

Rate and predictors of postpartum depression in a 22-year follow-up of a cohort of earthquake survivors in Armenia

Anahit Demirchyan · Diana Petrosyan ·
Haroutune K. Armenian

Received: 28 September 2013 / Accepted: 26 December 2013
© Springer-Verlag Wien 2014

Abstract Disasters have serious long-term impact on mental health for those exposed. The aim of this study was to identify predictors of postpartum depression among survivors of the 1988 devastating earthquake in Armenia. A nested case–control design was applied to investigate postpartum depression in a large-scale cohort of survivors followed between 1990 and 2012. From an original group of 725 adults who were assessed for psychopathology in 1990, 146 women reported having a delivery after the earthquake and were included in this study. Women with postpartum depression were identified using Edinburgh Postnatal Depression Scale. A logistic regression model was fitted to identify the predictors of postpartum depression. Of the 146 women, 19 (13.0 %) had postpartum depression. Five independent predictors of postpartum depression were identified: number of woman's stressful life events (odds ratio (OR)=2.06), her prior history of postpartum depression (OR=16.98), delivering sick/dead neonate (OR=13.65), poor living standards during the post-earthquake decade (OR=5.77), and perceiving oneself reliable in 1990 (OR=0.24). Anxiety in 1990 was marginally

significantly related to the outcome (OR=3.75). The rate of postpartum depression in this 22-year cohort was similar to that among the Armenian general population. Earthquake exposure was not related to postpartum depression, indicating that the impact of disaster-related trauma diminishes over time. The identified predictors provided evidence to develop interventions targeting groups of women most prone to postpartum depression under such circumstances.

Keywords Postpartum depression · Predictors · Earthquake survivors · Armenia

Introduction

Psychopathological morbidity is one of the important areas of investigation among populations exposed to natural and man-made disasters, as there is compelling evidence suggesting that disasters have adverse short- and long-term impact on mental health status of those exposed, particularly in terms of increasing the rates of post-traumatic stress disorder and depression (Armenian et al. 2002; Rubonis and Bickman 1991; North et al. 2004; Armenian et al. 2000). A meta-analysis of 50 post-disaster psychopathology studies (Rubonis and Bickman 1991) indicates that between 7 and 40 % of the subjects exposed to disasters show some form of psychopathology and that anxiety is the most prevalent among them followed by phobia, alcohol impairment, depression, drug impairment, and stress. The disaster effect-size in this meta-analysis was estimated to be 0.174, meaning that a 17.4 % increase in the prevalence rates of baseline psychopathology could be expected as a result of disaster exposure, and the effect-size was higher in the case of multiple causalities of stress and among victims of natural as opposed to man-made disasters (Rubonis and Bickman 1991).

A. Demirchyan (✉)
School of Public Health, American University of Armenia,
40 Marshal Baghramian Avenue, Yerevan 0019, Armenia
e-mail: ademirch@aua.am

D. Petrosyan
Global Fund Projects Coordinating Team, Ministry of Health,
Government Building #3, Yerevan 0010, Armenia
e-mail: d.petrosyan@moh.am

H. K. Armenian
Department of Epidemiology, Fielding
School of Public Health, UCLA,
650 Charles E. Young Dr. S, 16-035 Center for Health Sciences,
Los Angeles, CA 90095-1772, USA
e-mail: harmenian@ucla.edu

A prospective study examining the development of general psychopathology among traumatized adolescents over a 5–8-year period after the disaster showed that compared to unexposed controls, the relative risk for developing any affective or anxiety disorder, including late-onset depression, was significantly higher only among those survivors who had developed posttraumatic stress disorder (PTSD) and that recovery from PTSD was associated with recovery from other mental disorders (Bolton et al. 2000). A substantial evidence suggests that PTSD, depression, and trauma-specific phobia are usually highly intertwined in disaster survivors and that the prevalence of all these post-disaster mental health conditions significantly diminishes over time (Rubonis and Bickman 1991; Bolton et al. 2000; Meewisse et al. 2011). The intensity of traumatic exposure and other sources of life and childhood stress, as well as low socioeconomic status, are found to be predictive for post-disaster psychopathology (Meewisse et al. 2011; Qu et al. 2012; Harville et al. 2009b, 2010; O'Hara and Swain 1996; Beck 2001; Norris et al. 2002).

Studies have shown that women are more prone to post-disaster psychopathology than men (Rubonis and Bickman 1991; Norris et al. 2002). According to some evidence, pregnant and postpartum women may be especially vulnerable to mental health consequences of disasters, and developing PTSD poses these women at higher risk of developing one of the most common complications of childbearing—postpartum depression (Onoye et al. 2009; Bromet and Litcher-Kelly 2002; Benyakar and Collazo 2005).

Although longitudinal and epidemiological studies have yielded varying rates of postpartum depression depending on diagnostic instruments used and study methodology applied, a meta-analysis of 59 studies reported an average prevalence of 13 %, with most cases starting in the first 3 months postpartum (McCoy et al. 2006; O'Hara and Swain 1996). The consequences on the quality of life of the suffering women and her family members, as well as the adverse impact on infant's growth and development, place the postpartum depression in line with other major public health concerns (Wisner et al. 2006; Surkan et al. 2011; Cooper and Murray 1997; Austin et al. 2007).

