109/08039488.2013.786133>  
36  
37  
38 166 28. Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking  
39  
40 167 during adolescence and adulthood. *JAMA* 1999;282:1652–8.  
41  
42 168 <https://doi.org/10.1001/jama.282.17.1652>  
43  
44  
45  
46 169 29. Bellis MA, Lowey H, Leckenby N, Hughes K, Harrison D. Adverse childhood  
47  
48 170 experiences: retrospective study to determine their impact on adult health behaviours and  
49  
50  
51 171 health outcomes in a UK population. *J Public Health* 2013;1:81–91.  
52  
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1  
2  
3  
4 172 <https://doi.org/10.1093/pubmed/fdt038>.

5  
6 173 30. Kestila L, Koskinen S, Martelin T, et al. Influence of parental education, childhood  
7  
8  
9 174 adversities, and current living conditions on daily smoking in early adulthood. *Eur J Public*  
10  
11  
12 175 *Health* 2006;16:617–26. <https://doi.org/10.1093/eurpub/ckl054>

13  
14  
15 176 31. Kestilä L, Rahkonen O, Martelin T, Lahti-Koski M, Koskinen S. Do childhood social  
16  
17  
18 177 circumstances affect overweight and obesity in early adulthood? *Scand J Public Health*  
19  
20  
21 178 2009;37:206–19. <https://doi.org/10.1177/1403494808100827>

# BMJ Open

## Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-024609.R1
Article Type:	Research
Date Submitted by the Author:	19-Oct-2018
Complete List of Authors:	Amemiya, Airi; University of Tokyo School of Public Health, Department of Health Economics and Epidemiology Research Fujiwara, Takeo; Tokyo Medical and Dental University, Department of Global Health Promotion Shirai, Kokoro; Osaka University, Department of Public Health Kondo, Katsunori; Chiba University, Center for Preventive Medical Science Oksanen, Tuula; Finnish Institute of Occupational Health Pentti, Jaana; University of Turku, Department of Public Health Vahtera, Jussi; Työterveyslaitos
<b>Primary Subject Heading</b>:	Epidemiology
Secondary Subject Heading:	Diabetes and endocrinology, Cardiovascular medicine, Oncology, Smoking and tobacco
Keywords:	Adverse childhood experience, Life-course approach, International comparison study, Japan, Finland

SCHOLARONE™  
Manuscripts



**Title:****Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland**

Airi Amemiya<sup>1</sup>, Takeo Fujiwara\*<sup>2</sup>, Kokoro Shirai<sup>3</sup>, Katsunori Kondo<sup>4, 5, 6</sup>, Tuula

Oksanen<sup>7</sup>, Jaana Pentti<sup>8</sup>, Jussi Vahtera<sup>8, 9</sup>

1. Department of Social Medicine, National Research Institute for Child Health and Development, 2-10-1 Okura, Setagaya-ku, Tokyo 157-8535, Japan

2. Department of Global Health Promotion, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8510, Japan

3. Department of Public Health, Graduate School of Medicine, Associate Professor, 2-2 Yamadaoka, Suita, Osaka-shi, 565-0871 Osaka, Japan

4. Center for Preventive Medical Sciences, Chiba University, 1-8-1, Inohana, Chuo Ward, Chiba-shi, Chiba, 260-0856, Japan

5. Center for Well-being and Society, Nihon Fukushi University, Okuda, Mihama-cho, Chita-gun, Aichi 470-3295, Japan

6. Department of Gerontology and Evaluation Study, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, 7-430 Morioka-cho, Obu City,

1  
2  
3  
4  
5  
6 Aichi 474-8511, Japan  
7

8  
9 7. Finnish Institute of Occupational Health, FI-20032 TYÖTERVEYSLAITOS, Turku,  
10  
11  
12 Finland  
13

14  
15 8. Department of Public Health, University of Turku, 20014 Turun yliopisto, Turku,  
16  
17  
18 Finland  
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20  
21 9. Turku University Hospital, Kiinamylynkatu 4–8, Turku, Finland  
22  
23  
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28 **Corresponding author:**

29  
30 Takeo Fujiwara  
31

32  
33 Tel: +81-3-3417-2663  
34

35  
36 Email: [fujiwara.hlth@tmd.ac.jp](mailto:fujiwara.hlth@tmd.ac.jp)  
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42 **Word count: 3,577**  
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## ABSTRACT

**Objective:** We aimed to examine associations between adverse childhood experiences (ACEs) and adult diseases in older adults in Japan and Finland.

**Design:** Cross-sectional comparative study.

**Setting:** Data were evaluated from a gerontological study in Japan and two public health studies in Finland.

**Participants:** A total of 13,123 adults (mean age, 69.5 years) from Japan and 10,353 adults (mean age, 64.4 years) from Finland were included in this study. Logistic regression was used to examine the associations of each of, any of, and the cumulative number of ACEs (parental divorce, fear of a family member, and poverty in childhood; treated as ordered categorical variables) with poor self-rated health, cancer, heart disease or stroke, diabetes mellitus, smoking, and body mass index. Models were adjusted for sex, age, education, marital status, and working status.

**Results:** Of the respondents, 50% of those in Japan and 37% of those in Finland reported having experienced at least one of the measured ACEs. Number of ACEs was associated with poor self-rated health in both countries, and the point estimates were similar (odds ratio [OR]: 1.35, 95% confidence interval [CI]: 1.25-1.46 in Japan; OR: 1.34, 95% CI: 1.27-1.41 in Finland). Number of ACEs was associated with the prevalence of cancer,

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6 heart disease or stroke, diabetes mellitus, current smoking, and an increase in body mass  
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9 index in both countries.  
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12 **Conclusions:** Associations between ACEs and poor self-rated health, adult diseases, and  
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14 health behaviours were similar among older adults in both Japan and Finland. Although  
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16 the results are potentially subjected to recall and survival bias, this international  
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18 comparative study suggests that the impact of ACEs on health is noteworthy and  
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20 consistent across cultural and social environments.  
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### 30 **Strength and limitations of this study**

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33 • The strength of this study is that it is an international comparative study that  
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35 investigated the impact of adverse childhood experiences (ACEs) on the health of  
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37 older adults in different cultural and social environments (Japan and Finland) using  
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39 harmonised data.  
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- 45 • The limitation of this study is that it was a cross-sectional study, and therefore  
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47 differential recall and selection bias cannot be ruled out. Survival bias is also possible  
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49 because the participants were older adults.  
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- 54 • Another limitation of this study is that the pooled data of the two countries were not  
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56 accessible, and therefore interactive effects of the countries and ACE on adult health  
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were not clear.

For peer review only

## INTRODUCTION

An increasing number of studies have investigated the association between adverse childhood experiences (ACEs), including long-term financial difficulties, parental divorce, and fear of a family member, and unhealthy behaviours (e.g., obesity, alcohol consumption, smoking, and lower levels of physical activity), adult diseases (e.g., cardiovascular disease, diabetes, stroke, cancer, and depression), and even early death.<sup>1-4</sup>

Although some recent studies have investigated the impact of ACEs on adult health, it is not known whether ACEs has an impact on the health of older adults. The investigation of this topic is important to confirm the long-term adverse effects of ACE and manage ACEs. Further, the impact varies by country, although the pathways linking childhood adversities with adult health is likely to be dependent on cultural or social environments.<sup>5-</sup>

<sup>7</sup> Therefore, a comparison of countries with different cultural and/or social environments in childhood but similar welfare state regimes may provide further understanding of the underlying mechanisms of ACEs and older adult health.

Japan and Finland are both members of the Organization for Economic Co-operation and Development (OECD). The two countries employ a universal healthcare system<sup>8,9</sup> and provide free education to those aged 6 to 15 years.<sup>10</sup> According to the World Happiness Report, the level of social support received (measured by having someone to

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6 count on in times of trouble) is relatively high in both countries (92.3% and 94.8% in  
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9 2015, in Japan and Finland, respectively).<sup>11</sup> However, the two countries differ in terms of  
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12 equality (e.g., the Gini coefficient, a measure which represents the income distribution of  
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15 a country's residents,<sup>12</sup> was 0.38 in Japan in 2014 and 0.26 in Finland 2015). Out of 37  
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18 OECD countries, Japan ranked 22<sup>th</sup> and Finland ranked 7<sup>th</sup> in 2015 in terms of equality.<sup>13</sup>  
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21 Furthermore, immigration policies the two countries were different at the time of this  
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24 study; international migrants made up 1.3% of the total Japanese population, whereas  
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27 6.2% of the Finnish population were international migrants in 2017.<sup>14</sup> Another cultural  
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30 aspect that is between the two countries was divorce rate; the divorce rate in Japan in  
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33 2017 was 1.7/1,000 people,<sup>15</sup> and in Finland it was 2.5/1,000 people in 2015.<sup>16</sup> Finally,  
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36 the prevalence of ACEs also differed between Japan and Finland, with 37% of  
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39 participants (mean age of 73 years old) in a Japanese study reporting at least one ACE,<sup>17</sup>  
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42 and 61% of participants (mean age of 48 years old) in a Finnish study reporting at least  
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45 one ACE.<sup>18</sup>

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48 According to a systematic review, most of the recent studies evaluating the  
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51 impact of multiple ACEs on health throughout life were performed in the United states  
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54 (US) and the United Kingdom (UK), with only a few studies conducted in other  
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57 countries,<sup>19</sup> such as Asian <sup>20</sup>or Nordic countries.<sup>21 22</sup> The US and the UK are also members  
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6 of the OECD. However, while Japan, Finland and the UK employ a universal healthcare  
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9 system, the US does not. Further, only one study focused on older adults.<sup>23</sup> The purpose  
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12 of this study was, therefore, to examine the associations and related risk factors between  
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15 ACEs and adult diseases in older adults in Japan and Finland.  
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## 18 19 20 21 **METHODS**

### 22 23 24 **Sample**

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27 The data in this study were collected from surveys conducted among older individuals in  
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30 Finland and Japan. The Japanese data were from the Japan Gerontological Evaluation  
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33 Study (JAGES), which comprises community-dwelling individuals aged 65 years and  
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36 older from 30 municipalities (in 14 municipalities the entire population was surveyed,  
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39 whereas in the remaining 16 municipalities, random sampling was performed) who were  
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42 not eligible to receive benefits from public long-term care insurance services (e.g., those  
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45 without functional disability). Self-administered survey questionnaires were delivered by  
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48 post to those who were listed in a ledger of individuals insured for long-term care. The  
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51 participants of the JAGES might be healthier than the average older Japanese population  
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54 because they were living in a municipality where municipal officers were keen to  
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57 participate in the JAGES. The data used in this study were from participants (n = 137,736,  
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6 response rate = 71%) aged  $\geq 65$  years, one-fifth of whom were randomly chosen and  
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9 questioned for information on adverse experiences in childhood ( $n = 26,229$ ) in 2013.  
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12 The participants of the current study were restricted to an age range of 65-74 years ( $n =$   
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15 15,070). Participants with missing data on any ACEs ( $n=1,158$ ), self-rated health (SRH)  
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18 ( $n=325$ ), body mass index (BMI) ( $n= 483$ ), and smoking ( $n=163$ ) were excluded.  
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22 The Finnish data were drawn from two prospective cohort studies: the Finnish  
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24 Public Sector (FPS) study<sup>24</sup> and the Health and Social Support (HeSSup) study.<sup>25</sup> The  
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27 FPS study included employees representing a wide range of occupations working in ten  
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30 towns and six hospital districts. The participants of the FPS were individuals who were  
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33 at the time of the study, or had previously been, public sector employees; thus, they did  
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36 not fully represent the general Finnish population of the same age. The FPS data used in  
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39 this study were derived from employed and retired participants in the 2008/2009 survey,  
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42 and included information on self-reported ACEs ( $n = 42,877$ , response rate = 69%). For  
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45 this study, all FPS study respondents aged  $\geq 60$  years ( $n = 7,169$ ) were selected. The  
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48 HeSSup study targeted a sample representative of the Finnish population in four age  
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51 groups (20–24, 30–34, 40–44, and 50–54 years), in 1998. Therefore, the participants of  
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54 the HeSSup may be representative of the Finnish population.<sup>26</sup> In the 2012 follow-up  
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57 survey, information on self-reported ACEs was obtained from 11,924 participants  
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6 (response rate = 78%). Of them, those in the oldest age group (64–68 years) were selected  
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9 (n = 3,184). Self-administered survey questionnaires were used in the FPS and HeSSup  
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12 studies. The two Finnish cohorts were pooled. The studies together included 13,123  
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15 (6,214 men and 6,909 women) participants from Japan and 10,353 (3,201 men and 7,152  
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18 women) participants from Finland.  
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21 The JAGES was approved by the Ethics Committee for Research on Human  
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24 Subjects at Nihon Fukushi University, Japan (No. 10–05) and the Ethics Committee for  
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27 Medical Research at the University of Tokyo (No. 10555). The FPS study was approved  
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30 by the Ethics Committee of the Helsinki and Uusimaa Hospital District and HeSSup study  
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33 by the joint Ethics Committee of the University of Turku and the Turku University  
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36 Central Hospital. The studies include ethical approval for these secondary analyses. The  
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39 information about data management and handling is relevant and available for the study  
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42 administrators in each country.  
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### 48 **Participants and Public Involvement**

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50 Patients were not involved in the development of the research question, outcome  
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53 measures, design, or conduct of the study.  
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### 58 **Measurement of adverse childhood experiences**

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7 The questions related to ACEs were somewhat different between the three studies, but  
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9 the variables were harmonised. In short, we assessed three ACEs: (1) parental divorce  
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11 (the FPS study, HeSSup study, and JAGES), (2) fear of a family member (FPS and  
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13 HeSSup studies)/witness of domestic violence or physical abuse (JAGES), and (3)  
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15 financial difficulties in the family (FPS study, HeSSup study, and JAGES).  
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21 In the JAGES, we assessed ACEs using four questions modified from Felitti's  
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23 original ACE study[1] and the World Mental Health survey in Japan.<sup>27</sup> Respondents were  
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25 asked if they had experienced the following adversities in their childhood (yes/no):  
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27 parents' divorce/separation, financial difficulties in the family, being witness to domestic  
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29 violence, or physical abuse. We categorised those who responded having experienced  
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31 "being witness to domestic violence" and/or "physical abuse" as having "frequent fear of  
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33 a family member" to make these ACEs comparable to those in the FPS and HeSSup  
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35 studies. Violence against the child (physical abuse) and the mother (witnessing domestic  
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37 violence) may both result in "fear of a family member", and we therefore coded witness  
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39 of domestic violence or physical abuse as "fear of a family member". These ACEs  
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41 measures have been shown to predict the number of remaining teeth<sup>28</sup> and higher  
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43 functional limitation in Japan.<sup>29</sup> In the FPS and HeSSup studies, we assessed ACEs using  
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45 three survey questions modified from Statistics Finland's Survey of Living Conditions.<sup>30</sup>  
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6 Respondents were asked whether they had experienced the following adversities: parent's  
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9 divorce/separation, long-term financial difficulties in the family, and frequent fear of a  
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11 family member (the response categories "no", "yes", and "cannot say" were coded as  
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13 dummy variables), and the findings have been used in other studies to predict the presence  
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15 of coronary heart disease,<sup>31</sup> depression,<sup>31</sup> and non-adherence to statin therapy.<sup>7</sup> The  
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17 questions regarding each ACE are shown in Supplemental table S1.  
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24 For the present study, the three ACEs were analysed both separately and as a  
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26 summary variable (0, 1, 2 and 3 ACEs).  
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### 33 **Measurement of adult health and health behaviours**

