# Prospective study of predictors of poor self-rated health in a 23-year cohort of earthquake survivors in Armenia

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**Abstract**    Long-term prospective studies exploring general health outcomes among disaster survivors are rare. Self-rated health (SRH) — a proven correlate of morbidity and mortality prognosis — was used to investigate predictors of perceived health status among a 23-year cohort of survivors of 1988 Spitak earthquake in Armenia. A geographically-stratified subsample of 725 adults from a larger initial cohort was followed during the period of 1990—2012. A logistic regression model identified predictors of SRH. Adjusted relative risks for the long-term predictors of SRH were calculated. The rate of poor SRH among the survivors was 18.8%, fair 56.5%, and good/excellent 24.7%. In the fitted model, long-term risk factors of poor SRH included baseline body mass index, baseline multi-morbidity, number of experienced stressful life events, and perceived poor living standards during the post-earthquake decade, while participation in sports in the early 1990s was a protective factor. Short-term protective factors included socio-economic status score, social support, employment and dignity, while current household size was a risk factor for poor SRH. No association was found between earthquake exposure severity and SRH after 23 years. However, the identified predictors included a number of modifiable life-

## 1. Introduction

According to general population studies, every fifth person experiences a natural disaster during his/her life [1,2]. Psychological consequences of disasters have been extensively investigated, with post-traumatic stress disorder (PTSD) being the most frequently studied condition followed by depression and anxiety [3]. A substantial body of research has investigated factors associated with psychopathologies in the aftermath of disasters [4—6]. Fewer studies have explored long-term effects of disasters on survivors' mental health and have found that disasters could lead to enduring psychological distress [7,8].

There are very few studies on the longer-term influence of disasters on victims' quality of life showing that long-lasting psychological and environmental consequences of disasters could have an adverse impact on survivors' quality of life [9—11]. Considerable evidence suggests poorer general health outcomes among survivors of disasters and traumatized subjects in terms of increased physical morbidity and mortality several years after the trauma [11—15]. Nevertheless, studies of self-rated health (SRH) among disaster victims many years after the exposure are very rare [16,17].

On December 7, 1988, a devastating earthquake struck the northern regions of Armenia and left half a million people — one-sixth of the country's population — without shelter. Over 100,000 people were injured and 25,000 died. Rehabilitation after the earthquake was delayed because its timing coincided with a difficult transition of the country from the soviet system to a market economy aggravated by a number of cataclysms, including an economic blockade, an energy crisis and a war [18]. Thus, survivors had to cope with very difficult conditions for many years following the disaster. In 1990, a large-scale cohort study was initiated in the earthquake zone to prospectively measure the health outcomes of survivors [19]. The exceptional opportunity provided by this cohort study was used to explore the association between factors assessed at the baseline waves of the study in the early 1990s and SRH of the earthquake survivors over 23 years after the exposure.

SRH was used in this long-term follow-up study as a general measure of physical and mental health status due to its proven strong correlation with objective measures of health status and subsequent mortality [20—25]. This measure was considered particularly valuable for the study purposes as it reflects not only measurable aspects of health, but also subjective feelings and future expectations of well-being [26,27]. It presumably covers also medically unexplained symptoms, a phenomenon frequently detected among disaster survivors [13,28].

The prevalence and predictors of poor SRH have been extensively investigated in different countries and population groups, as this outcome measure is frequently used in health disparities research [29—31]. Two prior cross-sectional studies of SRH conducted among the general population in Armenia found high rates of perceived poor health and an independent relation between health and older age, poverty, lower education, unemployment, depression, and lack of social support [32,33]. The aim of this prospective study was to investigate the prevalence of poor SRH in a long-term cohort of survivors of the 1988 earthquake, to find out whether the severity of the earthquake exposure was related to this outcome after 23 years, and to identify long- and short-term determinants of poor SRH in this disadvantaged population group.

## 2. Methods

### 2.1. Participants

A subsample of participants from a large-scale cohort study of earthquake survivors initiated in 1990 was targeted for the recent follow-up study in 2012. This subsample, geographically-stratified to include participants from the most severely damaged areas, consisted of 1785 adults who, in addition to the assessment of earthquake-related experiences, living conditions, physical health status and health behavior at the first waves of the cohort study, underwent mental health assessment [34,35]. In 2012, 83.3% ($n = 1487$) of this sample was traced and 40.6% ($n = 725$) participated in face-to-face interviews. The rest of those traced were either dead (17.3%, $n = 309$), incapable to participate due to ailments (5.0%, $n = 89$), unwilling to participate (3.6%, $n = 64$), or moved out of

the country (16.8%, $n = 300$). The details of the cohort study methods are provided elsewhere [36]. The questionnaire of the follow-up assessment consisted of interviewer- and self-administered parts and included domains on demographic and socio-economic characteristics of participants, their physical and mental health status, health behavior, life events trajectory, social support, dignity and quality of life. The self-administered part of the questionnaire included a single-item measure of SRH. The Institutional Review Board of the American University of Armenia approved the study protocol. Respondents provided informed oral consent to participate.