Despite the high prevalence, the cause of postpartum depression remains unclear with extensive research conducted to determine the magnitude of the relationship between different risk factors and its development. The evidence suggests that the predictors of postpartum depression include prenatal depression, childcare stress, life stress, low level of social support, prenatal anxiety, low level of satisfaction with marital relationship and single marital status, history of previous depression and postpartum depression, low self-esteem, low socioeconomic status, poor delivery outcome, and unplanned/unwanted pregnancy (O'Hara and Swain 1996; Beck 2001; Fisher et al. 2012; Warner et al. 1996; Surkan et al. 2008; Cooper and Murray 1995).

Over the past two decades, the population of Armenia has faced several crises: the devastating earthquake of Spitak in 1988, the collapse of the Soviet Union in 1991, the war in Nagorno-Karabakh during 1988–1994, and the long-lasting economic crisis due to the difficult transition to a market economy aggravated by the blockade of the country applied by neighboring Turkey and Azerbaijan. In a population-based cohort study following the 1988 earthquake in Armenia, Armenian et al. (2002) found that depression was a major public health problem under such circumstances. In their study, half of the adult participants from the earthquake region were identified as fulfilling the criteria for major depression after 2 years following the disaster. According to this study, female gender, the severity of earthquake-related destruction, and the extent of material loss experienced by the family were independent risk factors for depression among the earthquake survivors (Armenian et al. 2002). A prospective study which followed the Spitak earthquake survivors for 4.5 years have demonstrated that the traumatized adults are at high risk of developing not only severe but chronic posttraumatic stress reactions that are related to chronic anxiety and depression (Goenjian et al. 2000).

In 2006, the prevalence of depressive symptoms among the general adult female population of Armenia was estimated to be as high as 53.0 % (Demirchyan et al. 2011). A recent study carried out among Yerevan residents revealed a 14.4 % prevalence of postpartum depression symptoms, which was not much different from that in other societies (Petrosyan et al. 2011).

The current nested case–control study used a unique opportunity provided by a large-scale cohort study—Post-earthquake Psychopathological Investigation (PEPSI)—which followed the 1988 Armenian (Spitak) earthquake survivors prospectively for over 22 years (Armenian et al. 1997, 1998). The cohort study made possible investigating the effect of a number of important baseline characteristics of female survivors of the earthquake on their odds of developing postpartum depression years after the disaster. The objective of this nested case–control study was to identify the rate and some risk factors of postpartum depression among women exposed to the earthquake adversities and the difficulties of post-earthquake period. The study also aimed to investigate whether the disaster had a long-term impact on women's postpartum mental health.

Methods

Participants The study participants were selected from the PEPSI cohort. The latter was initiated in 1990 to investigate the long-term health consequences of the 1988 Spitak earthquake. The cohort consisted of all employees of the healthcare services in the earthquake zone and their family members—32,743 individuals in total, whose contact information was

acquired from the Ministry of Health of Soviet Armenia. For the second phase of the cohort study in 1991, a geographically stratified sampling within the cohort was conducted to achieve higher representation from the areas most affected by the earthquake, which resulted in a subsample of 1,785 individuals aged 16–70 years who participated in a baseline psychological assessment (Armenian et al. 2000, 2002). In spring 2012, 1,487 participants of this baseline assessment were followed-up through household visits, and 725 individuals were again interviewed to obtain detailed data on their physical and mental health status (309 individuals had died, 389 were either out of country or unable to participate, and 64 refused to participate). The Institutional Review Board of the American University of Armenia approved the protocol of the follow-up study. Informed consent was obtained from the participants prior to their inclusion in the study. Of those 725 individuals who were interviewed in 2012, all female participants who reported having at least one delivery after the earthquake ($n=146$) were involved in the nested case–control study of determinants of postpartum depression among earthquake survivors.

Study instrument and variables The dependent variable was the status of possible postpartum depression experienced after the earthquake. The 2012 survey instrument had a special section on pregnancy history. Edinburgh Postnatal Depression Scale (EPDS) was included in this section to measure postpartum depression during the most depressed (perceived) postnatal period a participant experienced after the earthquake. All women who reported feeling depressed for more than a month during the first year after any of their deliveries that occurred after the earthquake completed the EPDS. This screening question was included in our instrument for several reasons. To diagnose postpartum depression, the Diagnostic and Statistical Manual of Mental Disorders—Fourth Edition (DSM-IV) criteria (American Psychiatric Association 2000) add a Postpartum Onset Specifier (within 4 weeks after delivery) to the diagnostic criteria for major depressive episode. According to these criteria, five disease-specific symptoms should be present during a 2-week period including either depressed mood or loss of interest/pleasure most of the day nearly every day. However, these criteria assume making diagnosis of an on-going condition. To make the diagnosis retrospectively, the minimal duration of the condition should be considered to exclude those women who experienced maternity blues that could last up to 2 weeks (Robertson et al. 2004), while the minimal duration of postpartum depressive episode is reported to be 4 weeks and the average duration 36 weeks (Cox et al. 1993). This conservative approach could also lead to a better estimate of the earthquake effect on postpartum depression rate, as it is shown that the effect size of disaster on psychopathology rates is significantly higher if the condition is assessed retrospectively

as opposed to prospective assessment (Rubonis and Bickman 1991). The maximal post-delivery onset time of the condition was also considered in this screening question to not miss those cases with late onset of postpartum depression—often over 6–7 months after the delivery (O’Hara et al. 2000; Robertson et al. 2004).