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35 Questions on adult health and health behaviours were somewhat different between the  
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37 countries. In the JAGES, SRH was measured using the question: "How do you feel about  
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39 your current health status: excellent, good, fair, or poor?" Responses were recoded to  
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41 dichotomous response variables (fair/poor as 0, and excellent/good as 1). A history of  
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43 being diagnosed with cancer, heart diseases or stroke, or diabetes mellitus was self-  
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45 reported (response categories: "yes" and "no"). BMI was calculated as participants' self-  
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47 reported weight in kilograms divided by height in meters squared. The smoking status  
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49 (current, former, or never) was based on replies to survey questionnaires.  
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7 In the FPS and HeSSup studies, SRH was measured through the question: “How  
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9 is your current health status?” with five response categories (from 1 [poor] to 5  
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11 [excellent]). The responses “moderate”, “good”, and “excellent” were categorised as  
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13 good (1), and the other response options as poor (0). Information on cancer was derived  
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15 from the National Cancer Registry, and prevalent cardiovascular disease (heart disease or  
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17 stroke) and diabetes mellitus were defined based on the special reimbursement for the  
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19 medication for these diseases, as obtained from the Social Insurance Institution of Finland.  
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21 In FPS and HeSSup, we used personal identification codes, assigned to all Finnish citizens,  
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23 to link the respondents to their records in national health registers. BMI was calculated  
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25 from self-reported weight and height. Smoking status (current, former, and never) was  
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27 based on survey responses. Questions regarding health and health behaviours are shown  
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29 in Supplemental table S2.  
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### 45 **Covariates**

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48 Education was divided into three levels: (i) 9 years or less, referring to a comprehensive  
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50 school education in Finland and junior high school education in Japan, (ii) 9–12 years,  
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52 describing post-compulsory secondary general academic and vocational education in  
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54 Finland and high school or technical college education in Japan, and (iii) 12 years or  
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6 more, referring to a university degree in both countries. Marital status was divided into  
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9 four categories: (i) single, never married and non-cohabiting, (ii) widowed, (iii) divorced,  
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12 and (iv) married or cohabiting with a partner. Working status was divided into two  
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15 categories: (i) working and (ii) retired or never worked (Japan). Regarding working status,  
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18 those who had never worked was not included in FPS because FPS is a study of  
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21 individuals who were at the time of study, or had previously been, public sector  
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24 employees and represented a wide range of occupations. Therefore, we combined ‘retired  
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27 and never worked’ as ‘not working’ in Japan to be comparable with the studies in Finland.  
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31 Missing values were treated as dummy variables.  
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### Statistical analysis

Logistic regression analysis was performed to examine the association of each ACE, any ACE, and the cumulative number of ACEs (e.g., 0, 1, 2, and 3 ACEs) with health outcomes. Linear regression analysis was used for BMI. Multinomial logistic regression was used for smoking status. Model 1 was adjusted for age and sex. Model 2 was further adjusted for education, marital status, and working status.

The odds ratios (ORs) and their 95% confidence intervals (95% CIs) were calculated. Statistical analysis was performed using Stata (ver. 13.1; StataCorp, College

Station, TX, USA).

## RESULTS

Table 1 shows the distribution of the variables for each country. The prevalence rates of parental divorce, fear of a family member, and childhood poverty were 3%, 9%, and 47%, respectively, in Japan. In Finland, these proportions were 9%, 13%, and 29%, respectively. Of the respondents, 50% of those in Japan and 37% of those in Finland reported having experienced at least one ACE. The mean age of the participants and the proportion of men were higher in Japan than in Finland.

Table 1. Characteristics of the study participants

	Japan (JAGES) (N = 13,123)		Finland (pooled FPS and HeSSup studies) (N = 10,353)		p
	N or mean	% or SD	N or mean	% or SD	
Parental divorce	336	2.6	958	9.3	p <0.01 <sup>a</sup>
Fear of a family member	1195	9.1	1348	13.0	p <0.01 <sup>a</sup>
Childhood poverty	6135	46.8	3013	29.1	p <0.01 <sup>a</sup>
Any adverse childhood experience	6561	50.0	3852	37.2	p <0.01 <sup>a</sup>
Total number of adverse childhood experiences	0	6562	6501	62.8	p <0.01 <sup>a</sup>
	1	5517	2634	25.4	
	2	983	969	9.4	
	3	61	249	2.4	
Age	69.5	2.8	64.4	2.9	p <0.01 <sup>b</sup>
Sex	male	6214	3201	30.9	p <0.01 <sup>a</sup>
	female	6909	7152	69.1	

SRH	poor/fair	1770	13.5	3780	36.5	p <0.01 <sup>a</sup>
Cancer		460	3.5	388	3.8	p <0.32 <sup>a</sup>
	missing			54	0.5	
Heart disease or stroke		1353	10.3	466	4.5	p <0.01 <sup>a</sup>
	missing			54	0.5	
Diabetes mellitus		1738	13.2	714	6.9	p <0.01 <sup>a</sup>
	missing			54	0.5	
BMI mean		23.0	3.1	26.7	4.4	p <0.01 <sup>b</sup>
Smoking	never	9221	70.3	6973	67.4	p <0.01 <sup>a</sup>
	former	2221	16.9	2444	23.6	
	current	1681	12.8	936	9.0	
Education	<9 years	4395	33.5	1868	18.0	p <0.01 <sup>a</sup>
	10-12 years	5476	41.7	3168	30.6	
	12+ years	3103	23.7	5234	50.6	
	missing	149	1.1	83	0.8	
Marital status	single	326	2.5	574	5.5	p <0.01 <sup>a</sup>
	divorced	535	4.1	1414	13.7	
	widowed	1606	12.2	741	7.2	
	married/cohabiting	10441	79.6	7557	73.0	
	missing	215	1.6	67	0.7	
Working status	not working	8604	65.6	3092	29.9	p <0.01 <sup>a</sup>
	working	4062	31.0	7230	69.8	
	missing	457	3.5	31	0.3	

JAGES; Japan Gerontological Evaluation Study, FPS; Finnish Public Sector, HeSSup; Health and Social Support, SD; standard deviation, SRH; self-rated health, BMI; body mass index  
a: Chi-squared test. b: t-test

As for SRH, the rate of “poor or fair” was higher in Finland than in Japan (37% and 14%, respectively). The prevalence of cancer was similar in both countries; however,



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6 that of heart disease or stroke and diabetes mellitus was higher in Japan. As for BMI, the  
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9 mean BMI was higher in Finland than in Japan. The distribution of smoking status was  
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12 similar. In the case of socioeconomic status, 50% of the people in Finland and 24% of  
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15 those in Japan were educated for 12 years or more. Of the participants in Finland, 70%  
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18 were currently working, whereas 66% of those in Japan were currently not working.  
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21 Table 2 shows the association between ACEs and SRH, and diseases (e.g., cancer,  
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23 heart disease or stroke, and diabetes mellitus). SRH was associated with each type of ACE  
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25 and the number of ACEs, for both countries. Interestingly, the point estimates were  
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27 similar. For example, the OR of the number of ACEs for poor/fair SRH was 1.35 (95%  
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29 CI: 1.25-1.46) in Japan and 1.34 (95% CI: 1.27-1.41) in Finland, after adjusting the  
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32 covariates (Model 2). The ORs of the number of ACEs for cancer, heart disease or stroke,  
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35 and diabetes mellitus were also similar in both studies in Model 2.  
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Table 2. Association between adverse childhood experiences and poor self-rated health and diseases among older adults in Japan and Finland.

		Japan				Finland			
		Model 1		Model 2		Model 1		Model 2	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
SRH (poor/fair)	Parental divorce (ref.no): Yes	<b>1.40</b>	<b>1.05 - 1.86</b>	<b>1.34</b>	<b>1.004 - 1.80</b>	<b>1.37</b>	<b>1.20 - 1.57</b>	<b>1.30</b>	<b>1.13 - 1.49</b>
	Fear of a family member (ref.no): Yes	<b>1.77</b>	<b>1.52 - 2.05</b>	<b>1.70</b>	<b>1.46 - 1.98</b>	<b>1.65</b>	<b>1.47 - 1.85</b>	<b>1.56</b>	<b>1.39 - 1.76</b>
	Childhood poverty (ref.no): Yes	<b>1.46</b>	<b>1.32 - 1.62</b>	<b>1.32</b>	<b>1.19 - 1.47</b>	<b>1.68</b>	<b>1.54 - 1.83</b>	<b>1.60</b>	<b>1.46 - 1.75</b>
	Any ACE (ref.no): Yes	<b>1.50</b>	<b>1.36 - 1.67</b>	<b>1.37</b>	<b>1.23 - 1.52</b>	<b>1.66</b>	<b>1.53 - 1.80</b>	<b>1.60</b>	<b>1.47 - 1.74</b>
	Number of ACEs (continuous variable)	<b>1.43</b>	<b>1.33 - 1.54</b>	<b>1.35</b>	<b>1.25 - 1.46</b>	<b>1.39</b>	<b>1.32 - 1.46</b>	<b>1.34</b>	<b>1.27 - 1.41</b>
Cancer	Parental divorce (ref.no): Yes	1.32	0.78 - 2.24	1.40	0.82 - 2.38	1.16	0.82 - 1.62	1.19	0.84 - 1.67
	Fear of a family member (ref.no): Yes	0.99	0.72 - 1.37	1.01	0.73 - 1.40	<b>1.36</b>	<b>1.03 - 1.80</b>	<b>1.40</b>	<b>1.06 - 1.85</b>
	Childhood poverty (ref.no): Yes	<b>1.26</b>	<b>1.04 - 1.52</b>	<b>1.31</b>	<b>1.08 - 1.59</b>	1.05	0.84 - 1.32	1.07	0.86 - 1.35
	Any ACE (ref.no): Yes	<b>1.26</b>	<b>1.04 - 1.52</b>	<b>1.31</b>	<b>1.08 - 1.59</b>	1.11	0.90 - 1.36	1.13	0.91 - 1.39
	Number of ACEs (continuous variable)	<b>1.16</b>	<b>1.008 - 1.33</b>	<b>1.20</b>	<b>1.04 - 1.38</b>	1.11	0.97 - 1.26	1.13	0.99 - 1.28
Heart disease or stroke	Parental divorce (ref.no): Yes	1.30	0.94 - 1.81	1.26	0.91 - 1.76	0.93	0.66 - 1.32	0.90	0.63 - 1.27
	Fear of a family member (ref.no): Yes	1.13	0.94 - 1.37	1.10	0.91 - 1.32	1.16	0.88 - 1.54	1.11	0.84 - 1.48
	Childhood poverty (ref.no): Yes	<b>1.16</b>	<b>1.03 - 1.30</b>	1.11	0.99 - 1.25	<b>1.35</b>	<b>1.10 - 1.64</b>	<b>1.30</b>	<b>1.07 - 1.59</b>
	Any ACE (ref.no): Yes	<b>1.15</b>	<b>1.02 - 1.29</b>	1.10	0.97 - 1.24	<b>1.32</b>	<b>1.09 - 1.59</b>	<b>1.28</b>	<b>1.05 - 1.55</b>
	Number of ACEs (continuous variable)	<b>1.14</b>	<b>1.04 - 1.24</b>	<b>1.10</b>	<b>1.01 - 1.20</b>	<b>1.14</b>	<b>1.01 - 1.28</b>	1.11	0.98 - 1.25
Diabetes mellitus	Parental divorce (ref.no): Yes	1.29	0.96 - 1.73	1.30	0.97 - 1.74	<b>1.37</b>	<b>1.07 - 1.75</b>	<b>1.34</b>	<b>1.05 - 1.72</b>
	Fear of a family member (ref.no): Yes	1.11	0.94 - 1.32	1.12	0.95 - 1.33	<b>1.46</b>	<b>1.18 - 1.80</b>	<b>1.42</b>	<b>1.15 - 1.76</b>
	Childhood poverty (ref.no): Yes	1.07	0.97 - 1.19	1.06	0.95 - 1.18	1.15	0.97 - 1.35	1.12	0.95 - 1.32

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Any ACE (ref.no): Yes	<b>1.12</b>	<b>1.01 - 1.24</b>	<b>1.11</b>	<b>1.001 - 1.24</b>	<b>1.21</b>	<b>1.04 - 1.42</b>	<b>1.19</b>	<b>1.02 - 1.39</b>
Number of ACEs (continuous variable)	<b>1.08</b>	<b>1.001 - 1.17</b>	1.08	0.995 - 1.17	<b>1.18</b>	<b>1.08 - 1.30</b>	<b>1.17</b>	<b>1.06 - 1.28</b>

“Any” denotes the presence of at least 1 ACE.  
 ACE; Adverse childhood experience, OR; odds ratio, CI; confidence interval; SRH, self-rated health; ref., reference  
 Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.  
 Odds ratios (95% confidence intervals) were derived from logistic regression models.  
 Bold text indicates statistically significant with a p-value less than 0.05.

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4 Table 3 shows the associations between ACEs and smoking. Former smoking and  
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7 current smoking were positively associated with the number of ACEs for both countries, and the  
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10 ORs were similar. Table 4 shows the association between ACEs and BMI. BMI was positively  
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13 associated with each type of ACE, and the number of ACEs in Finland. This association was  
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16 also observed in Japan; however, the coefficients in Japan were lower than those in Finland.  
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Table 3. Association between adverse childhood experiences and former and current smoking among older adults in Japan and Finland.

		Japan				Finland			
		Model 1		Model 2		Model 1		Model 2	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Former smoking (ref: never)	Parental divorce (ref.no): Yes	1.13	0.82 - 1.57	1.12	0.81 - 1.56	<b>1.54</b>	<b>1.31 - 1.81</b>	<b>1.48</b>	<b>1.26 - 1.74</b>
	Fear of a family member (ref.no): Yes	1.14	0.96 - 1.36	1.11	0.93 - 1.32	<b>1.45</b>	<b>1.26 - 1.67</b>	<b>1.38</b>	<b>1.20 - 1.60</b>
	Childhood poverty (ref.no): Yes	<b>1.14</b>	<b>1.02 - 1.26</b>	<b>1.13</b>	<b>1.02 - 1.26</b>	<b>1.42</b>	<b>1.28 - 1.57</b>	<b>1.37</b>	<b>1.24 - 1.53</b>
	Any ACE (ref.no): Yes	<b>1.13</b>	<b>1.02 - 1.26</b>	<b>1.12</b>	<b>1.01 - 1.25</b>	<b>1.45</b>	<b>1.31 - 1.60</b>	<b>1.40</b>	<b>1.27 - 1.55</b>
	Number of ACEs (continuous variable)	<b>1.11</b>	<b>1.03 - 1.21</b>	<b>1.11</b>	<b>1.02 - 1.20</b>	<b>1.30</b>	<b>1.22 - 1.38</b>	<b>1.26</b>	<b>1.19 - 1.35</b>
Current smoking (ref: never)	Parental divorce (ref.no): Yes	<b>1.46</b>	<b>1.06 - 2.01</b>	1.32	0.95 - 1.82	<b>1.64</b>	<b>1.32 - 2.03</b>	<b>1.49</b>	<b>1.20 - 1.85</b>
	Fear of a family member (ref.no): Yes	<b>1.29</b>	<b>1.07 - 1.55</b>	1.16	0.96 - 1.40	<b>1.45</b>	<b>1.19 - 1.76</b>	<b>1.32</b>	<b>1.09 - 1.61</b>
	Childhood poverty (ref.no): Yes	<b>1.20</b>	<b>1.07 - 1.35</b>	1.10	0.98 - 1.24	1.15	0.99 - 1.40	1.07	0.92 - 1.25
	Any ACE (ref.no): Yes	<b>1.24</b>	<b>1.10 - 1.39</b>	<b>1.13</b>	<b>1.01 - 1.27</b>	<b>1.33</b>	<b>1.16 - 1.53</b>	<b>1.24</b>	<b>1.08 - 1.43</b>
	Number of ACEs (continuous variable)	<b>1.20</b>	<b>1.10 - 1.31</b>	<b>1.11</b>	<b>1.02 - 1.22</b>	<b>1.22</b>	<b>1.12 - 1.33</b>	<b>1.15</b>	<b>1.06 - 1.26</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, OR; odds ratio, CI; confidence interval; ref, reference

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Odds ratios (95% confidence intervals) were derived from multinomial logistic regression models.