## 2.2. Variables

The outcome variable, SRH, was measured by a question: ''How would you describe your health in the last 30 days?'', with the response options: ''excellent'', ''very good'', ''good'', ''fair'', and ''poor'' and then dichotomized as poor versus fair/good.

The independent variables described characteristics of participants at two time points — in the 1990s (baseline or long-term) and in 2012 (follow-up or short-term) — and were grouped into socio-economic, health behavioral, psychosocial, health status and earthquake exposure domains. Information on baseline variables was collected prospectively at the baseline waves of the cohort study.

The socioeconomic domain included respondent's current age, gender, education, employment, marital status, socio-economic status (SES) score, affordability of healthcare, and perceived living standards during the post-earthquake decade. All these variables except the SES score were based on a single item. The SES score (ranging from 0 to 24) was a weighted sum of the following items: respondent's rating of family's living standards, number of possessed convenience/luxury items, household's average monthly expenditures, housing conditions, presence of a heating system, and being involved in a family poverty benefit program (reverse-coded).

The health behavioral domain included current smoking, binge drinking, regular walking (at least 3 h per week), as well as baseline smoking, drinking, and regular participation in sports. All these variables were measured by a single item.

The psychosocial domain included number of stressful negative life events experienced by respondent, his/her current memory score (ranging from 0 to 8) based on the Short-term Memory Recall test [37], current low dignity measured by the 18-item Human Dignity scale [38] and the scale score dichotomized at its lower third, and current good social

support based on a summative score of seven social support items dichotomized at its median. The threshold levels for dichotomization of the dignity and social support scores were identified through examining their univariate lowess smoothed scatter plots with poor SRH on the logit scale [39].

The health status domain included the following variables on the respondent's physical and mental health status: baseline and current multi-morbidity indicating the presence of two or more self-reported non-communicable health conditions; baseline body mass index (BMI) calculated based on the participants' self-reported weight and height at baseline; current poor quality of life (QOL) measured by EQ-5d-5L instrument [40] and the score dichotomized at its lower third; baseline depression and baseline PTSD, both measured using the criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM) revised Third Edition [34,35]; and current depression, PTSD, and anxiety, all measured using the criteria of the DSM-IV-TR Edition [41]. The validated revised 16-item Armenian-language version [42] of the Center for Epidemiologic Studies Depression (CES-D) scale [43] was used to measure current depression, with the score ranging from 0 to 48 dichotomized at 18/19 cut-off level [44]. Post-traumatic Stress Disorder Checklist-Civilian Version (PCL-C) was used to measure current PTSD with the score ranging from 17 to 85 dichotomized at 49/50 cut-off level [45], and the 10-item Anxiety subscale of the Symptom Checklist-90-R was applied to measure current anxiety, with the score ranging from 0 to 40 dichotomized at 10/11 cut-off level [46].

The earthquake exposure domain included: earthquake-related deaths in the family, earthquake-related injuries in respondent, and earthquake-caused material loss score calculated as a weighted sum of loss (complete, partial, or none) of money, furniture, vehicles, and everyday utensils (ranging from 0 to 8). Information on all these variables was collected prospectively at the first wave of the study in 1990.

## 2.3. Analysis

The SPSS-18 and STATA-10 statistical software were used for the analyses. Groups with poor versus fair/good SRH, and the total sample were analyzed descriptively, and significant differences between the groups were identified for each characteristic using bivariate logistic regression analysis. Continuous variables (age, SES score, household size, baseline BMI, current memory score, number of stressful life events, and earthquake-caused material loss score) were treated as