EPDS is the most widely used screening tool for identifying the risk of postpartum depression (Cox et al. 1987). It has ten items and a four-point response scale (0–3), resulting in a cumulative score 0–30, with higher scores indicating more depression. A 12/13 cut-point is used to distinguish between those with and without possible postpartum depression (Cox et al. 1987; Rubertsson et al. 2011; Matthey 2004). This instrument was first translated into Armenian and used in a case–control study by Petrosyan et al. in 2011. Considering the necessity to collect data on postpartum depressive symptoms retrospectively, this study used a slightly modified version of the Armenian language EPDS (the items were put in past tense and asked about the most depressed postpartum period a women experienced after the earthquake). Women meeting the criteria for having postpartum depression (a cumulative EPDS score 13 and over) after any of their post-earthquake deliveries were treated as cases in this study. Women who did not meet the criteria for having postpartum depression after any of their post-earthquake deliveries were treated as controls. When comparing women’s age at delivery and other delivery-related variables (delivery mode, neonate’s health, etc.) between women with and without postpartum depression, the delivery followed with the most severe depressive symptoms was considered for cases and compared with a randomly selected post-earthquake delivery (if more than one) for controls.

Independent variables included women’s sociodemographic characteristics (age at delivery, perceived socioeconomic status during the post-earthquake decade, number of stressful life events), pregnancy/delivery history (number of pregnancies and deliveries, history of miscarriages/stillbirths), outcomes of the pregnancy of interest (term of delivery, mode of delivery, neonate’s gender, birth length, birth weight, and health status at birth), extent of exposure to the earthquake (earthquake injuries, earthquake-related deaths in the family, earthquake-caused material loss score), and prior psychopathology.

Number of stressful life events was calculated based on a checklist of potentially traumatic events meeting the DSM-IV criterion A (American Psychiatric Association 2000). The list of the events was taken from Trauma History Screen (Carlson et al. 2011). Women were asked to indicate whether each of these events ever happened to them and the times each happened. We used the summative number of the events reported by each woman at the follow-up assessment.

Earthquake loss score was calculated as a weighted sum of earthquake-caused loss of money, furniture, car, and everyday

utensils (complete loss of each of these items contributed two units to the score, partial loss—one unit; thus, the score ranged from 0 to 8). The information on this score, as well as for earthquake injuries and earthquake-related deaths in the family, were obtained prospectively during the baseline assessments.

The variables on prior psychopathology included history of postpartum depression (reported retrospectively as postpartum depression episode (s) experienced before the delivery of interest) and post-earthquake psychopathology measured prospectively in 1991. The latter included anxiety, major depression, post-traumatic stress disorder, and panic. Each of these conditions was assessed using scales developed in accordance with DSM III-R criteria current at the time of the baseline psychopathological assessment in 1991 (Armenian et al. 2000, 2002).

This baseline instrument contained also the following item: “Do you think that during the last month your friends and relatives could rely on your help and support when experiencing some problems?” The variable on perceived reliability for friends/relatives was based on this single item. The data on the remaining variables were obtained retrospectively in 2012.

Analysis The characteristics of women with and without postpartum depression were analyzed descriptively and compared using Pearson’s chi-square test for proportions and independent *t* test for means. This was followed with bivariate logistic regression analysis to identify the crude association between each independent variable and the outcome of post-earthquake postpartum depression status. All the variables associated with the outcome at the $p < 0.25$ level in the bivariate analysis were entered into multivariate analysis in different combinations to check their controlled/mediated effect on the outcome (Hosmer and Lemeshow 2000). The independent variables were entered into logistic regression analysis either as dichotomous or continuous variables. In the latter case, their linearity was checked on the logistic scale. At the final step, a multivariate logistic regression model of predictors of post-earthquake postpartum depression was fitted. The model fit was assessed using Hosmer–Lemeshow goodness-of-fit test, the area under the receiver operating characteristic (ROC) curve, and the pseudo- R^2 . All the missing values (comprising 2.1 % of the total sample of 146 women) were treated as missing during the analysis. The analysis was conducted using SPSS-11 and STATA-10 statistical software.

Results

Overall, 146 women from the follow-up study sample reported having at least one delivery after the 1988 earthquake. Twenty women reported being depressed at least a month after one or more of these deliveries. Of them, one woman scored

on EPDS 9, which is well below the threshold 13. Thus, she was treated in this study as a control. Nineteen women scored on EPDS 13 or more and were treated as cases. The remaining 126 reported no postpartum depression after any of their post-earthquake deliveries and comprised the control group. Thus, the rate of postpartum depression in this sample of earthquake survivors was 13.0 %.