Bold text indicates statistically significant with a p-value less than 0.05.

Table 4. Association between adverse childhood experiences and body mass index among older adults in Japan and Finland.

	Japan				Finland			
	Model 1		Model 2		Model 1		Model 2	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Parental divorce (ref.no): Yes	0.18	-0.15 - 0.52	0.18	-0.15 - 0.51	<b>0.60</b>	<b>0.31 - 0.89</b>	<b>0.52</b>	<b>0.23 - 0.81</b>
Fear of a family member (ref.no): Yes	<b>0.22</b>	<b>0.03 - 0.40</b>	<b>0.20</b>	<b>0.02 - 0.39</b>	<b>0.49</b>	<b>0.24 - 0.75</b>	<b>0.40</b>	<b>0.15 - 0.65</b>
Childhood poverty (ref.no): Yes	<b>0.15</b>	<b>0.04 - 0.25</b>	0.07	-0.03 - 0.18	<b>0.49</b>	<b>0.30 - 0.67</b>	<b>0.40</b>	<b>0.22 - 0.59</b>
Any ACE (ref.no): Yes	<b>0.14</b>	<b>0.03 - 0.24</b>	0.07	-0.04 - 0.18	<b>0.40</b>	<b>0.23 - 0.57</b>	<b>0.33</b>	<b>0.15 - 0.50</b>
Number of ACEs (continuous variable)	<b>0.14</b>	<b>0.06 - 0.22</b>	<b>0.09</b>	<b>0.01 - 0.18</b>	<b>0.36</b>	<b>0.25 - 0.47</b>	<b>0.30</b>	<b>0.19 - 0.41</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, Coef.; coefficient, CI; confidence interval; BMI, body mass index.

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Coefficients (95% confidence intervals) were derived from regression models.

Bold text indicates statistically significant with a p-value less than 0.05.

## 1 DISCUSSION

2 To our knowledge, this is the first study that compares the impact of ACEs on health of older  
3 adults between two countries. This study showed that elderly individuals in Japan and Finland  
4 who had experienced ACEs had worse health profiles (sub-optimal SRH and presence of  
5 chronic diseases) and more often had biological and behavioural risk factors (high BMI and  
6 smoking) than those with no ACEs. The strength of these associations was weak or modest, and  
7 similar between the two countries. The only exception was BMI, which showed a more robust  
8 association in the Finnish cohorts than in the Japanese cohort.

9 Our finding which highlights the association between ACEs and poor adult health, is  
10 consistent with those of other studies. Although the association was weaker compared with  
11 other studies,<sup>5-7 19</sup> this might be due to survival bias as we focused on older adults. Regarding  
12 SRH, the association between fear of a family member in childhood and poor SRH among older  
13 adults was slightly stronger than that for parental divorce or childhood poverty in Japan;  
14 however, in Finland, such a difference was not observed. This result suggests that the  
15 prevention and detection of childhood abuse and intimate partner violence, as well as the  
16 follow-up provided, may not be as adequate in Japan compared with Finland. Alternatively,  
17 physical punishment might be more pervasive in Japan than in Finland;<sup>32</sup> physical punishment  
18 is legally forbidden in Finland but not in Japan. Regarding cancer, childhood poverty was  
19 associated with cancer among older people in Japan, but this association was not observed in

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4 20 Finland. Childhood poverty in Japan might lead to poverty in adulthood, which may result in  
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7 21 delays in medical check-ups or consultations. In spite of the provision of universal health care  
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10 22 in Japan, individual payment of medical expenses is at least 10% of the total cost, even among  
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13 23 older adults.

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16 24 Generally, the strength of these associations was similar between the two countries.  
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19 25 The consistency of our results in harmonised cohorts from two different countries suggests that  
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22 26 childhood adversities affect health similarly in these two societies. In spite of the differences in  
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25 27 the cultural and social environments of older adults in these countries,<sup>33 34</sup> it is interesting to  
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28 28 note that the associations observed were similar. A likely explanation could be the presence of  
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31 29 universal healthcare systems in these countries, which offer adequate medical treatment for  
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34 30 diseases over one's life span, and likely lead to the attenuation of the impact of ACEs on health  
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37 31 later in life. This might explain the lower OR of ACEs for diseases comparing previous studies,  
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40 32 because universal health care system might be effective to protect older adults with ACEs. In  
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43 33 addition, the presence of equal free educational opportunities in both countries may explain the  
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46 34 similar impact of ACEs on adult health, as educational attainment can attenuate the impact of  
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49 35 ACEs on later health.<sup>35</sup> The presence of high social support,<sup>36</sup> cultural engagement, access to  
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52 36 trusted adults<sup>37</sup> in both countries may also attenuate the impact of ACEs on later health through  
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55 37 the enhancement of resilience, described as the ability to adapt to adverse environment.<sup>38</sup> The  
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58 38 effect of ACEs on health, in different educational or healthcare systems, requires further study.  
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4 39 Similarly, ACEs were associated with smoking, which is consistent with the findings  
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7 40 of a previously conducted international comparison research in eight Eastern European  
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10 41 countries<sup>5</sup> and other studies in the US,<sup>1 39</sup> UK,<sup>40</sup> and Finland<sup>41</sup>, although this association was  
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13 42 weak in the current study. The Eastern European comparison study reported that ACEs were  
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16 43 associated with smoking among adults aged 14–66 years.<sup>5</sup> The relationships between ACEs and  
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19 44 smoking have predominantly been investigated among adults towards middle age; however,  
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22 45 few studies have examined these relationships using large community samples of older adults.  
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25 46 Our results suggest that ACEs have a consistent long-term effect on smoking among older  
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28 47 adults despite differences in the price of cigarettes or smoking advertisements between the  
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31 48 countries. A meta-analysis showed a moderate odds ratio for smoking among those with four  
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34 49 or more ACEs compared with those with no ACEs.<sup>19</sup> The association was weaker in the current  
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37 50 study than the results of the meta-analysis, possibly because there were only three ACEs  
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40 51 measured in the current study, and the association may have been underestimated because of  
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43 52 early death due to smoking and ACEs (e.g., survival bias).

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46 53 ACEs were associated with an increase in BMI in both countries; however, the impact  
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49 54 of ACEs was higher in Finland. This association was consistent with that observed in a previous  
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52 55 study which showed that ACEs elevated the risk of obesity in the US,<sup>1 2</sup> UK,<sup>40</sup> and Finland.<sup>42</sup>  
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55 56 The obesity rate among older individuals was higher in Finland than in Japan in the current  
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58 57 study; thus, we used continuous BMI as an outcome. The presence of sampling bias in the  
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4 58 current study may have also led to the lower impact of ACEs on BMI in Japan, as the JAGES  
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7 59 included only individuals without nursing care.  
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10 60 There are several limitations to this study. First, this was a cross-sectional study  
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13 61 conducted among older adults. Thus, differential recall and selection bias cannot be ruled out,  
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16 62 especially if those with a disease were more likely to recall ACEs or if those with the most  
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19 63 difficult ACEs did not participate. Second, these results, although based on harmonised  
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22 64 measures, were derived from only two egalitarian developed countries, which preclude to  
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25 65 generalize the findings to other countries. Further studies are warranted to investigate the  
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28 66 association between other ACEs and adult disease in different cultural settings, and in low- and  
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31 67 middle-income countries. Third, we did not assess other ACEs such as sexual abuse, neglect,  
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34 68 childhood neighbourhood deprivation, or family disfunction (i.e., mental disorder of a family  
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37 69 member, or incarcerated family member), and thus the number of ACEs were limited to only  
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40 70 three. Further studies are necessary to investigate the impact of other ACEs on the health of  
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43 71 older adults. Fourth, the assessment of fear of a family member in the JAGES, FPS and HeSSup  
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46 72 was different, which may result in heterogeneity between study estimates. Fifth, the participants  
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49 73 in the JAGES were without functional disability, and hence might be healthier than the average  
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52 74 Japanese older population. Therefore, the results of the study might be underestimated. Sixth,  
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55 75 there is a disparity in the measurement of ACEs and health, and ACEs and health behaviours,  
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58 76 across the JAGES, FPS, and HeSSup. The differences in measurement might result in  
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4 77 heterogeneity of the results. Seventh, considering other covariates such as levels of inequality,  
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7 78 current and previous household income, environmental risks (e.g., parental smoking), or genetic  
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10 79 variation was not feasible due to data availability. Eighth, the results might be subjected to  
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13 80 survival bias. The average age of the study participants was 69.5 years in Japan and 64.4 years  
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16 81 in Finland. People who passed away before the current study from ACE-related diseases or  
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19 82 health risk behaviours would not have been included in the current study. Therefore, the results  
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22 83 of the current study may underestimate the health effects of ACEs. Ninth, all the ACEs were  
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25 84 self-reported. Therefore, there may be recall or reporting biases. Finally, the data from Japan  
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28 85 (e.g., data from JAGES) excluded those with functional disability; therefore, the association  
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31 86 between ACE and health throughout life might be underestimated in Japan. Further, FPS and  
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34 87 HeSSup were not representative sample, thus prevalence of diseases, such as cancer, may be  
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37 88 different from other studies.

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40 89           Nonetheless, this is the first study that investigated the association between ACEs and  
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43 90 health and health behaviour among older people in two countries. In Japan and Finland, the  
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46 91 relationship between ACEs and health was similar for SRH, specific diseases and smoking. The  
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49 92 impact of ACEs on BMI was stronger in Finland than in Japan. These results suggest a notable  
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52 93 association between ACEs and health among older people, and that this association remains  
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55 94 consistent even in countries with different historical and cultural heritages.

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4 96 **Competing interests:** The authors declare that they have no conflict of interest.  
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10 98 **Funding:** This work was supported by the Japan Society for the Promotion of Science's  
11  
12  
13 99 KAKENHI Grants (grant number JP15H01972 and JP16K16633), Health Labour Sciences  
14  
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16 100 Research Grants (grant number H28-Choju-Ippan-002), Research and Development Grants for  
17  
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19 101 Longevity Science from the Japan Agency for Medical Research and Development (AMED),  
20  
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22 102 Personal Health Record Utilization Project from AMED, Research Funding for Longevity  
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25 103 Sciences from the National Center for Geriatrics and Gerontology (grant number 29-42), and  
26  
27  
28 104 the World Health Organization Centre for Health Development (WHO Kobe Centre) (WHO  
29  
30  
31 105 APW 2017/713981). Jussi Vahtera was supported by NordForsk (Nordic Research Program on  
32  
33  
34 106 Health and Welfare). Tuula Oksanen received funding from the Finnish Work Environment  
35  
36  
37 107 Fund (grant number 117094).  
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43 109 **Authors' contribution:** AA and TF conceived the design of the work. KK and JV obtained the  
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45  
46 110 data. TF and JP analysed data. All authors interpret the findings. AA wrote the first draft of the  
47  
48  
49 111 manuscript. TF and JV revised it critically for important intellectual content. All authors  
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52 112 approved the final version of the manuscript.  
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58 114 **Data sharing statement:** All available data can be obtained by contacting the corresponding  
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118 **References**

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- 120 1. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household  
121 dysfunction to many of the leading causes of death in adults. The Adverse Childhood  
122 Experiences (ACE) Study. *Am J Prev Med* 1998;14(4):245-58. [published Online First:  
123 1998/06/23]
- 124 2. Anda RF, Felitti VJ, Bremner JD, et al. The enduring effects of abuse and related adverse  
125 experiences in childhood. A convergence of evidence from neurobiology and epidemiology.  
126 *Eur Arch Psychiatry Clin Neurosci* 2006;256(3):174-86. doi: 10.1007/s00406-005-0624-4  
127 [published Online First: 2005/11/29]
- 128 3. Nandi A, Glymour MM, Kawachi I, et al. Using marginal structural models to estimate the direct  
129 effect of adverse childhood social conditions on onset of heart disease, diabetes, and stroke.  
130 *Epidemiology* 2012;23(2):223-32. doi: 10.1097/EDE.0b013e31824570bd  
131 00001648-201203000-00008 [pii] [published Online First: 2012/02/10]
- 132 4. Brown DW, Anda RF, Tiemeier H, et al. Adverse childhood experiences and the risk of premature  
133 mortality. *Am J Prev Med* 2009;37(5):389-96. doi: 10.1016/j.amepre.2009.06.021
- 134 5. Bellis MA, Hughes K, Leckenby N, et al. Adverse childhood experiences and associations with  
135 health-harming behaviours in young adults: surveys in eight eastern European countries.  
136 *Bull World Health Organ* 2014;92(9):641-55. doi: 10.2471/BLT.13.129247 [published Online  
137 First: 2014/11/08]
- 138 6. Anda RF, Butchart A, Felitti VJ, et al. Building a framework for global surveillance of the public  
139 health implications of adverse childhood experiences. *Am J Prev Med* 2010;39(1):93-8. doi:  
140 10.1016/j.amepre.2010.03.015  
141 S0749-3797(10)00277-1 [pii] [published Online First: 2010/06/16]
- 142 7. Halonen JI, Stenholm S, Pentti J, et al. Childhood Psychosocial Adversity and Adult  
143 Neighborhood Disadvantage as Predictors of Cardiovascular Disease: A Cohort Study.  
144 *Circulation* 2015;132(5):371-9. doi: 10.1161/CIRCULATIONAHA.115.015392 [published  
145 Online First: 2015/06/13]
- 146 8. Shibuya K, Hashimoto H, Ikegami N, et al. Future of Japan's system of good health at low cost  
147 with equity: beyond universal coverage. *Lancet* 2011;378(9798):1265-73. doi:  
148 10.1016/S0140-6736(11)61098-2  
149 S0140-6736(11)61098-2 [pii] [published Online First: 2011/09/03]
- 150 9. Vuorenkoski L, Mladovsky P, Mossialos E. Finland: Health system review. *Health systems in  
151 transition* 2008;10(4):1-168.
- 152 10. Cummings WK. Education and equality in Japan: Princeton University Press 2014.
- 153 11. John Helliwell, Richard Layard, Sachs J. The World Happiness Report: New York: Sustainable  
154 Development Solutions Network; 2016 [Available from: <http://worldhappiness.report/>  
155 accessed Nov, 18 2016.

