

Long-Term Mental Health Effects of Exposure to Earthquake-Related Prenatal Maternal Stress

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Abstract

Background: Many studies involving human subjects have shown that exposure to negative factors during pregnancy can have both short - and long-term effects. This study aims to examine the effects on the mental health of the adolescent children of mothers exposed to prenatal maternal stress during earthquakes.

Methods: The sample consisted of 407 adolescents aged 17 years at the time the study was conducted, as well as their mothers, who were pregnant during the earthquake of August 17, 1999 in Turkey. The mothers' mental state were evaluated using the Beck Depression Inventory (BDI), the Beck Anxiety Inventory (BAI) and the Traumatic Stress Symptom Checklist (TSSC). The evaluations of the mental status of the mother following earthquake exposure in pregnancy were conducted retrospectively using self-reported depression, anxiety and trauma scales. The mothers were asked to fill out the BDI and BAI questionnaires based on their mental state in the week following the earthquake, while for the TSSC they were asked to select the statements that best described their status in the 6 months following the earthquake. The adolescents' current depression, anxiety and Attention Deficit Hyperactivity Disorder (ADHD) symptoms were evaluated with the BDI, BAI and the Wender Utah Rating Scale. Given the contribution of stressful events to their current mental status and to the long-term effects of perinatal stress, the Traumatic Experiences List (TEL) was also administered. The presence of depression, anxiety and ADHD among adolescents and the link to the mother's mental status, and the factors predicting depression, anxiety and ADHD were analyzed.

Results: The adolescents whose mothers had mental complaints during pregnancy were found to have significantly higher levels of depression and mental complaints than those whose mothers had no mental complaints in their case histories ($p < 0.05$). The adolescents whose mothers had depression, anxiety and PTSD (past and present) were found to score significantly higher in the presence of ADHD ($p < 0.05$). In univariate logistic regression analyses, the mothers' mental complaints during pregnancy in the post-earthquake period, and the presence of depression, anxiety and PTSD in mothers were found to be significant predictors of depression, anxiety and ADHD among adolescents ($p < 0.05$). Multivariate logistic regression analyses identified the presence of anxiety in mothers during pregnancy as a significant predictor of depression and anxiety among adolescents, while the presence of PTSD in mothers during pregnancy was a significant predictor of ADHD among adolescents ($p < 0.05$).

Conclusions: The results suggest that disaster-related objective and subjective prenatal maternal stresses are a potential pathway through which the adolescent depression, anxiety and ADHD symptomatologies may be impacted. It is important for health care professionals to identify the mental state and potential stressful life-events of the mother during pregnancy, especially when there has been exposure to a significant external trauma, as the first step toward tailored interventions.

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INTRODUCTION

The intrauterine period of life is when the foundations of the physical and mental health of the developing fetus are established and secured. During this sensitive

period of cellular multiplication and differentiation, the developing fetus responds to internal and external factors, and this response can cause structural and

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functional changes in the tissues and organs, creating a susceptibility to certain diseases later in life [1]. One such factor, being the exposure to prenatal psychosocial or biological stress, is studied in terms of its effects on the emergence of medical conditions later in life, for which the fetal programming hypothesis has been adopted [1,2]. This hypothesis argues that exposure to maternal stress in the intrauterine environment alters the HPA axis, which is a neuroendocrine system associated with the central nervous system, the autonomic nervous system and stress response [3].

Maternal stress factors include perceived stress, pregnancy-related stress, daily struggles, exposure to natural disasters, and such maternal mental health issues as depression or anxiety. The extent of maternal stress during pregnancy varies significantly, although around half of all pregnant women experience depressive complaints and anxiety symptoms during pregnancy [4, 5]. In a study conducted using a self-report scale, 30 percent of the pregnant respondents reported being exposed to stress during pregnancy [6].

Many studies involving human subjects, as well as experimental animal studies, have shown that exposure to negative factors during pregnancy can have both short - and long-term effects, and can interact also with genetic factors. These effects can manifest in such physical conditions as cardiovascular disease or metabolic disorders later in life [7].

Studies have shown that prenatal maternal stress can affect birth outcomes, and can have long-lasting negative effects on the cognitive, behavioral and mental development of the child [8-11]. Studies conducted with women exposed to flooding during pregnancy found prenatal stress to be associated with low birth weight, preterm birth and behavioral problems, as well as psychiatric disorders in the offspring [12-18]. Prenatal maternal stress is considered to be a risk factor for the development of depression during childhood. In a study evaluating the 18-year-old children of mothers who were diagnosed with anxiety in week 18 of pregnancy, prenatal maternal anxiety was found to be a predictor of increased risk for childhood anxiety and depressive disorders [19]. In a study examining the effects of prenatal maternal anxiety and depression (in weeks 18 and 32 of pregnancy) on childhood psychopathology, prenatal maternal stress was found to play an important role in the development of subclinical or clinical anxiety disorders from childhood to early adulthood [20]. In another study conducted with pregnant women who had experienced a snow storm, the levels of objective exposure and subjective stress were measured, as well as their effects on children aged 4-12, and it was found that 8-12% of the children had emotional reactivity, anxiety or depression [21]. In a study examining the long-term effects of prenatal maternal stress, the 18-year old children of mothers who were exposed to the violent earthquake in China in 1976 were evaluated, and were found to be at higher risk of severe depression and

depressive symptoms [22]. In a prospective community-based study, the 17-18 year old children of mothers who experienced stressful life events in early pregnancy were found to be at a higher risk of developing depression and depressive symptoms [23].