Table 1 displays the distribution of selected characteristics of interest between women with and without postpartum depression. Women with postpartum depression were significantly older than controls at the time of the delivery. On average, the deliveries took place 5 years after the earthquake (median 4 years, range 0–16). The distribution of the time-lag between the earthquake and the deliveries is provided in Table 2. The mean time past since the earthquake was longer for women with postpartum depression than for those without postpartum depression (6.3 vs. 5.0 years), but the difference was not statistically significant.

Compared to women without postpartum depression, significantly higher proportion of those with postpartum depression reported having miscarriages or stillbirths in the past. Women with postpartum depression had a history of this condition more frequently than controls did (15.8 vs. 1.6 %, respectively). They also reported significantly higher number of stressful events in their life than controls did. Women with postpartum depression gave birth to a sick or dead neonate after the delivery of interest more often than women without postpartum depression did (21.1 vs. 2.4 %). Compared to those without postpartum depression, a much higher proportion of women with postpartum depression perceived their living standards as below average during the first post-earthquake decade (68.4 vs. 38.6 %). Among the prospectively obtained variables, only anxiety and perceived reliability were marginally significantly different between women with and without postpartum depression: A higher percentage of those with postpartum depression had anxiety and perceived themselves as not reliable for friends/relatives at the baseline assessment. No significant differences were revealed between the two groups with respect to earthquake-related variables—earthquake loss score, earthquake-related injuries, or earthquake-caused deaths in the family (Table 1).

The fitted logistic regression model (Table 3) identified five independent predictors of postpartum depression in this post-earthquake cohort: number of stressful life events experienced by a woman, her prior history of postpartum depression, delivering sick or dead neonate at the given delivery, perceived poor living standards during the post-earthquake decade, and perceived unreliability at the baseline assessment. Baseline anxiety was marginally significantly related to postpartum depression in the fitted model.

When controlling for all other significant variables, each stressful life event experienced by a woman increased her chance of having postpartum depression more than twice.

Table 1 Distribution of selected characteristics between women with postpartum depression and women without postpartum depression among a cohort of the 1988 Armenian earthquake survivors

Characteristics	Women with postpartum depression (n=19)	Women without postpartum depression (n=127)	OR ^a	CI ^a
Age at delivery, mean (SD)*	31.4 (5.5)	27.8 (5.0)	1.14	1.04–1.26
Post-earthquake years preceding the delivery, mean (SD)	6.3 (4.6)	5.0 (3.3)	1.10	0.97–1.25
Number of stressful life events, mean (SD)*	3.3 (1.3)	2.5 (1.0)	1.88	1.22–2.90
Overall number of pregnancies, mean (SD)	6.6 (4.5)	5.2 (3.5)	1.09	0.98–1.22
Overall number of deliveries, mean (SD)**	3.1 (1.4)	2.4 (0.9)	1.74	1.13–2.68
Earthquake loss score, mean (SD)	2.5 (2.2)	2.7 (1.9)	0.96	0.74–1.23
Earthquake-caused injuries				
One or more, %	5.3	8.7	0.59	0.07–4.82
None, %	94.7	91.3	1.00	
Earthquake-related deaths in the family				
One or more, %	15.8	12.6	1.30	0.34–4.97
None, %	84.2	87.4	1.00	
Living standards during post-earthquake decade**				
Poor/very poor, %	68.4	38.6	3.45	1.23–9.67
Very good/good/average, %	31.6	61.4	1.00	
Ever had miscarriage or stillbirth*				
Yes, %	57.9	24.8	4.17	1.54–11.30
No, %	42.1	75.2		
Neonate's health status at the given delivery*				
Sick/birth defect/stillbirth, %	21.1	2.4	10.84	2.21–53.18
Healthy, %	78.9	97.6	1.00	
History of postpartum depression*				
Yes, %	15.8	1.6	11.72	1.82–75.53
No, %	84.2	98.4	1.00	
Perceived reliability at baseline***				
Reliable for friends/relatives, %	36.8	59.5	0.40	0.15–1.08
Not reliable for friends/relatives, %	63.2	40.5	1.00	
Anxiety at baseline***				
Yes, %	78.9	56.7	2.86	0.90–9.11
No, %	21.1	43.3	1.00	
Depression at baseline				
Yes, %	52.6	48.8	1.67	0.44–3.07
No, %	47.4	51.2	1.00	
PTSD at baseline				
Yes, %	38.9	51.6	0.60	0.22–1.64
No, %	61.1	48.4	1.00	
Panic at baseline				
Yes, %	36.8	29.1	1.42	0.52–3.89
No, %	63.2	70.9	1.00	

SD standard deviation, ORs odds ratios, CIs confidence intervals
 *Significant $p < 0.01$; **significant $p < 0.05$; ***marginally significant $p < 0.1$
^a ORs and CIs from bivariate logistic regression analysis