- 1  
2  
3 156 12. Yitzhaki S, Schechtman E. Social Welfare, Relative Deprivation, and the Gini Coefficient.  
4  
5 157 *Springer Ser Stat* 2013;253-73. doi: 10.1007/978-1-4614-4720-7\_13  
6  
7 158 13. OECD. OECD Income Distribution Database (IDD): Gini, poverty, income, methods and  
8 159 concepts 2016 [Available from: [http://www.oecd.org/social/income-distribution-](http://www.oecd.org/social/income-distribution-database.htm)  
9 160 [database.htm](http://www.oecd.org/social/income-distribution-database.htm) accessed Jul, 18 2017.  
10  
11 161 14. United Nations. International Migration 2017 2017 [Available from:  
12 162 [http://www.un.org/en/development/desa/population/migration/publications/wallchart/docs/](http://www.un.org/en/development/desa/population/migration/publications/wallchart/docs/MigrationWallChart2017.pdf)  
13 163 [MigrationWallChart2017.pdf](http://www.un.org/en/development/desa/population/migration/publications/wallchart/docs/MigrationWallChart2017.pdf) accessed August 27 2018.  
14  
15 164 15. Japanese Ministry of Internal Affairs and Communications. Statistical Handbook of Japan 2017  
16 165 2017 [Available from: <http://www.stat.go.jp/english/data/handbook/c0117.html> accessed  
17 166 August 27 2018.  
18  
19 167 16. eurostat. Marriage and divorce statistics 2015 [Available from:  
20 168 [https://ec.europa.eu/eurostat/statistics-](https://ec.europa.eu/eurostat/statistics-explained/index.php/Marriage_and_divorce_statistics)  
21 169 [explained/index.php/Marriage and divorce statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php/Marriage_and_divorce_statistics) accessed August 27 2018.  
22  
23 170 17. Amemiya A, Fujiwara T, Murayama H, et al. Adverse childhood experiences and higher-level  
24 171 functional limitations among older Japanese people: results from the JAGES study. *J*  
25 172 *Gerontol A Biol Sci Med Sci* 2017 doi: 10.1093/gerona/glx097 [published Online First:  
26 173 2017/05/20]  
27  
28 174 18. Halonen JI, Vahtera J, Kivimaki M, et al. Adverse experiences in childhood, adulthood  
29 175 neighbourhood disadvantage and health behaviours. *J Epidemiol Community Health*  
30 176 2014;68(8):741-6. doi: 10.1136/jech-2013-203441 [published Online First: 2014/04/26]  
31  
32 177 19. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences  
33 178 on health: a systematic review and meta-analysis. *Lancet Public Health* 2017;2(8):e356-e66.  
34 179 doi: 10.1016/S2468-2667(17)30118-4 [published Online First: 2017/12/19]  
35  
36 180 20. Xiao Q, Dong MX, Yao J, et al. Parental alcoholism, adverse childhood experiences, and later  
37 181 risk of personal alcohol abuse among Chinese medical students. *Biomed Environ Sci*  
38 182 2008;21(5):411-9. doi: 10.1016/S0895-3988(08)60062-8 [published Online First: 2009/01/13]  
39  
40 183 21. Pirkola S, Isometsa E, Aro H, et al. Childhood adversities as risk factors for adult mental  
41 184 disorders. *Soc Psych Psych Epid* 2005;40(10):769-77. doi: 10.1007/s00127-005-0950-x  
42  
43 185 22. Harkonmaki K, Korkeila K, Vahtera J, et al. Childhood adversities as a predictor of disability  
44 186 retirement. *J Epidemiol Commun H* 2007;61(6):479-84. doi: DOI 10.1136/jech.2006.052670  
45  
46 187 23. Lucas RE. Time does not heal all wounds - A longitudinal study of reaction and adaptation to  
47 188 divorce. *Psychol Sci* 2005;16(12):945-50. doi: DOI 10.1111/j.1467-9280.2005.01642.x  
48  
49 189 24. Laaksonen E, Martikainen P, Lahelma E, et al. Socioeconomic circumstances and common  
50 190 mental disorders among Finnish and British public sector employees: evidence from the  
51 191 Helsinki Health Study and the Whitehall II Study. *Int J Epidemiol* 2007;36(4):776-86. doi:  
52 192 dym074 [pii]  
53 193 10.1093/ije/dym074 [published Online First: 2007/05/23]  
54  
55 194 25. Feldt T, Lintula H, Suominen S, et al. Structural validity and temporal stability of the 13-item

- 1  
2  
3 195 sense of coherence scale: prospective evidence from the population-based HeSSup study.  
4 196 *Qual Life Res* 2007;16(3):483-93. doi: 10.1007/s11136-006-9130-z
- 5  
6 197 26. Korkeila K, Suominen S, Ahvenainen J, et al. Non-response and related factors in a nation-wide  
7 198 health survey. *Eur J Epidemiol* 2001;17(11):991-9. [published Online First: 2002/10/17]
- 8  
9 199 27. Fujiwara T, Kawakami N. Association of childhood adversities with the first onset of mental  
10 200 disorders in Japan: results from the World Mental Health Japan, 2002-2004. *J Psychiatr*  
11 201 *Res* 2011;45(4):481-7. doi: 10.1016/j.jpsychires.2010.08.002  
12  
13 202 S0022-3956(10)00243-8 [pii] [published Online First: 2010/08/24]
- 14  
15 203 28. Matsuyama Y, Fujiwara T, Aida J, et al. Experience of childhood abuse and later number of  
16 204 remaining teeth in older Japanese: a life-course study from Japan Gerontological  
17 205 Evaluation Study project. *Community Dent Oral Epidemiol* 2016;44(6):531-39. doi:  
18 206 10.1111/cdoe.12246
- 19  
20 207 29. Amemiya A, Fujiwara T, Murayama H, et al. Adverse Childhood Experiences and Higher-Level  
21 208 Functional Limitations Among Older Japanese People: Results From the JAGES Study. *J*  
22 209 *Gerontol A Biol Sci Med Sci* 2018;73(2):261-66. doi: 10.1093/gerona/glx097 [published  
23 210 Online First: 2017/05/20]
- 24  
25 211 30. Rahkonen O, Lahelma E, Huuhka M. Past or present? Childhood living conditions and current  
26 212 socioeconomic status as determinants of adult health. *Soc Sci Med* 1997;44(3):327-36. doi:  
27 213 S0277953696001025 [pii] [published Online First: 1997/02/01]
- 28  
29 214 31. Korkeila J, Vahtera J, Korkeila K, et al. Childhood adversities as predictors of incident coronary  
30 215 heart disease and cerebrovascular disease. *Heart* 2010;96(4):298-303. doi:  
31 216 10.1136/hrt.2009.188250  
32 217 96/4/298 [pii] [published Online First: 2010/03/03]
- 33  
34 218 32. Iwai H. Social Tolerance for the Use of Physical Punishment by Parents: An Analysis of  
35 219 Attitude toward Physical Punishment using JGSS-2008. *JGSS Research Series* 2010;No.7
- 36  
37 220 33. Chartier MJ, Walker JR, Naimark B. Separate and cumulative effects of adverse childhood  
38 221 experiences in predicting adult health and health care utilization. *Child Abuse Negl*  
39 222 2010;34(6):454-64. doi: 10.1016/j.chiabu.2009.09.020
- 40  
41 223 34. Fujiwara T, Kondo K, Shirai K, et al. Associations of childhood socioeconomic status and  
42 224 adulthood height with functional limitations among Japanese older people: results from the  
43 225 JAGES 2010 Project. *J Gerontol A Biol Sci Med Sci* 2014;69(7):852-9. doi:  
44 226 10.1093/gerona/glt189
- 45  
46 227 35. Tani Y, Fujiwara T, Kondo N, et al. Childhood Socioeconomic Status and Onset of Depression  
47 228 among Japanese Older Adults: The JAGES Prospective Cohort Study. *Am J Geriatr*  
48 229 *Psychiatry* 2016;24(9):717-26. doi: 10.1016/j.jagp.2016.06.001
- 49  
50 230 36. Kuh D, Shlomo YB. A life course approach to chronic disease epidemiology: Oxford University  
51 231 Press 2004.
- 52  
53 232 37. Bellis MA, Hardcastle K, Ford K, et al. Does continuous trusted adult support in childhood  
54 233 impart life-course resilience against adverse childhood experiences - a retrospective study



- 1  
2  
3 234 on adult health-harming behaviours and mental well-being. *BMC Psychiatry*  
4 235 2017;17(1):110. doi: 10.1186/s12888-017-1260-z [published Online First: 2017/03/25]  
5  
6 236 38. Bellis MA, Hughes K, Ford K, et al. Adverse childhood experiences and sources of childhood  
7 237 resilience: a retrospective study of their combined relationships with child health and  
8 238 educational attendance. *BMC Public Health* 2018;18(1):792. doi: 10.1186/s12889-018-5699-  
9 239 8 [published Online First: 2018/06/27]  
10  
11 240 39. Runsten S, Korkeila K, Koskenvuo M, et al. Can social support alleviate inflammation  
12 241 associated with childhood adversities? *Nord J Psychiatry* 2014;68(2):137-44. doi:  
13 242 10.3109/08039488.2013.786133  
14  
15 243 40. Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking during  
16 244 adolescence and adulthood. *JAMA* 1999;282(17):1652-8.  
17  
18 245 41. Bellis MA, Lowey H, Leckenby N, et al. Adverse childhood experiences: retrospective study to  
19 246 determine their impact on adult health behaviours and health outcomes in a UK population.  
20 247 *J Public Health (Oxf)* 2014;36(1):81-91. doi: 10.1093/pubmed/fdt038 [published Online  
21 248 First: 2013/04/17]  
22  
23 249 42. Kestila L, Koskinen S, Martelin T, et al. Influence of parental education, childhood adversities,  
24 250 and current living conditions on daily smoking in early adulthood. *Eur J Public Health*  
25 251 2006;16(6):617-26. doi: 10.1093/eurpub/ckl054  
26  
27  
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4 253 **Supplemental table S1.** Measurement of adverse childhood experience

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7 254 **Supplemental table S2.** Measurement of health and health behaviours

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256 Supplemental table S1. Measurement of adverse childhood experience

Items	JAGES		FPS, HeSSup			
	Question	Answer	Code	Question	Answer	Code
<b>Parental divorce in childhood</b>	Did you experience any of the following before the age of 18?;			The respondents were asked whether they had experienced the following adversities in their childhood:		
	Parents' divorce	No	0	Divorce/separation of the parents	No	0
		Yes	1		Yes	1
		Unkn own	miss ing		Do not know or cannot say	miss ing
<b>Severe financial difficulties</b>	Financial trouble	No	0	Long-term financial difficulties in the family	No	0
		Yes	1		Yes	1
		Unkn own	miss ing		Do not know or cannot say	miss ing
<b>Fear of a family member</b>	1) Your father was violent with your mother (being witness to domestic violence) 2) You were hit hard by your mother/father causing an injury (physical abuse)	No	0	Frequent fear for a family member	No	0
		Yes <sup>a</sup>	1		Yes	1
		Unkn own	miss ing		Do not know or cannot say	miss ing

**a: If someone answers yes to the question of either of 1) or 2), the code is "Yes".**

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259 Supplemental table S2. Measurement of health and health behaviours

Items	JAGES		FPS			
	Question	Answer	Code	Question	Answer	Code
Self-rated health	How is your current health status?	Excellent	0	<b>How is your current health status?</b>	Good	0
		Good	0		Fairly good	0
		Fair	1		Moderate	1
		Poor	1		Fairly poor	1
Cancer	Circle the number of all diseases for which you are currently receiving treatment or experiencing; Cancer	No	0	National Cancer Register	No	0
		Yes	1		Yes within 5 years	1
					Unknown	Missing
Heart disease or stroke	Circle the number of all diseases for which you are currently receiving treatment or experiencing; 1) Heart disease, 2) Stroke (e.g. brain hemorrhage, cerebral infarction)	No	0	Special reimbursement for the medication, from Social Insurance Institution of Finland	No	0
		Yes <sup>a</sup>	1		Yes	1
					Unknown	Missing
Diabetes mellitus	Circle the number of all diseases for which you are currently receiving treatment or experiencing; Diabetes mellitus	No	0	Special reimbursement for the medication, from Social Insurance Institution of Finland	No	0

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Smoking	Do you smoke cigarettes?	Yes	1	Do you smoke or have you ever smoked regularly, i.e. every day or almost every day?	Yes	1
					Unknown	Missing
		No	0		Never	0
		I used to smoke	1		Yes, before	1
		Yes	2		Yes, I still do	2

**a: If someone answers yes to the question of either of 1) or 2), the code is "Yes".**

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1 **Supplemental table S1.** Measurement of adverse childhood experience

2 **Supplemental table S2.** Measurement of health and health behaviours

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4 Supplemental table S1. Measurement of adverse childhood experience

Items	JAGES			FPS, HeSSup		
	Question	Answer	Code	Question	Answer	Code
	Did you experience any of the following before the age of 18?;			The respondents were asked whether they had experienced the following adversities in their childhood:		
<b>Parental divorce in childhood</b>	Parents' divorce	No	0	Divorce/separation of the parents	No	0
		Yes	1		Yes	1
		Unknown	missing		Do not know or cannot say	missing
<b>Severe financial difficulties</b>	Financial trouble	No	0	Long-term financial difficulties in the family	No	0
		Yes	1		Yes	1
		Unknown	missing		Do not know or cannot say	missing
<b>Fear of a family member</b>	1) Your father was violent with your mother (being witness to domestic violence)	No	0	Frequent fear for a family member	No	0
		Yes <sup>a</sup>	1		Yes	1
		Unknown	missing		Do not know or cannot say	missing
	2) You were hit hard by your mother/father causing an injury (physical abuse)					

a: If someone answers yes to the question of either of 1) or 2), the code is "Yes".

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7 Supplemental table S2. Measurement of health and health behaviours

Items	JAGES			FPS		
	Question	Answer	Code	Question	Answer	Code
Self-rated health	How is your current health status?	Excellent	0	<b>How is your current health status?</b>	Good	0
		Good	0		Fairly good	0
		Fair	1		Moderate	1
		Poor	1		Fairly poor	1
					Poor	1
Cancer	Circle the number of all diseases for which you are currently receiving treatment or experiencing; Cancer	No	0	National Cancer Register	No	0
		Yes	1		Yes within 5 years	1
					Unknown	Missing
Heart disease or stroke	Circle the number of all diseases for which you are currently receiving treatment or experiencing; 1) Heart disease, 2) Stroke (e.g. brain hemorrhage, cerebral infarction)	No	0	Special reimbursement for the medication, from Social Insurance Institution of Finland	No	0
		Yes <sup>a</sup>	1		Yes	1
					Unknown	Missing
Diabetes mellitus	Circle the number of all diseases for which you are currently receiving treatment or experiencing; Diabetes mellitus	No	0	Special reimbursement for the medication, from Social Insurance Institution of Finland	No	0
		Yes	1		Yes	1
				Unknown	Missing	
Smoking	Do you smoke cigarettes?	No	0	Do you smoke or have you ever smoked regularly, i.e. every day or almost every day?	Never	0



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I used to	1	Yes, before	1
smoke			
Yes	2	Yes, I still do	2

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a: If someone answers yes to the question of either of 1) or 2), the code is "Yes".