continuous after examining the linearity of their association with the outcome on the logistic scale [39]. For the three levels of education, dummy variables were created. The remaining variables were dichotomized before being entered into logistic regression analysis to achieve better interpretability of the results. The research team then performed a series of multivariate logistic regression analyses with inclusion of all those variables associated with the outcome at the $p < .25$ level in the bivariate analysis [39]. As the final step, logistic regression model of determinants of SRH was fitted. The variables were entered into the logistic regression analysis in conceptually coherent blocks in different combinations using the enter method. The variables not related to the outcome ($p \geqslant .10$) when controlling for the remaining variables in the model were excluded from the model if their removal did not change the associations between the remaining variables and the outcome. The variables included in the final model were checked for interaction. The Variance Inflation Factor (VIF) statistics was applied to check for possible multi-collinearity issues due to the high number of variables included in the multivariate logistic regression analysis. The model fit was assessed using Hosmer—Lemeshow goodness of fit test, area under the Receiver Operating Characteristic (ROC) curve, and Pseudo R2. The current physical and mental health status variables were omitted from this model, because they were treated as correlates rather than determinants of SRH in this study. Missing values comprised 5.7% of cases included in the multiple logistic regression analysis and were treated as missing during the analysis. Adjusted relative risks were also calculated for prospective determinants of SRH applying the method of generalized linear regression with a log link, normal distribution, and robust variance estimator [47,48].

## 3. Results

Seven hundred nineteen participants (99.2% of the total sample of 725) responded to the item on SRH. The mean age of the respondents was 58.4 years (SD 12.1). Over two-thirds of them were women (Table 1). The majority had complete secondary and a quarter university or higher education. More than half of the participants were unemployed or unable to work, and 58.0% reported low affordability of healthcare. Over half of the participants (56.5%) perceived their health in the last 30 days as ''fair'', one-fourth (24.7%) as good and 18.8% as poor.

Those who reported poor health were older, poorer, and less educated. Neither baseline, nor current smoking or drinking practices were significantly related to SRH during bivariate comparisons. Among the health behavioral variables, only those reflecting the level of physical activity, both baseline and current, were significantly associated with perceived health status (Table 1).

All the current psychosocial variables (memory, dignity, social support, and number of stressful life events) were highly related to SRH in bivariate comparisons. The same was true for all the current health status variables (QOL, multi-morbidity, depression, anxiety, and PTSD). Baseline multi-morbidity and baseline BMI were also significantly associated with SRH, while baseline psychopathology was not related to it. Similarly, no relation was found between the earthquake exposure variables and survivors' SRH 23 years after the exposure.

In the multivariate logistic regression analysis, the association between SRH and its correlates — current physical and mental health status variables — remained strong after controlling for all the remaining significant variables (Table 2). In the model controlled for all significant variables, current poor QOL and current multi-morbidity increased the likelihood of poor rating of own health over five times, and current depression — over four times, mediating the effect of current anxiety and PTSD on SRH.

The final fitted logistic regression model of determinants of poor SRH identified nine significant variables (Table 3). Three of these were baseline variables, information on which was collected prospectively over two decades ago — BMI, multi-morbidity, and regular participation in sports. When controlling for the remaining significant variables, baseline multi-morbidity increased the chance of current poor SRH almost twice. Each one point increase in the baseline BMI (kg/m$^2$) was associated with 11.0% higher chance of current poor SRH. Regular participation in sports in the early 1990s decreased the chance of poor SRH in 2012 more than two times.

The next two baseline determinants of SRH were perceived living standards during the post-earthquake decade and the number of reported stressful negative life events. Both were strong predictors of SRH. Poor living standards during the post-earthquake decade increased the chance of current poor SRH 2.3 times. Each additional stressful life event was associated with 15.0% higher chance of poor SRH in the final model.

**Table 1** Distribution of selected baseline and current variables by SRH status among a cohort of survivors of the 1988 earthquake in Armenia.