Both history of postpartum depression and delivering sick or dead child at the given delivery dramatically increased the odds of experiencing postpartum depression. However, confidence intervals for these associations were too wide because of the small number of women in the sample with these characteristics (less than five in both groups). Perceived poor

living standards during the post-earthquake decade were associated with over five-fold higher chance of having postpartum depression. Perceived reliability at the baseline assessment decreased four times the odds of experiencing postpartum depression. Baseline anxiety was associated with almost four-fold increased chance of postpartum depression later in

Table 2 Distribution of the time-lag between the earthquake and the post-earthquake deliveries of interest among the cohort of the 1988 Armenian earthquake survivors ($N=146$)

Years passed after the earthquake	% (n) of deliveries within that period
0–2	21.2 (31)
3–4	33.6 (49)
5–6	17.1 (25)
7–8	14.4 (21)
9–10	5.5 (8)
11–12	2.1 (3)
13–14	3.4 (5)
15–16	2.7 (4)

life, although the association was marginally significant. The final model achieved good fit indices—a p value of 0.56 for Hosmer and Lemeshow goodness of fit test, an area under the ROC curve of 0.85, and a pseudo- R^2 of 0.33 (Table 3).

Discussion

In this study, the estimated rate of postpartum depression among the earthquake survivors was 13.0 %, which is similar to the prevalence of this condition among the general population of Armenia and elsewhere (Petrosyan et al. 2011; O'Hara and Swain 1996). Reports about the influence of disasters on the rates of postpartum depression are conflicting. Few studies observed somewhat higher rates of postpartum depression among those exposed to disasters (Savage et al. 2010; Qu et al. 2012), while others reported rates of postpartum depression in these groups similar to other postpartum populations (Harville et al. 2009a, 2010; Hibino et al. 2009).

Evidence suggests that PTSD increases the likelihood of developing postpartum depression (Onoye et al. 2009) and that the severity of exposure to a traumatic event is predictive for postpartum psychopathology (Harville et al. 2009b, 2010; Chang et al. 2002). However, we did not find a significant association between postpartum depression and baseline PTSD or the severity of earthquake exposure (measured by baseline variables of earthquake-caused injuries, deaths

among family members, and material loss score). This could be attributable to the fact that most studies of disaster-related postpartum depression were conducted immediately or within several months after a disaster (Harville et al. 2010; Qu et al. 2012), while this study covered a period of many years with the median time between the earthquake exposure and delivery of interest reaching 4 years. Indeed, it was shown that the time passed since the disaster is inversely related to its effect size—the longer the time passed since the disaster event, the lower the effect of the disaster on psychopathology rates (Rubonis and Bickman 1991). Nevertheless, the baseline variables of perceived reliability and earthquake-related anxiety were found to be independent determinants of postpartum depression, a finding well documented in the literature (Beck 2001; Hibino et al. 2009; Petrosyan et al. 2011). It is noteworthy that the baseline data about earthquake exposures used in this study was collected independently in a different time period.

This study identified a significant independent relation between postpartum depression and the number of stressful life events experienced by a woman. The role of life stress in predicting postpartum depression is demonstrated in a number of studies (O'Hara and Swain 1996; Beck 2001; Vesga-Lopez et al. 2008).

The prior history of postpartum depression was a strong predictor of postpartum depression in this study, while the presence of depressive symptoms at the baseline assessment was not. The tendency of the reoccurrence of postpartum depression is well established (Cooper and Murray 1995; Dennis and Ross 2006). Several studies indicate also that the history of major depression is predictive for postpartum depression (Appleby et al. 1994; Downs et al. 2008; McCoy et al. 2006; Chaaya et al. 2002). However, there is evidence suggesting that previous postpartum depression is more indicative for future postpartum depression, while previous major depression poses women to higher risk for further non-postpartum episodes of depression (Cooper and Murray 1995).

Perceived poor living standards during the first post-earthquake decade (when 92 % of the studied deliveries took place) were among significant independent predictors of

Table 3 Logistic regression model on predictors of postpartum depression in a nested case-control study among the cohort of the 1988 Armenian earthquake survivors (valid $N=143$)

Characteristics	OR	95 % CI	p value
Number of stressful life events	2.06	1.24–3.44	0.01
Poor living standards during post-earthquake decade	5.77	1.49–22.24	0.01
Neonate's poor health/birth defect or stillbirth	13.65	1.74–106.94	0.01
History of postpartum depression	16.98	1.57–184.28	0.02
Perceived reliability at baseline	0.24	0.06–0.86	0.03
Anxiety at baseline	3.75	0.88–15.94	0.07
Model's fit statistics	Hosmer and Lemeshow goodness of fit test, $p=0.56$		
	Area under the ROC curve=0.85		
	Pseudo- $R^2=0.33$		

N number of cases, OR odds ratio, CI confidence interval

postpartum depression. The observed relation between poor socioeconomic conditions and postpartum depression is also consistent with literature repeatedly documenting the existence of such association (O'Hara and Swain 1996; Fisher et al. 2012; Beck 2001; Qu et al. 2012). Poor living conditions and lack of financial resources may increase the level of stress experienced by a woman and contribute to her lower self-esteem, thus increasing the risk of postpartum depression (Brown and Moran 1997).