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# BMJ Open

## Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-024609.R2
Article Type:	Research
Date Submitted by the Author:	03-May-2019
Complete List of Authors:	Amemiya, Airi; University of Tokyo School of Public Health, Department of Health Economics and Epidemiology Research Fujiwara, Takeo; Tokyo Medical and Dental University, Department of Global Health Promotion Shirai, Kokoro; Osaka University, Department of Public Health Kondo, Katsunori; Chiba University, Center for Preventive Medical Science Oksanen, Tuula; Finnish Institute of Occupational Health Pentti, Jaana; University of Turku, Department of Public Health Vahtera, Jussi; Työterveyslaitos
<b>Primary Subject Heading</b> :	Epidemiology
Secondary Subject Heading:	Diabetes and endocrinology, Cardiovascular medicine, Oncology, Smoking and tobacco
Keywords:	Adverse childhood experience, Life-course approach, International comparison study, Japan, Finland

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**Title:****Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland**

Airi Amemiya<sup>1</sup>, Takeo Fujiwara\*<sup>2</sup>, Kokoro Shirai<sup>3</sup>, Katsunori Kondo<sup>4, 5, 6</sup>, Tuula Oksanen<sup>7</sup>, Jaana Pentti<sup>8</sup>, Jussi Vahtera<sup>8, 9</sup>

1. Department of Social Medicine, National Research Institute for Child Health and Development, 2-10-1 Okura, Setagaya-ku, Tokyo 157-8535, Japan

2. Department of Global Health Promotion, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8510, Japan

3. Department of Public Health, Graduate School of Medicine, Associate Professor, 2-2 Yamadaoka, Suita, Osaka-shi, 565-0871 Osaka, Japan

4. Center for Preventive Medical Sciences, Chiba University, 1-8-1, Inohana, Chuo Ward, Chiba-shi, Chiba, 260-0856, Japan

5. Center for Well-being and Society, Nihon Fukushi University, Okuda, Mihama-cho, Chita-gun, Aichi 470-3295, Japan

6. Department of Gerontology and Evaluation Study, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, 7-430 Morioka-cho, Obu City,

1  
2  
3  
4  
5  
6 Aichi 474-8511, Japan  
7  
8

9 7. Finnish Institute of Occupational Health, FI-20032 TYÖTERVEYSLAITOS, Turku,  
10  
11  
12 Finland  
13

14  
15 8. Department of Public Health, University of Turku, 20014 Turun yliopisto, Turku,  
16  
17  
18 Finland  
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20  
21 9. Turku University Hospital, Kiinamylynkatu 4–8, Turku, Finland  
22  
23  
24  
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27 **Corresponding author:**  
28

29  
30 Takeo Fujiwara  
31

32  
33 Tel: +81-3-3417-2663  
34

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36 Email: [fujiwara.hlth@tmd.ac.jp](mailto:fujiwara.hlth@tmd.ac.jp)  
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## ABSTRACT

**Objective:** We aimed to examine the association between adverse childhood experiences (ACEs) and adult diseases in older adults in Japan and Finland.

**Design:** Cross-sectional comparative study.

**Setting:** Data from a gerontological study in Japan and two public health studies in Finland were evaluated.

**Participants:** A total of 13,123 adults (mean age, 69.5 years) from Japan and 10,353 adults (mean age, 64.4 years) from Finland were included in this study. Logistic regression was used to examine the associations of each of, any of, and the cumulative number of ACEs (parental divorce, fear of a family member, and poverty in childhood; treated as ordered categorical variables) with poor self-rated health, cancer, heart disease or stroke, diabetes mellitus, smoking, and body mass index. Models were adjusted for sex, age, education, marital status, and working status.

**Results:** Of the respondents, 50% of those in Japan and 37% of those in Finland reported having experienced at least one of the measured ACEs. Number of ACEs was associated with poor self-rated health in both countries, and the point estimates were similar (odds ratio [OR]: 1.35, 95% confidence interval [CI]: 1.25-1.46 in Japan; OR: 1.34, 95% CI: 1.27-1.41 in Finland). Number of ACEs was associated with the prevalence of cancer,

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6 heart disease or stroke, diabetes mellitus, current smoking, and an increase in body mass  
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9 index in both countries.  
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12 **Conclusions:** The association between ACEs and poor self-rated health, adult diseases,  
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14 and health behaviours was similar among older adults in both Japan and Finland. This  
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16 international comparative study suggests that the impact of ACEs on health is noteworthy  
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18 and consistent across cultural and social environments.  
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#### 28 **Strength and limitations of this study**

- 29  
30 • This is an international comparative study that investigated the impact of adverse  
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32 childhood experiences (ACEs) on the health of older adults in different cultural and  
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34 social environments (Japan and Finland) using harmonised data.  
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- 39 • The limitation of this study is that it was a cross-sectional study, and therefore  
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41 differential recall and selection bias cannot be ruled out. Survival bias is also possible  
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43 because the participants were older adults.  
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- 47 • Another limitation of this study is that the pooled data of the two countries were not  
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49 accessible, and therefore interactive effects of the countries and ACE on adult health  
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51 were not clear.  
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## INTRODUCTION

Although there is an increasing number of studies that have investigated the association between adverse childhood experiences (ACEs, such as long-term financial difficulties, parental divorce, and fear of a family member) and unhealthy behaviours (e.g., obesity, alcohol consumption, smoking, and lower levels of physical activity), adult diseases (e.g., cardiovascular disease, diabetes, stroke, cancer, and depression), and even early death,<sup>1-4</sup> few studies have investigated whether ACEs has an impact on the health of older adults. Because of the rising number of older adults in the world, it is therefore necessary to elucidate the risk factors for diseases among older people.

Further, to address the impact of ACEs on health of older people, it is also crucial to elucidate the commonality of the association, because the pathways linking childhood adversities with adult health are likely to be dependent on cultural or social environments.<sup>5-7</sup> Therefore, a comparison of countries with different cultural and/or social environments in childhood, but with similar welfare state regimes, may provide further understanding of the underlying mechanisms of ACEs and older adult health. According to a systematic review, most of the recent studies evaluating the impact of multiple ACEs on health were performed in the United States (US) and the United Kingdom (UK), with only a few studies conducted in other countries,<sup>8</sup> such as Asia<sup>9</sup> or Nordic countries.<sup>10 11</sup>

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6 Because the US and UK are developed countries with high inequality, there is a need to  
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9 confirm the association in developed but relatively equal, egalitarian countries, such as  
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12 Japan or Finland.  
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15 Japan (population: approximately 127 million) and Finland (population:  
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17 approximately 5.5 million) are members of the Organization for Economic Co-operation  
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19 and Development (OECD). The two countries employ a universal healthcare system<sup>12 13</sup>  
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21 and provide free education to those aged 6 to 15 years.<sup>14</sup> According to the World  
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23 Happiness Report, the level of social support received (measured by having someone to  
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25 count on in times of trouble) is relatively high in both countries (92.3% and 94.8% in  
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27 Japan and Finland in 2015, respectively).<sup>15</sup> However, the two countries differ in terms of  
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29 equality (e.g., the Gini coefficient, a measure which represents the income distribution of  
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31 a country's residents,<sup>16</sup> was 0.38 in Japan in 2014 and 0.26 in Finland 2015). Out of the  
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33 37 OECD countries, Japan ranked 22<sup>th</sup> and Finland ranked 7<sup>th</sup> in 2015 in terms of  
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35 equality.<sup>17</sup> Furthermore, immigration policies in the two countries were different at the  
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37 time of this study; international migrants made up 1.3% of the total Japanese population,  
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39 whereas 6.2% of the Finnish population were international migrants in 2017.<sup>18</sup> Moreover,  
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41 the divorce rate in Japan in 2017 was 1.7/1,000 people,<sup>19</sup> whereas it was 2.5/1,000 people  
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43 in Finland in 2015.<sup>20</sup> Finally, the prevalence of ACEs also differed between Japan and  
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7 Finland, with 37% of participants (mean age of 73 years old) in a Japanese study reporting  
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9 at least one ACE,<sup>21</sup> and 61% of participants (mean age of 48 years old) in a Finnish study  
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11 reporting at least one ACE.<sup>22</sup> Corporal punishment is not forbidden in Japan, but in  
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13 Finland, it has been prohibited by law since 1983. In summary, both Japan and Finland  
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15 are developed and egalitarian countries, but their differences in terms of inequality,  
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17 immigration percentage, divorce rate, or policy on corporal punishment might contribute  
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19 to the differential impact of ACEs on diseases in older adults. For example, deetiolated  
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21 social capital due to inequality<sup>23</sup> might contribute to stronger impact of ACEs on health  
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23 in older adults.  
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33 Therefore, the purpose of this study was to examine and compare the association  
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35 between ACEs and adult diseases, including unhealthy behaviours such as smoking, in  
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37 older adults in Japan and Finland.  
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## 45 **METHODS**

### 46 **Sample**

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49 The data in this study were collected from surveys conducted among older individuals in  
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51 Finland and Japan. The Japanese data were from the Japan Gerontological Evaluation  
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53 Study (JAGES), which comprises community-dwelling individuals aged 65 years and  
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6 older from 30 municipalities (in 14 municipalities the entire population was surveyed,  
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9 whereas in the remaining 16 municipalities random sampling was performed) who were  
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12 not eligible to receive benefits from public long-term care insurance services (e.g., those  
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15 without functional disability). Self-administered survey questionnaires were delivered by  
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18 post to those who were listed in a ledger of individuals insured for long-term care. The  
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21 participants of the JAGES might be healthier than the average older Japanese population  
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24 because one of the inclusion criteria to participate in the JAGES study is not receiving  
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27 long-term care. The data used were from participants aged  $\geq 65$  years (n = 137,736,  
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30 response rate = 71%), with a fifth randomly chosen and questioned for information on  
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33 adverse experiences in childhood (n = 26,229) in 2013. The participants of the current  
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36 study were restricted to an age range of 65-74 years (n = 15,070). Participants with  
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39 missing data on any ACEs (n=1,158), self-rated health (SRH) (n=325), body mass index  
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42 (BMI) (n= 483), and smoking (n=163) were excluded.

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46 The Finnish data were drawn from two prospective cohort studies, the Finnish  
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48 Public Sector (FPS) study<sup>24</sup> and the Health and Social Support (HeSSup) study.<sup>25</sup> The  
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51 FPS study included employees representing a wide range of occupations working in ten  
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54 towns and six hospital districts. The participants of the FPS were individuals who were,  
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57 at the time of the study or had previously been, public sector employees; thus, they did  
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6 not fully represent the general Finnish population of the same age. The FPS data used in  
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9 this study were derived from employed and retired participants in the 2008/2009 survey,  
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12 and included information on self-reported ACEs (n = 42,877, response rate = 69%). For  
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15 this study, all FPS study respondents were aged  $\geq 60$  years, and those who provided  
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18 information on any ACEs, SRH, BMI, and smoking were selected (n=7,169). The  
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21 HeSSup study targeted a sample representative of the Finnish population in four age  
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24 groups (20–24, 30–34, 40–44, and 50–54 years), in 1998. Therefore, the participants of  
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27 the HeSSup may be representative of the Finnish population.<sup>26</sup> In the 2012 follow-up  
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30 survey, information on self-reported ACEs was obtained from 11,924 participants  
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33 (response rate = 78%). Of them, those in the oldest age group (64–68 years) who provided  
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36 data on any ACEs, SRH, BMI, and smoking were selected (n = 3,184). Self-administered  
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39 survey questionnaires were used in the FPS and HeSSup studies. The two Finnish cohorts  
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42 were pooled. The studies together included 13,123 (6,214 men and 6,909 women)  
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45 participants from Japan and 10,353 (3,201 men and 7,152 women) participants from  
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48 Finland.

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52 The JAGES was approved by the Ethics Committee for Research on Human  
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54 Subjects at Nihon Fukushi University, Japan (No. 10–05) and the Ethics Committee for  
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57 Medical Research at the University of Tokyo (No. 10555). The FPS study was approved  
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6 by the Ethics Committee of the Helsinki and Uusimaa Hospital District and HeSSup study  
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9 by the joint Ethics Committee of the University of Turku and the Turku University  
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12 Central Hospital. The studies include ethical approval for secondary analyses. The  
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15 information on data management and handling is relevant and available for the study  
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18 administrators in each country. We did not handle any personal identifiers in the analysis.  
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### 23 **Participants and Public Involvement**

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25 Patients were not involved in the development of the research question, outcome  
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29 measures, design, or conduct of the study.  
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### 35 **Measurement of adverse childhood experiences**

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38 The questions related to ACEs were somewhat different between the three studies, but  
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41 the variables were harmonised. In short, we assessed three ACEs: (1) parental divorce  
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44 (the FPS study, HeSSup study, and JAGES), (2) fear of a family member (FPS and  
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47 HeSSup studies)/witness of domestic violence or physical abuse (JAGES), and (3)  
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50 financial difficulties in the family (FPS study, HeSSup study, and JAGES).  
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53 In the JAGES, we assessed ACEs using four questions modified from Felitti's  
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56 original ACE study[1] and the World Mental Health survey in Japan.<sup>27</sup> Respondents were  
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59 asked if they had experienced the following adversities in their childhood (yes/no):  
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parents' divorce/separation, financial difficulties in the family, being witness to domestic violence, or physical abuse. We categorised those who responded having experienced "being witness to domestic violence" and/or "physical abuse" as having "frequent fear of a family member" to make these ACEs comparable to those in the FPS and HeSSup studies. Violence against the child (physical abuse) and the mother (witnessing domestic violence) may both result in "fear of a family member", and we therefore coded witness of domestic violence or physical abuse as "fear of a family member". These ACEs measures have been shown to predict the number of remaining teeth<sup>28</sup> and higher functional limitation in Japan.<sup>29</sup> In the FPS and HeSSup studies, we assessed ACEs using three survey questions modified from Statistics Finland's Survey of Living Conditions.<sup>30</sup> Respondents were asked whether they had experienced the following adversities: parent's divorce/separation, long-term financial difficulties in the family, and frequent fear of a family member (the response categories "no", "yes", and "cannot say" were coded as dummy variables), and the findings have been used in other studies to predict the presence of coronary heart disease,<sup>31</sup> depression,<sup>31</sup> and non-adherence to statin therapy.<sup>7</sup> The questions regarding each ACE are shown in Supplemental table S1.

For the present study, the three ACEs were analysed both separately and as a summary variable (0, 1, 2 and 3 ACEs).

## Measurement of adult health and health behaviours

Questions on adult health and health behaviours were somewhat different between the countries. In the JAGES, SRH was measured using the question: “How do you feel about your current health status: excellent, good, fair, or poor?” Responses were recoded to dichotomous response variables (fair/poor as 0, and excellent/good as 1). A history of being diagnosed with cancer, heart diseases or stroke, or diabetes mellitus was self-reported (response categories: “yes” and “no”). BMI was calculated as participants’ self-reported weight in kilograms divided by height in meters squared. The smoking status (current, former, or never) was based on replies to survey questionnaires.