| | N | SRH Poor (n = 135) | SRH Fair/good (n = 584) | p-Value | Total (n = 719) |
|---|---|---|---|---|---|
| *Socioeconomic variables* | | | | | |
| Age, mean (SD) | 719 | 62.5 (12.5) | 57.4 (11.8) | <.001 | 58.4 (12.1) |
| Socio-economic status score, mean (SD) | 715 | 10.4 (3.9) | 12.7 (3.9) | <.001 | 12.3 (4.0) |
| Household size, mean (SD) | 718 | 4.2 (1.9) | 4.5 (2.3) | .14 | 4.2 (2.0) |
| Gender | | | | | |
|   Female (%) | 719 | 69.6 | 67.5 | .68 | 67.9 |
|   Male (%) | | 30.4 | 32.5 | | 32.1 |
| Education | | | | | |
|   Incomplete secondary (%) | 719 | 13.3 | 6.0 | <.001 | 7.4 |
|   Complete secondary (%) | | 78.5 | 66.8 | | 69.0 |
|   University/higher (%) | | 8.1 | 27.2 | | 23.6 |
| Employment | | | | | |
|   Employed (%) | 719 | 23.7 | 49.8 | <.001 | 44.9 |
|   Unemployed (%) | | 76.3 | 50.2 | | 55.1 |
| Marital status | | | | | |
|   Married (%) | 719 | 63.0 | 71.9 | .047 | 70.2 |
|   Single/divorced/widowed (%) | | 37.0 | 28.1 | | 29.8 |
| Low affordability of healthcare (%) | 719 | 71.9 | 54.8 | <.001 | 58.0 |
| Perceived living standards during post-earthquake 10 years | | | | | |
|   Very good/good/average (%) | 719 | 31.9 | 56.8 | <.001 | 52.2 |
|   Poor/very poor (%) | | 68.1 | 43.2 | | 47.8 |
| *Health behavioral variables* | | | | | |
| Current smoking (%) | 719 | 17.0 | 18.7 | .71 | 18.4 |
| Current binge drinking (%) | 714 | 9.7 | 6.7 | .27 | 7.3 |
| Current regular walking (⩾3 h/week) (%) | 717 | 26.9 | 40.3 | .004 | 37.8 |
| Baseline smoking (%) | 719 | 20.0 | 19.0 | .44 | 19.2 |
| Baseline drinking (perceived) (%) | 719 | 24.4 | 25.7 | .83 | 25.5 |
| Baseline regular participation in sports (%) | 717 | 8.1 | 16.0 | .021 | 14.5 |
| *Psychosocial variables* | | | | | |
| Number of stressful life events, mean (SD) | 719 | 5.5 (2.1) | 4.8 (2.1) | <.001 | 4.9 (2.1) |
| Current memory score, mean (SD) | 717 | 3.9 (2.4) | 5.0 (2.2) | <.001 | 4.8 (2.2) |
| Current good social support (%) | 709 | 37.1 | 63.6 | <.001 | 58.7 |
| Current low dignity (%) | 699 | 44.0 | 26.3 | <.001 | 29.5 |
| *Health status variables* | | | | | |
| Current poor quality of life (%) | 707 | 74.4 | 22.1 | <.001 | 32.0 |
| Current multi-morbidity (%) | 715 | 97.8 | 71.7 | <.001 | 76.6 |
| Current depression (%) | 697 | 38.1 | 7.2 | <.001 | 12.8 |
| Current anxiety (%) | 703 | 54.1 | 22.1 | <.001 | 28.2 |
| Current PTSD (%) | 688 | 29.5 | 11.8 | <.001 | 15.1 |
| Baseline multi-morbidity (%) | 719 | 28.1 | 14.7 | <.001 | 17.2 |
| Baseline depression (%) | 701 | 49.6 | 50.9 | .85 | 50.6 |
| Baseline PTSD (%) | 706 | 52.2 | 48.4 | .44 | 49.2 |
| Baseline body mass index, mean (SD) | 711 | 27.1 (4.6) | 24.9 (4.4) | <.001 | 25.3 (4.5) |
| *Earthquake exposure variables* | | | | | |
| Earthquake-related deaths in the family (%) | 719 | 7.4 | 10.1 | .42 | 9.6 |
| Earthquake-related injuries (%) | 719 | 9.6 | 8.4 | .61 | 8.6 |
| Earthquake-caused material loss score, mean (SD) | 709 | 2.7 (1.9) | 2.7 (2.0) | .79 | 2.7 (2.0) |

N, number of valid responses; SD, standard deviation; p-value: two-sided.

**Table 2** Association of SRH with health status correlates: quality of life, multi-morbidity and depression in the cohort of survivors of the 1988 earthquake in Armenia (valid $N$ = 672).

| Health correlates | OR[a] | 95% CI | $p$-Value |
|---|---|---|---|
| Current poor quality of life | 5.69 | 3.39—9.55 | <.001 |
| Current multi-morbidity | 5.49 | 1.59—18.98 | .007 |
| Current depression | 4.17 | 2.29—7.60 | <.001 |

[a] Controlled for all significant variables (baseline body mass index, baseline multi-morbidity, perceived poor living standards during post-earthquake 10 years, socio-economic status score, and household size).