Delivering a sick or dead child was found to independently predict mother's postpartum depression. Both stillbirth and delivering preterm or sick child were found to be associated with higher risk of postpartum depression in other studies as well (Surkan et al. 2008; Vigod et al. 2010). Again, enhanced stress caused by these adverse birth outcomes might be responsible for higher chance of postpartum depression in these women. Neonate's poor health could increase the childcare stress, which is a known risk factor for postpartum depression (Beck 2001).

This study has a number of limitations. For the outcome variable and some independent variables, the information was collected retrospectively, which could potentially lead to a recall bias and inability to determine causal relationships. Self-report bias could be another possibility, as the study lacked clinically validated data. Hence, selection bias could have a place with some cases treated as controls and some controls as cases. This could attenuate the ability of the study to find some true associations.

Due to a small sample size, the precision of statistical analysis suffered because of the small number of women with the characteristic of interest. In particular, the numbers of those who had history of postpartum depression or delivered sick/dead child were less than five among both women with and without postpartum depression, which resulted in wide confidence intervals in logistic regression analysis.

The study design limited our ability to investigate the role of major problems during the given pregnancy/delivery (e.g., poor marital relationship, lack of support, pregnancy/delivery complications) in predicting postpartum depression, while these problems are known risk factors of this psychopathology (Vesga-Lopez et al. 2008; Beck 2001; Fisher et al. 2012). Also, the generalizability of our findings to other population groups or other types of disasters may be of concern. Thus, the study findings should be viewed in the context of all the listed limitations concerning the outcome variable, the sample size, and the study design.

Unlike most studies of disaster-related postpartum depression, the deliveries of interest in this study occurred many years after the earthquake, which probably made weaker the influence of disaster-related trauma on psychological status of women during their postpartum period. This could be the reason of not finding an association between the earthquake exposure variables and postpartum depression in this study.

However, this study adds some evidence to the possibility that disaster exposure alone might not be associated with elevated risk of postpartum depression thereafter.

Despite the discussed limitations, this study makes an important contribution to the field as one of the few cohort studies investigating the rate and determinants of postpartum depression among earthquake survivors (Harville et al. 2010). Unlike other studies, this study followed the earthquake survivors for more than two decades, which made possible including in the analysis all cases of postpartum depression that occurred during that period. The study demonstrated that the risk of developing postpartum depression among traumatized subjects diminishes substantially over time. The data on some variables found to be risk factors for postpartum depression were obtained prospectively, thus making their relation to the outcome free from any bias related to recall or direction of association. The study findings have a number of practical implications, as they indicate the characteristics of women at higher risk for postpartum depression, thus providing evidence to develop interventions and preventive strategies targeting the groups of women most prone to postpartum mental disorders.

Acknowledgments The baseline phases of the cohort study were supported by a grant from the Armenian Relief Society, Inc., Watertown, MA 012172 USA and by the Ministry of Health of the Republic of Armenia. The Turpanjian Family Educational Foundation financed the follow-up phase in 2012.

Conflict of interest The authors declare that they have no conflict of interest.

References

- American Psychiatric Association (2000) Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR, 4th edn. American Psychiatric Association, Washington, DC
- Appleby L, Gregoire A, Platz C, Prince M, Kumar R (1994) Screening women for high risk of postnatal depression. *J Psychosom Res* 38(6):539–545
- Armenian HK, Melkonian A, Noji EK, Hovanesian AP (1997) Deaths and injuries due to the earthquake in Armenia: a cohort approach. *Int J Epidemiol* 26(4):806–813. doi:10.1093/ije/26.4.806
- Armenian HK, Melkonian AK, Hovanesian AP (1998) Long term mortality and morbidity related to degree of damage following the 1988 earthquake in Armenia. *Am J Epidemiol* 148(11):1077–1084
- Armenian HK, Morikawa M, Melkonian AK, Hovanesian AP, Haroutunian N, Saigh PA, Akiskal K, Akiskal HS (2000) Loss as a determinant of PTSD in a cohort of adult survivors of the 1988 earthquake in Armenia: implications for policy. *Acta Psychiatr Scand* 102(1):58–64. doi:10.1034/j.1600-0447.2000.102001058.x
- Armenian HK, Morikawa M, Melkonian AK, Hovanesian A, Akiskal K, Akiskal HS (2002) Risk factors for depression in the survivors of the 1988 earthquake in Armenia. *J Urban Health: Bull N Y Acad Med* 79(3):373–382. doi:10.1093/jurban/79.3.373
- Austin MP, Kildea S, Sullivan E (2007) Maternal mortality and psychiatric morbidity in the perinatal period: challenges and opportunities for prevention in the Australian setting. *Med J Aust* 186(7):364–367