In the FPS and HeSSup studies, SRH was measured through the question: “How is your current health status?” with five response categories (from 1 [poor] to 5 [excellent]). The responses “moderate”, “good”, and “excellent” were categorised as good (1), and the other response options as poor (0). Information on cancer was derived from the National Cancer Registry, and prevalent cardiovascular disease (heart disease or stroke) and diabetes mellitus were defined based on the special reimbursement for the medication for these diseases, as obtained from the Social Insurance Institution of Finland. In FPS and HeSSup, we used personal identification codes, assigned to all Finnish citizens,

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6 to link the respondents to their records in national health registers. BMI was calculated  
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9 from self-reported weight and height. Smoking status (current, former, and never) was  
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12 based on survey responses. Questions regarding health and health behaviours are shown  
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15 in Supplemental table S2.  
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### 21 **Covariates**

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24 Education was divided into three levels: (i) 9 years or less, referring to a comprehensive  
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26 school education in Finland and junior high school education in Japan, (ii) 9–12 years,  
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28 describing post-compulsory secondary general academic and vocational education in  
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30 Finland and high school or technical college education in Japan, and (iii) 12 years or  
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32 more, referring to a university degree in both countries. Marital status was divided into  
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34 four categories: (i) single, never married and non-cohabiting, (ii) widowed, (iii) divorced,  
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36 and (iv) married or cohabiting with a partner. Working status was divided into two  
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38 categories: (i) working and (ii) retired or never worked (Japan). Regarding working status,  
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40 those who had never worked were not included in FPS because FPS is a study of  
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42 individuals who were at the time of study, or had previously been, public sector  
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44 employees and represented a wide range of occupations. Therefore, we combined ‘retired  
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46 and never worked’ as ‘not working’ in Japan to be comparable with the studies in Finland.  
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Missing values were treated as dummy variables.

### Statistical analysis

Logistic regression analysis was performed to examine the association of each ACE, any ACE, and the cumulative number of ACEs (e.g., 0, 1, 2, and 3 ACEs) with health outcomes. Linear regression analysis was used for BMI. Multinomial logistic regression was used for smoking status. Model 1 was adjusted for age and sex. Model 2 was further adjusted for education, marital status, and working status.

The odds ratios (ORs) and their 95% confidence intervals (95% CIs) were calculated. Statistical analysis was performed using Stata (ver. 13.1; StataCorp, College Station, TX, USA).

## RESULTS

Table 1 shows the distribution of the variables for each country. The prevalence rates of parental divorce, fear of a family member, and childhood poverty were 3%, 9%, and 47%, respectively, in Japan. In Finland, these proportions were 9%, 13%, and 29%, respectively. Of the respondents, 50% of those in Japan and 37% of those in Finland reported having experienced at least one ACE. The mean age of the participants and the proportion of men



were higher in Japan than in Finland.

Table 1. Characteristics of the study participants

	Japan (JAGES) (N = 13,123)		Finland (pooled FPS and HeSSup studies) (N = 10,353)			
	N or mean	% or SD	N or mean	% or SD		
Parental divorce	336	2.6	958	9.3	p <0.01 <sup>a</sup>	
Fear of a family member	1195	9.1	1348	13.0	p <0.01 <sup>a</sup>	
Childhood poverty	6135	46.8	3013	29.1	p <0.01 <sup>a</sup>	
Any adverse childhood experience	6561	50.0	3852	37.2	p <0.01 <sup>a</sup>	
Total number of adverse childhood experiences	0	6562	50.0	6501	62.8	p <0.01 <sup>a</sup>
	1	5517	42.0	2634	25.4	
	2	983	7.5	969	9.4	
	3	61	0.5	249	2.4	
Age	69.5	2.8	64.4	2.9	p <0.01 <sup>b</sup>	
Sex						
	Male	6214	47.4	3201	30.9	p <0.01 <sup>a</sup>
	Female	6909	52.7	7152	69.1	
SRH	Poor/fair	1770	13.5	3780	36.5	p <0.01 <sup>a</sup>
Cancer		460	3.5	388	3.8	p <0.32 <sup>a</sup>
	Missing			54	0.5	
Heart disease or stroke		1353	10.3	466	4.5	p <0.01 <sup>a</sup>
	Missing			54	0.5	
Diabetes mellitus		1738	13.2	714	6.9	p <0.01 <sup>a</sup>
	Missing			54	0.5	
BMI mean		23.0	3.1	26.7	4.4	p <0.01 <sup>b</sup>

Smoking	Never	9221	70.3	6973	67.4	p <0.01 <sup>a</sup>
	Former	2221	16.9	2444	23.6	
	Current	1681	12.8	936	9.0	
Education	<9 years	4395	33.5	1868	18.0	p <0.01 <sup>a</sup>
	10-12 years	5476	41.7	3168	30.6	
	12+ years	3103	23.7	5234	50.6	
	Missing	149	1.1	83	0.8	
Marital status	Single	326	2.5	574	5.5	p <0.01 <sup>a</sup>
	Divorced	535	4.1	1414	13.7	
	Widowed	1606	12.2	741	7.2	
	Married/cohabit	10441	79.6	7557	73.0	
	Missing	215	1.6	67	0.7	
Working status	Not working	8604	65.6	3092	29.9	p <0.01 <sup>a</sup>
	Working	4062	31.0	7230	69.8	
	Missing	457	3.5	31	0.3	

JAGES; Japan Gerontological Evaluation Study, FPS; Finnish Public Sector, HeSSup; Health and Social Support, SD; standard deviation, SRH; self-rated health, BMI; body mass index

a: Chi-squared test. b: t-test

As for SRH, the rate of “poor or fair” was higher in Finland than in Japan (37% and 14%, respectively). The prevalence of cancer was similar in both countries; however, that of heart disease or stroke and diabetes mellitus was higher in Japan. As for BMI, the mean BMI was higher in Finland than in Japan. The distribution of smoking status was

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6 similar. In the case of socioeconomic status, 50% of the people in Finland and 24% of  
7 those in Japan were educated for 12 years or more. Of the participants in Finland, 70%  
8 were currently working, whereas 66% of those in Japan were currently not working.  
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15 Table 2 shows the association between ACEs and SRH, and diseases (e.g., cancer,  
16 heart disease or stroke, and diabetes mellitus). SRH was associated with each type of ACE  
17 and the number of ACEs, for both countries. Interestingly, the point estimates were  
18 similar. For example, the OR of the number of ACEs for poor/fair SRH was 1.35 (95%  
19 CI: 1.25-1.46) in Japan and 1.34 (95% CI: 1.27-1.41) in Finland, after adjusting the  
20 covariates (Model 2). The ORs of the number of ACEs for cancer, heart disease or stroke,  
21 and diabetes mellitus were also similar in both studies in Model 2. As for each ACE, fear  
22 of a family member showed significant risk for cancer and diabetes in Finland, which was  
23 not observed in Japan.  
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Table 2. Association between adverse childhood experiences and poor self-rated health and diseases among older adults in Japan and Finland.

		Japan				Finland			
		Model 1		Model 2		Model 1		Model 2	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
SRH (poor/fair)	Parental divorce (ref.no): Yes	<b>1.40</b>	<b>1.05 - 1.86</b>	<b>1.34</b>	<b>1.004 - 1.80</b>	<b>1.37</b>	<b>1.20 - 1.57</b>	<b>1.30</b>	<b>1.13 - 1.49</b>
	Fear of a family member (ref.no): Yes	<b>1.77</b>	<b>1.52 - 2.05</b>	<b>1.70</b>	<b>1.46 - 1.98</b>	<b>1.65</b>	<b>1.47 - 1.85</b>	<b>1.56</b>	<b>1.39 - 1.76</b>
	Childhood poverty (ref.no): Yes	<b>1.46</b>	<b>1.32 - 1.62</b>	<b>1.32</b>	<b>1.19 - 1.47</b>	<b>1.68</b>	<b>1.54 - 1.83</b>	<b>1.60</b>	<b>1.46 - 1.75</b>
	Any ACE (ref.no): Yes	<b>1.50</b>	<b>1.36 - 1.67</b>	<b>1.37</b>	<b>1.23 - 1.52</b>	<b>1.66</b>	<b>1.53 - 1.80</b>	<b>1.60</b>	<b>1.47 - 1.74</b>
	Number of ACEs (continuous variable)	<b>1.43</b>	<b>1.33 - 1.54</b>	<b>1.35</b>	<b>1.25 - 1.46</b>	<b>1.39</b>	<b>1.32 - 1.46</b>	<b>1.34</b>	<b>1.27 - 1.41</b>
Cancer	Parental divorce (ref.no): Yes	1.32	0.78 - 2.24	1.40	0.82 - 2.38	1.16	0.82 - 1.62	1.19	0.84 - 1.67
	Fear of a family member (ref.no): Yes	0.99	0.72 - 1.37	1.01	0.73 - 1.40	<b>1.36</b>	<b>1.03 - 1.80</b>	<b>1.40</b>	<b>1.06 - 1.85</b>
	Childhood poverty (ref.no): Yes	<b>1.26</b>	<b>1.04 - 1.52</b>	<b>1.31</b>	<b>1.08 - 1.59</b>	1.05	0.84 - 1.32	1.07	0.86 - 1.35
	Any ACE (ref.no): Yes	<b>1.26</b>	<b>1.04 - 1.52</b>	<b>1.31</b>	<b>1.08 - 1.59</b>	1.11	0.90 - 1.36	1.13	0.91 - 1.39
	Number of ACEs (continuous variable)	<b>1.16</b>	<b>1.008 - 1.33</b>	<b>1.20</b>	<b>1.04 - 1.38</b>	1.11	0.97 - 1.26	1.13	0.99 - 1.28
Heart disease or stroke	Parental divorce (ref.no): Yes	1.30	0.94 - 1.81	1.26	0.91 - 1.76	0.93	0.66 - 1.32	0.90	0.63 - 1.27
	Fear of a family member (ref.no): Yes	1.13	0.94 - 1.37	1.10	0.91 - 1.32	1.16	0.88 - 1.54	1.11	0.84 - 1.48
	Childhood poverty (ref.no): Yes	<b>1.16</b>	<b>1.03 - 1.30</b>	1.11	0.99 - 1.25	<b>1.35</b>	<b>1.10 - 1.64</b>	<b>1.30</b>	<b>1.07 - 1.59</b>

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	Any ACE (ref.no): Yes	<b>1.15</b>	<b>1.02 - 1.29</b>	1.10	0.97 - 1.24	<b>1.32</b>	<b>1.09 - 1.59</b>	<b>1.28</b>	<b>1.05 - 1.55</b>
	Number of ACEs (continuous variable)	<b>1.14</b>	<b>1.04 - 1.24</b>	<b>1.10</b>	<b>1.01 - 1.20</b>	<b>1.14</b>	<b>1.01 - 1.28</b>	1.11	0.98 - 1.25
Diabetes mellitus	Parental divorce (ref.no): Yes	1.29	0.96 - 1.73	1.30	0.97 - 1.74	<b>1.37</b>	<b>1.07 - 1.75</b>	<b>1.34</b>	<b>1.05 - 1.72</b>
	Fear of a family member (ref.no): Yes	1.11	0.94 - 1.32	1.12	0.95 - 1.33	<b>1.46</b>	<b>1.18 - 1.80</b>	<b>1.42</b>	<b>1.15 - 1.76</b>
	Childhood poverty (ref.no): Yes	1.07	0.97 - 1.19	1.06	0.95 - 1.18	1.15	0.97 - 1.35	1.12	0.95 - 1.32
	Any ACE (ref.no): Yes	<b>1.12</b>	<b>1.01 - 1.24</b>	<b>1.11</b>	<b>1.001 - 1.24</b>	<b>1.21</b>	<b>1.04 - 1.42</b>	<b>1.19</b>	<b>1.02 - 1.39</b>
	Number of ACEs (continuous variable)	<b>1.08</b>	<b>1.001 - 1.17</b>	1.08	0.995 - 1.17	<b>1.18</b>	<b>1.08 - 1.30</b>	<b>1.17</b>	<b>1.06 - 1.28</b>

“Any” denotes the presence of at least 1 ACE.  
 ACE; Adverse childhood experience, OR; odds ratio, CI; confidence interval; SRH, self-rated health; ref., reference  
 Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.  
 Odds ratios (95% confidence intervals) were derived from logistic regression models.  
 Bold text indicates statistically significant with a p-value less than 0.05.

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4 Table 3 shows the associations between ACEs and smoking. Former smoking and  
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7 current smoking were positively associated with the number of ACEs for both countries, and the  
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10 ORs were similar. Table 4 shows the association between ACEs and BMI. BMI was positively  
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13 associated with each type of ACE, and with the number of ACEs in Finland. This positive  
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16 association was also significant in Japan.  
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Table 3. Association between adverse childhood experiences and former and current smoking among older adults in Japan and Finland.

		Japan				Finland			
		Model 1		Model 2		Model 1		Model 2	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Former smoking (ref: never)	Parental divorce (ref.no): Yes	1.13	0.82 - 1.57	1.12	0.81 - 1.56	<b>1.54</b>	<b>1.31 - 1.81</b>	<b>1.48</b>	<b>1.26 - 1.74</b>
	Fear of a family member (ref.no): Yes	1.14	0.96 - 1.36	1.11	0.93 - 1.32	<b>1.45</b>	<b>1.26 - 1.67</b>	<b>1.38</b>	<b>1.20 - 1.60</b>
	Childhood poverty (ref.no): Yes	<b>1.14</b>	<b>1.02 - 1.26</b>	<b>1.13</b>	<b>1.02 - 1.26</b>	<b>1.42</b>	<b>1.28 - 1.57</b>	<b>1.37</b>	<b>1.24 - 1.53</b>
	Any ACE (ref.no): Yes	<b>1.13</b>	<b>1.02 - 1.26</b>	<b>1.12</b>	<b>1.01 - 1.25</b>	<b>1.45</b>	<b>1.31 - 1.60</b>	<b>1.40</b>	<b>1.27 - 1.55</b>
	Number of ACEs (continuous variable)	<b>1.11</b>	<b>1.03 - 1.21</b>	<b>1.11</b>	<b>1.02 - 1.20</b>	<b>1.30</b>	<b>1.22 - 1.38</b>	<b>1.26</b>	<b>1.19 - 1.35</b>
Current smoking (ref: never)	Parental divorce (ref.no): Yes	<b>1.46</b>	<b>1.06 - 2.01</b>	1.32	0.95 - 1.82	<b>1.64</b>	<b>1.32 - 2.03</b>	<b>1.49</b>	<b>1.20 - 1.85</b>
	Fear of a family member (ref.no): Yes	<b>1.29</b>	<b>1.07 - 1.55</b>	1.16	0.96 - 1.40	<b>1.45</b>	<b>1.19 - 1.76</b>	<b>1.32</b>	<b>1.09 - 1.61</b>
	Childhood poverty (ref.no): Yes	<b>1.20</b>	<b>1.07 - 1.35</b>	1.10	0.98 - 1.24	1.15	0.99 - 1.40	1.07	0.92 - 1.25
	Any ACE (ref.no): Yes	<b>1.24</b>	<b>1.10 - 1.39</b>	<b>1.13</b>	<b>1.01 - 1.27</b>	<b>1.33</b>	<b>1.16 - 1.53</b>	<b>1.24</b>	<b>1.08 - 1.43</b>
	Number of ACEs (continuous variable)	<b>1.20</b>	<b>1.10 - 1.31</b>	<b>1.11</b>	<b>1.02 - 1.22</b>	<b>1.22</b>	<b>1.12 - 1.33</b>	<b>1.15</b>	<b>1.06 - 1.26</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, OR; odds ratio, CI; confidence interval; ref, reference

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Odds ratios (95% confidence intervals) were derived from multinomial logistic regression models.