**Table 3** Logistic regression model of long- and short-term determinants of poor SRH in the cohort of survivors of the 1988 earthquake in Armenia (valid $N$ = 678).

| Characteristics | OR | 95% CI | $p$-Value |
|---|---|---|---|
| Baseline body mass index | 1.11 | 1.06—1.17 | <.001 |
| Baseline multi-morbidity | 1.90 | 1.13—3.19 | .015 |
| Baseline regular participation in sports | 0.43 | 0.19—0.98 | .044 |
| Perceived poor living standards during post-earthquake 10 years | 2.34 | 1.42—3.86 | .001 |
| Number of stressful life events | 1.15 | 1.03—1.28 | .010 |
| Current good social support | 0.43 | 0.27—0.69 | <.001 |
| Current socioeconomic status score | 0.92 | 0.86—0.99 | .017 |
| Current employment | 0.45 | 0.27—0.75 | .002 |
| Current household size | 1.16 | 1.05—1.29 | .005 |
| Current low dignity | 1.56 | 0.97—2.50 | .065 |

*Model fit statistics*: Hosmer and Lemeshow goodness of fit test, $p$ = .97; Area under the ROC curve = 0.817; Pseudo $R^2$ = 0.211. $N$, number of cases; OR, odds ratio; CI, confidence interval.

Of the current variables, social support, SES score, employment and household size were among independent determinants of SRH. Current good social support and current employment both decreased the likelihood of poor SRH over two times. An increase of the household size by one member was associated with a 16.0% higher chance of poor SRH. Each unit increase in the SES score decreased the chance of poor SRH by 8.0%. Although marginally significant, low dignity was also associated with a considerably higher chance of poor SRH in the final model. The model achieved good fit indices (Table 3). The highest value for VIF detected in this model did not exceed 1.3, indicating no issue of collinearity [49]. No interactions between the studied variables were found.

Adjusted relative risks were calculated for the variables reflecting baseline characteristics, using the advantage the cohort study design provides. Three of these variables (except baseline multi-morbidity and baseline regular participation in sports) — baseline BMI, perceived living standards during the post-earthquake decade, and number of stressful life events — remained significant predictors of SRH in the final model (Table 4). When controlling for the remaining significant variables, the risk of poor SRH was 58% higher for those who reported poor living standards during the post-earthquake decade as compared with those who reported average/good living standards during that period. On average, the risk of poor SRH increased independently by 5% for each additional unit of the baseline BMI (kg/m$^2$) and by 10% for each additional stressful life event experienced by a respondent.

## 4. Discussion

The prevalence of poor SRH in this long-term cohort of earthquake survivors was rather high (18.8%) with no significant between-gender differences (19.3% among women and 17.8% among men). However, the proportion of those rating their health as less than good (fair/poor) was significantly higher among women (78.3%) than among men (68.9%), which is consistent with other reports [50—52]. Although higher when compared with western European countries and the United States [53,54], the observed rates of poor SRH in this study were comparable to the rates previously reported in Armenia [32,33] and other former Soviet Union countries [55,56]. The strong independent relation of SRH with the correlate measures of physical and mental health in this study affirmed the use of this measure as a valid marker of general health status of the survivors.

**Table 4** Computed relative risks of poor SRH in the cohort of survivors of the 1988 earthquake in Armenia (valid *N* = 679).[a]

| Characteristics | RR[b] | 95% CI | *p*-Value |
|---|---|---|---|
| Baseline body mass index | 1.05 | 1.02—1.07 | <.001 |
| Perceived poor living standards during post-earthquake 10 years | 1.58 | 1.17—2.13 | .003 |
| Number of stressful life events | 1.10 | 1.04—1.16 | .001 |

*N*, number of cases; CI, confidence interval.
[a] Generalized linear model, with a log link, normal distribution, and robust variance estimator.
[b] RR, relative risk, controlled mutually and for the remaining significant variables (current good social support, current employment, current household size, current socioeconomic status score, and current low dignity).

This cohort study was unique, as it provided a rare opportunity to explore the relation between current SRH and baseline psychosocial, earthquake exposure, lifestyle, and other factors, the data on which were collected prospectively over two decades ago independently from the study outcome. Among the many prospectively-obtained baseline variables, three independent long-term predictors of SRH were identified, all related to the survivors' baseline health status and/or lifestyle: baseline BMI, multi-morbidity, and regular participation in sports. All these factors are well-known determinants of SRH [57—62]. However, their persistent influence on perceived health status even after 23 years is an important finding of this study, clearly demonstrating the role of healthy lifestyle for future optimal health.