- Beck CT (2001) Predictors of postpartum depression: an update. *Nurs Res* 50(5):275–285. doi:10.1097/00006199-200109000-00004
- Benyakar M, Collazo CR (2005) Psychological interventions for people exposed to disasters. In: López-Ibor JJ, Christodoulou G, Maj M, Sartorius N, Okasha A (eds) *Disasters and mental health*. Wiley, Chichester, pp 81–97
- Bolton D, O’Ryan D, Udwin O, Boyle S, Yule W (2000) The long-term psychological effects of a disaster experienced in adolescence: II: general psychopathology. *J Child Psychol Psychiatry* 41(4):513–523. doi:10.1111/1469-7610.00636
- Bromet EJ, Litcher-Kelly L (2002) Psychological response of mothers of young children to the Three Mile Island and Chernobyl nuclear plant accidents one decade later. In: Havenaar JM, Cwikel JG, Bromet EJ (eds) *Toxic turmoil: psychological and societal consequences of ecological disasters*. The Plenum series on stress and coping. Springer, New York, pp 69–84
- Brown GW, Moran PM (1997) Single mothers, poverty and depression. *Psychol Med* 27(1):21–33. doi:10.1017/S0033291796004060
- Carlson EB, Smith SR, Palmieri PA, Dalenberg C, Ruzek JI, Kimerling R, Burling TA, Spain DA (2011) Development and validation of a brief self-report measure of trauma exposure: the Trauma History Screen. *Psychol Assess* 23(2):463–477. doi:10.1037/a0022294
- Chaaya M, Campbell OM, El Kak F, Shaar D, Harb H, Kaddour A (2002) Postpartum depression: prevalence and determinants in Lebanon. *Arch Womens Ment Health* 5(2):65–72. doi:10.1007/s00737-002-0140-8
- Chang HL, Chang TC, Lin TY, Kuo SS (2002) Psychiatric morbidity and pregnancy outcome in a disaster area of Taiwan 921 earthquake. *Psychiatry Clin Neurosci* 56(2):139–144. doi:10.1046/j.1440-1819.2002.00948.x
- Cooper PJ, Murray L (1995) Course and recurrence of postnatal depression. Evidence for the specificity of the diagnostic concept. *Br J Psychiatry* 166(2):191–195. doi:10.1192/bjp.166.2.191
- Cooper P, Murray L (1997) Prediction, detection, and treatment of postnatal depression. *Arch Dis Child* 77(2):97–99. doi:10.1136/adc.77.2.97
- Cox JL, Holden JM, Sagovsky R (1987) Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 150:782–786. doi:10.1192/bjp.150.6.782
- Cox JL, Murray D, Chapman G (1993) A controlled study of the onset, duration and prevalence of postnatal depression. *Br J Psychiatry* 163:27–31. doi:10.1192/bjp.163.1.27
- Demirchyan A, Petrosyan V, Thompson ME (2011) Psychometric value of the Center for Epidemiologic Studies Depression (CES-D) scale for screening of depressive symptoms in Armenian population. *J Affect Disord* 133(3):489–498. doi:10.1016/j.jad.2011.04.042
- Dennis CL, Ross LE (2006) The clinical utility of maternal self-reported personal and familial psychiatric history in identifying women at risk for postpartum depression. *Acta Obstet Gynecol Scand* 85(10):1179–1185. doi:10.1080/00016340600697595
- Downs DS, DiNallo JM, Kirner TL (2008) Determinants of pregnancy and postpartum depression: prospective influences of depressive symptoms, body image satisfaction, and exercise behavior. *Ann Behav Med* 36(1):54–63. doi:10.1007/s12160-008-9044-9
- Fisher J, Cabral de Mello M, Patel V, Rahman A, Tran T, Holton S, Holmes W (2012) Prevalence and determinants of common perinatal mental disorders in women in low- and lower-middle-income countries: a systematic review. *Bull World Health Organ* 90(2):139G–149G. doi:10.2471/BLT.11.091850
- Goenjian AK, Steinberg AM, Najarian LM, Fairbanks LA, Tashjian M, Pynoos RS (2000) Prospective study of posttraumatic stress, anxiety, and depressive reactions after earthquake and political violence. *Am J Psychiatry* 157(6):911–916. doi:10.1176/appi.ajp.157.6.911
- Harville EW, Xiong X, Buekens P (2009a) Hurricane Katrina and perinatal health. *Birth* 36(4):325–331. doi:10.1111/j.1523-536X.2009.00360.x
- Harville EW, Xiong X, Pridjian G, Elkind-Hirsch K, Buekens P (2009b) Postpartum mental health after Hurricane Katrina: a cohort study. *BMC Pregnancy Childbirth* 9:21. doi:10.1186/1471-2393-9-21
- Harville E, Xiong X, Buekens P (2010) Disasters and perinatal health: a systematic review. *Obstet Gynecol Surv* 65(11):713–728. doi:10.1097/OGX.0b013e31820eddb
- Hibino Y, Takaki J, Kambayashi Y, Hitomi Y, Sakai A, Sekizuka N, Ogino K, Nakamura H (2009) Relationship between the Noto-Peninsula earthquake and maternal postnatal depression and child-rearing. *Environ Health Prev Med* 14(5):255–260. doi:10.1007/s12199-009-0090-0
- Hosmer DW, Lemeshow S (2000) *Applied logistic regression*, 2nd edn. Wiley-Interscience, New York
- Matthey S (2004) Calculating clinically significant change in postnatal depression studies using the Edinburgh Postnatal Depression Scale. *J Affect Disord* 78(3):269–272
- McCoy SJB, Beal JM, Shipman SBM, Payton ME, Watson GH (2006) Risk factors for postpartum depression: a retrospective investigation at 4-weeks postnatal and a review of the literature. *J Am Osteopath Assoc* 106(4):193–198
- Meewisse ML, Olf M, Kleber R, Kitchiner NJ, Gersons BP (2011) The course of mental health disorders after a disaster: predictors and comorbidity. *J Trauma Stress* 24(4):405–413. doi:10.1002/jts.20663
- Norris FH, Friedman MJ, Watson PJ, Byrne CM, Diaz E, Kaniasty K (2002) 60,000 disaster victims speak: part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry* 65(3):207–239. doi:10.1521/psyc.65.3.207.20173
- North CS, Kawasaki A, Spitznagel EL, Hong BA (2004) The course of PTSD, major depression, substance abuse, and somatization after a natural disaster. *J Nerv Ment Dis* 192(12):823–829. doi:10.1097/01.nmd.0000146911.52616.22
- O’Hara MW, Swain AM (1996) Rates and risk of postpartum depression—a meta-analysis. *Int Rev Psychiatr* 8:37–54
- O’Hara MW, Stuart S, Gorman LL, Wenzel A (2000) Efficacy of interpersonal psychotherapy for postpartum depression. *Arch Gen Psychiatry* 57(11):1039–1045. doi:10.1001/archpsyc.57.11.1039
- Onoye JM, Goebert D, Morland L, Matsu C, Wright T (2009) PTSD and postpartum mental health in a sample of Caucasian, Asian, and Pacific Islander women. *Arch Womens Ment Health* 12(6):393–400. doi:10.1007/s00737-009-0087-0
- Petrosyan D, Armenian HK, Arzoumanian K (2011) Interaction of maternal age and mode of delivery in the development of postpartum depression in Yerevan, Armenia. *J Affect Disord* 135(1–3):77–81. doi:10.1016/j.jad.2011.06.061
- Qu Z, Wang X, Tian D, Zhao Y, Zhang Q, He H, Zhang X, Xu F, Guo S (2012) Posttraumatic stress disorder and depression among new mothers at 8 months later of the 2008 Sichuan earthquake in China. *Arch Womens Ment Health* 15:49–55. doi:10.1007/s00737-011-0255-x
- Robertson E, Grace S, Wallington T, Stewart DE (2004) Antenatal risk factors for postpartum depression: a synthesis of recent literature. *Gen Hosp Psychiatry* 26(4):289–295. doi:10.1016/j.genhosppsych.2004.02.006
- Rubertsson C, Borjesson K, Berglund A, Josefsson A, Sydsjö G (2011) The Swedish validation of Edinburgh Postnatal Depression Scale (EPDS) during pregnancy. *Nord J Psychiatry* 65(6):414–418. doi:10.3109/08039488.2011.590606
- Rubonis AV, Bickman L (1991) Psychological impairment in the wake of disaster: the disaster–psychopathology relationship. *Psychol Bull* 109(3):384–399. doi:10.1037/0033-2909.109.3.384
- Savage J, Giarratano G, Bustamante-Forest R, Pollock C, Robichaux A, Pitre S (2010) Post-Katrina perinatal mood and the use of alternative therapies. *J Holist Nurs* 28(2):123–132. doi:10.1177/0898010109348388