Bold text indicates statistically significant with a p-value less than 0.05.

Table 4. Association between adverse childhood experiences and body mass index among older adults in Japan and Finland.

	Japan				Finland			
	Model 1		Model 2		Model 1		Model 2	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Parental divorce (ref.no): Yes	0.18	-0.15 - 0.52	0.18	-0.15 - 0.51	<b>0.60</b>	<b>0.31 - 0.89</b>	<b>0.52</b>	<b>0.23 - 0.81</b>
Fear of a family member (ref.no): Yes	<b>0.22</b>	<b>0.03 - 0.40</b>	<b>0.20</b>	<b>0.02 - 0.39</b>	<b>0.49</b>	<b>0.24 - 0.75</b>	<b>0.40</b>	<b>0.15 - 0.65</b>
Childhood poverty (ref.no): Yes	<b>0.15</b>	<b>0.04 - 0.25</b>	0.07	-0.03 - 0.18	<b>0.49</b>	<b>0.30 - 0.67</b>	<b>0.40</b>	<b>0.22 - 0.59</b>
Any ACE (ref.no): Yes	<b>0.14</b>	<b>0.03 - 0.24</b>	0.07	-0.04 - 0.18	<b>0.40</b>	<b>0.23 - 0.57</b>	<b>0.33</b>	<b>0.15 - 0.50</b>
Number of ACEs (continuous variable)	<b>0.14</b>	<b>0.06 - 0.22</b>	<b>0.09</b>	<b>0.01 - 0.18</b>	<b>0.36</b>	<b>0.25 - 0.47</b>	<b>0.30</b>	<b>0.19 - 0.41</b>

“Any” denotes the presence of at least 1 ACE.

ACE; Adverse childhood experience, Coef.; coefficient, CI; confidence interval; BMI, body mass index.

Model 1: Adjusted for age and sex. Model 2: Further adjusted for education, marital status, and working status.

Coefficients (95% confidence intervals) were derived from regression models.

Bold text indicates statistically significant with a p-value less than 0.05.



## 1 DISCUSSION

2 To our knowledge, this is the first study that compares the impact of ACEs on health of older  
3 adults between two countries. This study showed that elderly individuals in Japan and Finland  
4 who had experienced ACEs had worse health profiles (sub-optimal SRH and presence of  
5 chronic diseases) and more often had biological and behavioural risk factors (high BMI and  
6 smoking) than those with no ACEs. The strength of these associations was weak or modest, and  
7 similar between the two countries, although careful interpretation is needed because the  
8 assessment of ACEs in Japan and Finland was different. The only exception was BMI, which  
9 showed a more robust association in the Finnish cohorts than in the Japanese cohort.

10 Our finding which highlights the association between ACEs and poor health among  
11 older adults is consistent with those of other studies. The association was weaker compared  
12 with those in other studies,<sup>5-7 8</sup> and this might be due to survival bias as we focused on older  
13 adults. Regarding SRH, the association between fear of a family member in childhood (i.e. in  
14 Japan, it was assessed as witness of intimate partner violence) and poor SRH among older adults  
15 was slightly stronger than that for parental divorce or childhood poverty in Japan; however, in  
16 Finland, such a difference was not observed. Considering that the prevalence of intimate partner  
17 violence in Japan was 0.1%, while 0.25% in Finland in the OECD report,<sup>32</sup> this result can be  
18 interpreted as the detection of intimate partner violence may not be as adequate in Japan  
19 compared with Finland, and thus the problem might be unresolved and showed stronger impact

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4 20 for SRH in older age. Alternatively, physical punishment might be more pervasive in Japan  
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7 21 than in Finland;<sup>33</sup> physical punishment is forbidden by law in Finland but not in Japan.  
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10 22 Regarding cancer, childhood poverty was associated with cancer among older people in Japan,  
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13 23 but this association was not observed in Finland. Childhood poverty in Japan might lead to  
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16 24 poverty in older age,<sup>29</sup> which may result in delays in medical check-ups or consultations.  
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19 25 Previous study has shown that adults with lower health literacy, which is more likely to happen  
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22 26 among those living in poverty, are less likely to use healthcare services in Japan.<sup>34</sup>  
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25 27 Generally, the strength of these associations was similar between the two countries.  
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28 28 The consistency of our results in harmonised cohorts from two different countries suggests that  
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31 29 childhood adversities affect health similarly in these two societies. In spite of the differences in  
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34 30 the cultural and social environments of older adults in these countries,<sup>35 36</sup> it is interesting to  
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37 31 note that the associations observed were similar. A likely explanation could be the presence of  
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40 32 universal healthcare system in these countries, which offers adequate medical treatment for  
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43 33 diseases over one's life span, and is likely lead to the attenuation of the impact of ACEs on  
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46 34 health later in life. This might explain the lower OR of ACEs for diseases comparing previous  
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49 35 studies, because universal health care system might be effective to protect older adults with  
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52 36 ACEs. In addition, the presence of equal free educational opportunities in both countries may  
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55 37 explain the similar impact of ACEs on adult health, as educational attainment can attenuate the  
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58 38 impact of ACEs on later health.<sup>37</sup> The presence of high social support,<sup>38</sup> cultural engagement,  
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4 39 access to trusted adults<sup>39</sup> in both countries may also attenuate the impact of ACEs on later-life  
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7 40 health through the enhancement of resilience, described as the ability to adapt to adverse  
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10 41 environment.<sup>40</sup> The effect of ACEs on health, in different educational or healthcare systems,  
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13 42 requires further study.

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16 43 Similarly, ACEs were associated with smoking, which is consistent with the findings  
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19 44 of a previous comparative research in eight Eastern European countries<sup>5</sup> and other studies in  
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22 45 the US,<sup>1 41</sup> UK,<sup>42</sup> and Finland<sup>43</sup>, although this association was weak in the current study. The  
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25 46 Eastern European comparative study reported that ACEs were associated with smoking among  
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28 47 adults aged 14–66 years.<sup>5</sup> The relationship between ACEs and smoking has predominantly been  
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31 48 investigated among adults towards middle age; however, few studies have examined these  
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34 49 relationships using large community samples of older adults. Our results suggest that ACEs  
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37 50 have a consistent long-term effect on smoking among older adults despite the differences in the  
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40 51 price of cigarettes or smoking advertisements between the countries. A meta-analysis showed  
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43 52 a moderate odds ratio for smoking among those with four or more ACEs compared with those  
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46 53 with no ACEs.<sup>8</sup> The association was weaker in the current study than that in the meta-analysis,  
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49 54 possibly because there were only three ACEs measured in the current study, and the association  
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52 55 may have been underestimated because of early death due to smoking and ACEs (e.g., survival  
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55 56 bias).

57 ACEs were associated with an increase in BMI in both countries; however, the impact  
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4 58 of ACEs was higher in Finland. This association was consistent with that observed in a previous  
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7 59 study which showed that ACEs elevated the risk of obesity in the US,<sup>1 2</sup> UK,<sup>42</sup> and Finland.<sup>44</sup>  
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10 60 The obesity rate among older individuals was higher in Finland than in Japan in the current  
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13 61 study; thus, we used continuous BMI as an outcome. The presence of sampling bias in the  
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16 62 current study may have also led to the lower impact of ACEs on BMI in Japan, as the JAGES  
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19 63 included only individuals without nursing care.

22 64 On the contrary, “fear of a family member” showed significant positive association  
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25 65 with cancer and diabetes in Finland, which was not observed in Japan. This might be due to the  
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28 66 difference in the assessment of fear of a family member. In the Finnish study, it was asked as it  
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31 67 is, while in JAGES, witness of domestic violence was used as a proxy measurement of fear of  
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34 68 a family member. It may be possible that in Japan, witness of domestic violence may not always  
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37 69 induce fear of a family member, say, if the child was used to it. Thus, in Japan the association  
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40 70 was weak. Alternatively, fear of a family member may not necessarily be a risk factor for adult  
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43 71 disease in Japan because of the rich social network, especially among kin relatives,<sup>45 46</sup> which  
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46 72 provides an environment for children to escape from a fearful family member. Further study  
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49 73 using the same question is needed to confirm whether the discrepancy is due to the difference  
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52 74 in the assessment of social environment.

55 75 There are several limitations to this study. First, this was a cross-sectional study  
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58 76 conducted among older adults. As ACEs were self-reported, differential recall bias cannot be  
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4 77 ruled out. Recent review showed poor agreement between prospective and retrospective  
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7 78 assessment of childhood maltreatment.<sup>47</sup> However, in contrast, other review studies reported  
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10 79 that the validity of retrospective assessment of ACEs is acceptable.<sup>48 49</sup> Second, these results,  
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13 80 although based on harmonised measures, were derived from only two egalitarian developed  
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16 81 countries, which preclude the generalisation of the findings to other countries. Further studies  
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19 82 are warranted to investigate the association between other ACEs and adult disease in different  
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22 83 cultural settings, and in low- and middle-income countries. Third, we did not assess other ACEs  
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25 84 such as sexual abuse, neglect, childhood neighbourhood deprivation, or family disfunction (i.e.,  
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28 85 mental disorder of a family member, or incarcerated family member), and thus the number of  
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31 86 ACEs were limited to only three. The limited number of ACEs precluded to assess stronger  
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34 87 impact of ACEs on adult diseases, as a previous meta-analysis revealed.<sup>8</sup> Further studies are  
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37 88 necessary to investigate the impact of other ACEs on the health of older adults. Fourth, there is  
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40 89 a disparity in the measurement of ACEs and health, and ACEs and health behaviours, across  
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43 90 the JAGES, FPS, and HeSSup. The differences in measurement might result in heterogeneity  
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46 91 of the results. More specifically, the assessment of fear of a family member in the JAGES, FPS  
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49 92 and HeSSup was different, which may result in heterogeneity between study estimates. Fifth,  
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52 93 the participants in the JAGES did not have functional disability, and hence might be healthier  
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55 94 than the average Japanese older population. Therefore, the results of the study might be  
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58 95 underestimated. Alternatively, the results might be subjected to survival bias. The average age  
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4 96 of the study participants was 69.5 years in Japan and 64.4 years in Finland. People who passed  
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7 97 away before the current study from ACE-related diseases or health risk behaviours would not  
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10 98 have been included in the current study. Therefore, the results of the current study may  
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13 99 underestimate the health effects of ACEs. Further, FPS was a not representative sample, thus  
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16 100 the prevalence of diseases, such as cancer, may be different from other studies. Sixth,  
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19 101 considering other covariates such as levels of inequality, current and previous household  
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22 102 income, environmental risks (e.g., parental smoking), or genetic variation was not feasible due  
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25 103 to data availability. In fact, education level was higher in the Finnish sample than in the  
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28 104 Japanese sample. Finally, we were unable to pool the data of the two countries due to restriction  
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31 105 on the Finnish data, and therefore interactive effects of the countries and ACE on adult health  
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34 106 were unclear.

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37 107         Nonetheless, this is the first study that investigated the association between ACEs and  
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40 108 health and health behaviour among older people in two countries. In Japan and Finland, the  
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43 109 relationship between ACEs and health was similar for SRH, specific diseases and smoking. The  
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46 110 impact of ACEs on BMI was stronger in Finland than in Japan. These results suggest a notable  
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49 111 association between ACEs and health among older people, and that this association remains  
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52 112 consistent even in countries with a different social environment. Based on these findings, health  
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55 113 policy to address ACEs is needed to prevent future diseases among older adults.

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4 115 **Competing interests:** The authors declare that they have no conflict of interest.  
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10 117 **Funding:** This work was supported by the Japan Society for the Promotion of Science's  
11  
12  
13 118 KAKENHI Grants (grant number JP15H01972 and JP16K16633), Health Labour Sciences  
14  
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16 119 Research Grants (grant number H28-Choju-Ippan-002), Research and Development Grants for  
17  
18  
19 120 Longevity Science from the Japan Agency for Medical Research and Development (AMED),  
20  
21  
22 121 Personal Health Record Utilization Project from AMED, Research Funding for Longevity  
23  
24  
25 122 Sciences from the National Center for Geriatrics and Gerontology (grant number 29-42), and  
26  
27  
28 123 the World Health Organization Centre for Health Development (WHO Kobe Centre) (WHO  
29  
30  
31 124 APW 2017/713981). Jussi Vahtera was supported by NordForsk (Nordic Research Program on  
32  
33  
34 125 Health and Welfare). Tuula Oksanen received funding from the Finnish Work Environment  
35  
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37 126 Fund (grant number 117094).  
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43 128 **Authors' contribution:** TF conceived design, KS, KK, JV collected data, TF, AA, TO, JP, JV  
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46 129 analysed data, AA wrote first draft, TF, TO, and JV finalized manuscript. All authors approved  
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49 130 final version of manuscript. All authors approved the final version of the manuscript.  
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55 132 **Data sharing statement:** FPS and HeSSup data is not available for out of research team.  
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58 133 JAGES data may be available if proposal is approved by research team.  
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134 **References**

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1. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med* 1998;14(4):245-58. [published Online First: 1998/06/23]
2. Anda RF, Felitti VJ, Bremner JD, et al. The enduring effects of abuse and related adverse experiences in childhood. A convergence of evidence from neurobiology and epidemiology. *Eur Arch Psychiatry Clin Neurosci* 2006;256(3):174-86. doi: 10.1007/s00406-005-0624-4 [published Online First: 2005/11/29]
3. Nandi A, Glymour MM, Kawachi I, et al. Using marginal structural models to estimate the direct effect of adverse childhood social conditions on onset of heart disease, diabetes, and stroke. *Epidemiology* 2012;23(2):223-32. doi: 10.1097/EDE.0b013e31824570bd00001648-201203000-00008 [pii] [published Online First: 2012/02/10]
4. Brown DW, Anda RF, Tiemeier H, et al. Adverse childhood experiences and the risk of premature mortality. *Am J Prev Med* 2009;37(5):389-96. doi: 10.1016/j.amepre.2009.06.021
5. Bellis MA, Hughes K, Leckenby N, et al. Adverse childhood experiences and associations with health-harming behaviours in young adults: surveys in eight eastern European countries. *Bull World Health Organ* 2014;92(9):641-55. doi: 10.2471/BLT.13.129247 [published Online First: 2014/11/08]
6. Anda RF, Butchart A, Felitti VJ, et al. Building a framework for global surveillance of the public health implications of adverse childhood experiences. *Am J Prev Med* 2010;39(1):93-8. doi: 10.1016/j.amepre.2010.03.015 S0749-3797(10)00277-1 [pii] [published Online First: 2010/06/16]
7. Halonen JI, Stenholm S, Pentti J, et al. Childhood Psychosocial Adversity and Adult Neighborhood Disadvantage as Predictors of Cardiovascular Disease: A Cohort Study. *Circulation* 2015;132(5):371-9. doi: 10.1161/CIRCULATIONAHA.115.015392 [published Online First: 2015/06/13]
8. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health* 2017;2(8):e356-e66. doi: 10.1016/S2468-2667(17)30118-4 [published Online First: 2017/12/19]
9. Xiao Q, Dong MX, Yao J, et al. Parental alcoholism, adverse childhood experiences, and later risk of personal alcohol abuse among Chinese medical students. *Biomed Environ Sci* 2008;21(5):411-9. doi: 10.1016/S0895-3988(08)60062-8 [published Online First: 2009/01/13]
10. Pirkola S, Isometsa E, Aro H, et al. Childhood adversities as risk factors for adult mental