Neither earthquake exposure variables, nor baseline PTSD were associated with SRH 23 years after the event. According to a meta-analysis investigating factors influencing the relationship between disasters and their mental health consequences, the time elapsed since the disaster was inversely related to its effect size [63]. As SRH covers both physical and mental components of health, this inverse relation could possibly explain the lack of association between earthquake exposure and perceived health status 23 years after the disaster among this study sample.

Unlike baseline psychopathology, current depression, anxiety and PTSD were strongly related to SRH, acting as its correlates rather than determinants and demonstrating the ability of SRH to also capture mental aspects of overall health. In the model controlled for all significant variables, only depression remained a strong predictor of SRH, mediating the relation between the latter and the remaining two psychopathologies: anxiety and PTSD. This finding suggests a high shared variability between these common mental disorders among disaster survivors, a finding well supported in the literature [64—66].

This study identified a strong independent relation between SRH and the number of experienced stressful negative life events, with each additional such event increasing the risk of perceived poor health by 10%. This finding was consistent with the results of other studies reporting a significant independent association between stressful life events and both poor SRH [17,67] and adverse mental [5,68] and physical health outcomes [69,70].

Current socio-economic status score and living standards during the post-earthquake decade were among the independent predictors of SRH in this study. Perceived poor living standards during the first 10 years after the earthquake were among the strongest predictors of poor SRH, increasing the risk of the latter by 58%. These findings provided evidence supporting the role of socioeconomic inequities in determining SRH of disaster survivors and were consistent with other studies among populations exposed to disasters [9—11,71]. Poor living standards during early post-disaster period, when victims are especially vulnerable, were particularly detrimental for further SRH.

Respondent's current family size and employment status were also among the independent determinants of SRH. Living in larger families and being unemployed were characteristics associated with an increased likelihood of poor SRH. Although these factors mainly reflect a respondent's socioeconomic status, their association with SRH remained significant when controlling for current socioeconomic status scores, indicating either limited versatility of the latter or some other pathway of their relation to the outcome, for instance, a better sense of perceived control and coherence that employment possibly provides. Also, the data on these variables were collected during the follow-up study simultaneously with the outcome and a reverse causation could have a place, when poor health status resulted in unemployment or a necessity to live in an extended family.

Current good social support was a strong protective factor for SRH in this study. The close relation between social resource loss and adverse health consequences of disasters is well documented in

the literature [3]. Disruption of social networks and lack of social support were found to be important risk factors for psychological distress among trauma-exposed populations [5,7]. The significant independent relation between social support and SRH among disaster survivors is also documented [72]. However, the direction of the association between social support and SRH is difficult to establish in the current study, as a reciprocal relation between the two is possible.

Although marginally significant in the fitted model, perceived low dignity was also associated with poor SRH among long-term survivors of the earthquake. This is an interesting finding in the light of studies demonstrating the importance of self-efficacy, perceived control and optimism to avoid adverse health consequences of disasters [3]. This finding emphasizes the importance of provision of psychological support to disaster victims.

The main limitation of this study was that SRH was not measured during the baseline phases of the cohort study. Because of this, it was not possible to investigate the changes in survivors' perceived health status over the study period. Lack of generalizability of these findings to other population groups with different experiences and socio-cultural profiles could be another limitation of the study. This study was also limited in revealing the direction of association between poor SRH and its current predictors, as the data on these variables were collected at the same time with the outcome during the follow-up assessment in 2012. Data on two predictors of SRH reflecting prior experiences (stressful negative life events and perceived living standards during the post-earthquake decade) were collected retrospectively, which could be subject to recall bias. However, the consistency of these findings with relevant literature reassures us in the validity of the identified associations.

This study was unique as it followed earthquake survivors for over two decades. It was able to investigate the influence of a number of prospectively obtained baseline variables on survivors' current SRH and to reveal associations between these and the outcome free from any bias related to recall or direction of association. The study demonstrated that the influence of earthquake exposure on survivors' health diminished over time. However, it found other factors that had life-long influences on survivors' SRH status. Cumulative lifetime stress, lifestyle factors including the level of physical activity, poor living standards, and baseline multi-morbidity were among these factors. While some of the identified risk factors are not easily modifiable, others like lifestyle factors

and the levels of material, social and psychological support to survivors are reasonably modifiable. Hence, timely efforts to improve these factors among disaster victims could have a long-lasting impact on their health.

## Conflict of interest

H.K. Armenian is an associate editor at the Journal of Epidemiology and Global Health.

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