- Surkan PJ, Radestad I, Cnattingius S, Steineck G, Dickman PW (2008) Events after stillbirth in relation to maternal depressive symptoms: a brief report. *Birth* 35(2):153–157
- Surkan PJ, Kennedy CE, Hurley KM, Black MM (2011) Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis. *Bull World Health Organ* 89(8):608–615. doi:[10.2471/BLT.11.088187](https://doi.org/10.2471/BLT.11.088187)
- Vesga-Lopez O, Blanco C, Keyes K, Olsson M, Grant BF, Hasin DS (2008) Psychiatric disorders in pregnant and postpartum women in the United States. *Arch Gen Psychiatry* 65(7):805–815. doi:[10.1001/archpsyc.65.7.805](https://doi.org/10.1001/archpsyc.65.7.805)
- Vigod SN, Villegas L, Dennis CL, Ross LE (2010) Prevalence and risk factors for postpartum depression among women with preterm and low-birth-weight infants: a systematic review. *Bjog* 117(5):540–550. doi:[10.1111/j.1471-0528.2009.02493.x](https://doi.org/10.1111/j.1471-0528.2009.02493.x)
- Warner R, Appleby L, Whitton A, Faragher B (1996) Demographic and obstetric risk factors for postnatal psychiatric morbidity. *Br J Psychiatry* 168(5):607–611. doi:[10.1192/bjp.168.5.607](https://doi.org/10.1192/bjp.168.5.607)
- Wisner KL, Chambers C, Sit DK (2006) Postpartum depression: a major public health problem. *JAMA* 296(21):2616–2618. doi:[10.1001/jama.296.21.2616](https://doi.org/10.1001/jama.296.21.2616)