- 1  
2  
3 172 disorders. *Soc Psych Psych Epid* 2005;40(10):769-77. doi: 10.1007/s00127-005-0950-  
4 173 x  
5  
6 174 11. Harkonmaki K, Korkeila K, Vahtera J, et al. Childhood adversities as a predictor of  
7 175 disability retirement. *J Epidemiol Commun H* 2007;61(6):479-84. doi: DOI  
8 176 10.1136/jech.2006.052670  
9  
10 177 12. Shibuya K, Hashimoto H, Ikegami N, et al. Future of Japan's system of good health at low  
11 178 cost with equity: beyond universal coverage. *Lancet* 2011;378(9798):1265-73. doi:  
12 179 10.1016/S0140-6736(11)61098-2  
13  
14 180 S0140-6736(11)61098-2 [pii] [published Online First: 2011/09/03]  
15  
16 181 13. Vuorenkoski L, Mladovsky P, Mossialos E. Finland: Health system review. *Health systems*  
17 182 *in transition* 2008;10(4):1-168.  
18  
19 183 14. Cummings WK. Education and equality in Japan: Princeton University Press 2014.  
20 184 15. John Helliwell, Richard Layard, Sachs J. The World Happiness Report: New York:  
21 185 Sustainable Development Solutions Network; 2016 [Available from:  
22 186 <http://worldhappiness.report/> accessed Nov, 18 2016.  
23  
24 187 16. Yitzhaki S, Schechtman E. Social Welfare, Relative Deprivation, and the Gini Coefficient.  
25 188 *Springer Ser Stat* 2013:253-73. doi: 10.1007/978-1-4614-4720-7\_13  
26  
27 189 17. OECD. OECD Income Distribution Database (IDD): Gini, poverty, income, methods and  
28 190 concepts 2016 [Available from: [http://www.oecd.org/social/income-distribution-](http://www.oecd.org/social/income-distribution-database.htm)  
29 191 [database.htm](http://www.oecd.org/social/income-distribution-database.htm) accessed Jul, 18 2017.  
30  
31 192 18. United Nations. International Migration 2017 2017 [Available from:  
32 193 [http://www.un.org/en/development/desa/population/migration/publications/wallchart/d](http://www.un.org/en/development/desa/population/migration/publications/wallchart/docs/MigrationWallChart2017.pdf)  
33 194 [ocs/MigrationWallChart2017.pdf](http://www.un.org/en/development/desa/population/migration/publications/wallchart/docs/MigrationWallChart2017.pdf) accessed August 27 2018.  
34  
35 195 19. Japanese Ministry of Internal Affairs and Communications. Statistical Handbook of Japan  
36 196 2017 2017 [Available from: <http://www.stat.go.jp/english/data/handbook/c0117.html>  
37 197 accessed August 27 2018.  
38  
39 198 20. eurostat. Marriage and divorce statistics 2015 [Available from:  
40 199 [https://ec.europa.eu/eurostat/statistics-](https://ec.europa.eu/eurostat/statistics-explained/index.php/Marriage_and_divorce_statistics)  
41 200 [explained/index.php/Marriage\\_and\\_divorce\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php/Marriage_and_divorce_statistics) accessed August 27 2018.  
42  
43 201 21. Amemiya A, Fujiwara T, Murayama H, et al. Adverse childhood experiences and higher-  
44 202 level functional limitations among older Japanese people: results from the JAGES study.  
45 203 *J Gerontol A Biol Sci Med Sci* 2017 doi: 10.1093/gerona/glx097 [published Online First:  
46 204 2017/05/20]  
47  
48 205 22. Halonen JI, Vahtera J, Kivimaki M, et al. Adverse experiences in childhood, adulthood  
49 206 neighbourhood disadvantage and health behaviours. *J Epidemiol Community Health*  
50 207 2014;68(8):741-6. doi: 10.1136/jech-2013-203441 [published Online First: 2014/04/26]  
51  
52 208 23. Kawachi I, Kennedy BP, Lochner K, et al. Social capital, income inequality, and mortality.  
53 209 *Am J Public Health* 1997;87(9):1491-8.  
54  
55 210 24. Laaksonen E, Martikainen P, Lahelma E, et al. Socioeconomic circumstances and common

- 1  
2  
3 211 mental disorders among Finnish and British public sector employees: evidence from the  
4 212 Helsinki Health Study and the Whitehall II Study. *Int J Epidemiol* 2007;36(4):776-86.  
5 213 doi: dym074 [pii]  
6  
7 214 10.1093/ije/dym074 [published Online First: 2007/05/23]  
8  
9 215 25. Feldt T, Lintula H, Suominen S, et al. Structural validity and temporal stability of the 13-  
10 216 item sense of coherence scale: prospective evidence from the population-based HeSSup  
11 217 study. *Qual Life Res* 2007;16(3):483-93. doi: 10.1007/s11136-006-9130-z  
12  
13 218 26. Korkeila K, Suominen S, Ahvenainen J, et al. Non-response and related factors in a nation-  
14 219 wide health survey. *Eur J Epidemiol* 2001;17(11):991-9. [published Online First:  
15 220 2002/10/17]  
16  
17 221 27. Fujiwara T, Kawakami N. Association of childhood adversities with the first onset of mental  
18 222 disorders in Japan: results from the World Mental Health Japan, 2002-2004. *J Psychiatr*  
19 223 *Res* 2011;45(4):481-7. doi: 10.1016/j.jpsychires.2010.08.002  
20 224 S0022-3956(10)00243-8 [pii] [published Online First: 2010/08/24]  
21  
22 225 28. Matsuyama Y, Fujiwara T, Aida J, et al. Experience of childhood abuse and later number  
23 226 of remaining teeth in older Japanese: a life-course study from Japan Gerontological  
24 227 Evaluation Study project. *Community Dent Oral Epidemiol* 2016;44(6):531-39. doi:  
25 228 10.1111/cdoe.12246  
26  
27 229 29. Amemiya A, Fujiwara T, Murayama H, et al. Adverse Childhood Experiences and Higher-  
28 230 Level Functional Limitations Among Older Japanese People: Results From the JAGES  
29 231 Study. *J Gerontol A Biol Sci Med Sci* 2018;73(2):261-66. doi: 10.1093/gerona/glx097  
30 232 [published Online First: 2017/05/20]  
31  
32 233 30. Rahkonen O, Lahelma E, Huuhka M. Past or present? Childhood living conditions and  
33 234 current socioeconomic status as determinants of adult health. *Soc Sci Med*  
34 235 1997;44(3):327-36. doi: S0277953696001025 [pii] [published Online First:  
35 236 1997/02/01]  
36  
37 237 31. Korkeila J, Vahtera J, Korkeila K, et al. Childhood adversities as predictors of incident  
38 238 coronary heart disease and cerebrovascular disease. *Heart* 2010;96(4):298-303. doi:  
39 239 10.1136/hrt.2009.188250  
40 240 96/4/298 [pii] [published Online First: 2010/03/03]  
41  
42 241 32. OECD Social Policy Division - Directorate of Employment LaSA. Family Violence. 2013.  
43 242 [https://www.oecd.org/els/soc/SF3\\_4\\_Family\\_violence\\_Jan2013.pdf](https://www.oecd.org/els/soc/SF3_4_Family_violence_Jan2013.pdf).  
44 243  
45 244 33. Iwai H. Social Tolerance for the Use of Physical Punishment by Parents:  
46 245 An Analysis of Attitude toward Physical Punishment using JGSS-2008. *JGSS Research Series*  
47 246 2010;No.7  
48  
49 247 34. Goto E, Ishikawa H, Okuhara T, et al. Relationship of health literacy with utilization of  
50 248 health-care services in a general Japanese population. *Prev Med Rep* 2019;14:100811.  
51 249 doi: 10.1016/j.pmedr.2019.01.015 [published Online First: 2019/03/01]  
52  
53  
54  
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2  
3 250 experiences in predicting adult health and health care utilization. *Child Abuse Negl*  
4 251 2010;34(6):454-64. doi: 10.1016/j.chiabu.2009.09.020
- 6 252 36. Fujiwara T, Kondo K, Shirai K, et al. Associations of childhood socioeconomic status and  
7 253 adulthood height with functional limitations among Japanese older people: results from  
8 254 the JAGES 2010 Project. *J Gerontol A Biol Sci Med Sci* 2014;69(7):852-9. doi:  
9 255 10.1093/gerona/glt189
- 12 256 37. Tani Y, Fujiwara T, Kondo N, et al. Childhood Socioeconomic Status and Onset of  
13 257 Depression among Japanese Older Adults: The JAGES Prospective Cohort Study. *Am*  
14 258 *J Geriatr Psychiatry* 2016;24(9):717-26. doi: 10.1016/j.jagp.2016.06.001
- 17 259 38. Kuh D, Shlomo YB. A life course approach to chronic disease epidemiology: Oxford  
18 260 University Press 2004.
- 20 261 39. Bellis MA, Hardcastle K, Ford K, et al. Does continuous trusted adult support in childhood  
21 262 impart life-course resilience against adverse childhood experiences - a retrospective  
22 263 study on adult health-harming behaviours and mental well-being. *BMC Psychiatry*  
23 264 2017;17(1):110. doi: 10.1186/s12888-017-1260-z [published Online First: 2017/03/25]
- 26 265 40. Bellis MA, Hughes K, Ford K, et al. Adverse childhood experiences and sources of  
27 266 childhood resilience: a retrospective study of their combined relationships with child  
28 267 health and educational attendance. *BMC Public Health* 2018;18(1):792. doi:  
29 268 10.1186/s12889-018-5699-8 [published Online First: 2018/06/27]
- 32 269 41. Runsten S, Korkeila K, Koskenvuo M, et al. Can social support alleviate inflammation  
33 270 associated with childhood adversities? *Nord J Psychiatry* 2014;68(2):137-44. doi:  
34 271 10.3109/08039488.2013.786133
- 36 272 42. Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking during  
37 273 adolescence and adulthood. *JAMA* 1999;282(17):1652-8.
- 39 274 43. Bellis MA, Lowey H, Leckenby N, et al. Adverse childhood experiences: retrospective  
40 275 study to determine their impact on adult health behaviours and health outcomes in a UK  
41 276 population. *J Public Health (Oxf)* 2014;36(1):81-91. doi: 10.1093/pubmed/ftd038  
42 277 [published Online First: 2013/04/17]
- 45 278 44. Kestila L, Koskinen S, Martelin T, et al. Influence of parental education, childhood  
46 279 adversities, and current living conditions on daily smoking in early adulthood. *Eur J*  
47 280 *Public Health* 2006;16(6):617-26. doi: 10.1093/eurpub/ckl054
- 49 281 45. Nonoyama H. The Family and Family Sociology in Japan. *The American Sociologist*  
50 282 2000;31(3):27-41.
- 53 283 46. Ochiai E. Sekaino Nakano Sengo Nihon Kazoku (in Japanese). In: Rekishi Kenkyu Kai  
54 284 Nihonshi Kenkyu Kai, ed. Nihonshi Koza 10 Sengo Nihonron. Tokyo: Univeristy of  
55 285 Tokyo Press 2005.
- 57 286 47. Baldwin JR, Reuben A, Newbury JB, et al. Agreement Between Prospective and  
58 287 Retrospective Measures of Childhood Maltreatment: A Systematic Review and Meta-  
59 288 analysis. *JAMA Psychiatry* 2019 doi: 10.1001/jamapsychiatry.2019.0097 [published

- 1  
2  
3 289 Online First: 2019/03/21]  
4  
5 290 48. Hardt J, Rutter M. Validity of adult retrospective reports of adverse childhood experiences:  
6 291 review of the evidence. *J Child Psychol Psychiatry* 2004;45(2):260-73. [published  
7  
8 292 Online First: 2004/02/26]  
9  
10 293 49. Reuben A, Moffitt TE, Caspi A, et al. Lest we forget: comparing retrospective and  
11 294 prospective assessments of adverse childhood experiences in the prediction of adult  
12 295 health. *J Child Psychol Psychiatry* 2016;57(10):1103-12. doi: 10.1111/jcpp.12621  
13  
14 296 [published Online First: 2016/09/21]  
15  
16  
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1 **Supplemental table S1.** Measurement of adverse childhood experience

2 **Supplemental table S2.** Measurement of health and health behaviours

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4 Supplemental table S1. Measurement of adverse childhood experience

Items	JAGES			FPS, HeSSup		
	Question	Answer	Code	Question	Answer	Code
	Did you experience any of the following before the age of 18?;			The respondents were asked whether they had experienced the following adversities in their childhood:		
<b>Parental divorce in childhood</b>	Parents' divorce	No	0	Divorce/separation of the parents	No	0
		Yes	1		Yes	1
		Unknown	missing		Do not know or cannot say	missing
<b>Severe financial difficulties</b>	Financial trouble	No	0	Long-term financial difficulties in the family	No	0
		Yes	1		Yes	1
		Unknown	missing		Do not know or cannot say	missing
<b>Fear of a family member</b>	1) Your father was violent with your mother (being witness to domestic violence)	No	0	Frequent fear for a family member	No	0
		Yes <sup>a</sup>	1		Yes	1
		Unknown	missing		Do not know or cannot say	missing
	2) You were hit hard by your mother/father causing an injury (physical abuse)					

a: If someone answers yes to the question of either of 1) or 2), the code is "Yes".

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7 Supplemental table S2. Measurement of health and health behaviours

Items	JAGES			FPS		
	Question	Answer	Code	Question	Answer	Code
Self-rated health	How is your current health status?	Excellent	0	<b>How is your current health status?</b>	Good	0
		Good	0		Fairly good	0
		Fair	1		Moderate	1
		Poor	1		Fairly poor	1
					Poor	1
Cancer	Circle the number of all diseases for which you are currently receiving treatment or experiencing; Cancer	No	0	National Cancer Register	No	0
		Yes	1		Yes within 5 years	1
					Unknown	Missing
Heart disease or stroke	Circle the number of all diseases for which you are currently receiving treatment or experiencing; 1) Heart disease, 2) Stroke (e.g. brain hemorrhage, cerebral infarction)	No	0	Special reimbursement for the medication, from Social Insurance Institution of Finland	No	0
		Yes <sup>a</sup>	1		Yes	1
					Unknown	Missing
Diabetes mellitus	Circle the number of all diseases for which you are currently receiving treatment or experiencing; Diabetes mellitus	No	0	Special reimbursement for the medication, from Social Insurance Institution of Finland	No	0
		Yes	1		Yes	1
					Unknown	Missing
Smoking	Do you smoke cigarettes?	No	0	Do you smoke or have you ever smoked regularly, i.e. every day or almost every day?	Never	0



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I used to	1	Yes, before	1
smoke			
Yes	2	Yes, I still do	2

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a: If someone answers yes to the question of either of 1) or 2), the code is "Yes".

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