The present study models earthquakes (as natural disasters that act as a stress factor) as anxiety-inducing situations that affect large numbers of people at once, with generalizable results. This study aims to examine the effects on the mental health of the adolescent children of mothers exposed to prenatal maternal stress during earthquakes.

METHODS

Ethical Approval

All the procedures were performed in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards (28.12.2016/ 59090411-44E.14677583 from: Istanbul Provincial Directorate of National Education). Written and verbally informed consent was obtained from each participant.

Participants

The sample consisted of 407 adolescents aged 17 years (born between August 17, 1999 and May 27, 2000) at the time the study was conducted, and who were attending secondary school. Sample selection was made among adolescents whose mothers were pregnant during the earthquake of August 17, 1999 in Turkey. Two schools that attended by students who live in three regions that have different socioeconomic and demographic characteristics and affected by the earthquake to varying degrees were selected. The students selected from the students who continue their formal education in these secondary education institutions and agree to participate in the study were be the sample of the study.

Adolescents who their mothers exposed the earthquake in the perinatal period and all participants of sufficient cognitive ability to answer the scales were included in the study, and those with a psychotic disorder, mental retardation, severe neurological disorder or cognitive deficits were excluded.

The earthquake of August 17, 1999 affected nine provinces in Turkey to varying degrees, killing 17,479 people and destroying 66,441 buildings. A total of 454 people lost their lives in Istanbul, which was one of the provinces affected by the earthquake, and which has 13 districts located in a 1st degree earthquake zone. The students of the secondary schools in the study, located in the Avcılar, Küçükçekmece and Beşiktaş districts of Istanbul, experienced the earthquake with their families in localities affected to varying degrees. The participants who experienced the earthquake in Regions 1, 2 and 3 (the region most affected by the earthquake was named

Region 1) were coded as Group 1, Group 2 and Group 3, respectively, while those who lived in a region that was unaffected by the earthquake at the time were coded as Group 4.

Measures

The standard scales of the study were administered to 407 mother and adolescent child groups. The respondent mothers were asked to fill out a Sociodemographic Questionnaire containing items on age, educational attainment, occupation and economic status, the region of residence at the time of the earthquake, substance use and any physical conditions, among others.

The evaluations of the mental status of the mothers following earthquake exposure in pregnancy were conducted retrospectively using self-reported depression, anxiety and trauma scales. The mothers' levels of post-earthquake depression and anxiety were evaluated using the Beck Depression Inventory (BDI) [24, 25] and the Beck Anxiety Inventory (BAI) [26,27]; and the Traumatic Stress Symptom Checklist (TSSC) was used to identify the stress levels and symptoms experienced by the mothers as a result of this traumatic experience [28]. The mothers were asked to fill out the BDI and BAI questionnaires based on their mental state during in the week following the earthquake, while for the TSSC, they were asked to select the statements that best described their status in the 6 months following the earthquake. The items in all of these scales were presented in the past tense, with statements like "I was not sad or troubled" or "I was pessimistic about the future" in the BDI; "I was not really bothered" and "It wasn't nice, but I put up with it" in the BAI; and "I couldn't erase certain memories/ images of the earthquake from my mind" and "I often had nightmares" in the TSSC. The TSSC was also administered in the "present tense" format to evaluate whether the symptoms of trauma had persisted. In addition to the scales, the mothers were asked whether they had suffered any psychological complaints prior to pregnancy, or during pregnancy in both the pre-earthquake and post-earthquake periods.

The adolescent respondents were asked to fill out a Sociodemographic Questionnaire with items on age, gender, educational attainment, addictive substance use and any physical conditions, among others. Their current depression and anxiety symptoms were evaluated with the BDI and BAI. When filling out the questionnaires for BDI and BAI, the adolescents were asked to select the statements that best described them within the last week, including the current day. The Wender Utah Rating Scale was used to evaluate any Attention Deficit Hyperactivity Disorder (ADHD) symptoms and findings that could be related to prenatal maternal stress [29, 30]. Given the contribution of stressful events to current mental status and to the long-term effects of perinatal stress, the Traumatic Experiences List (TEL) was also administered [31]. The TEL consists of 10 items that are used to identify such traumatic experiences as accidents,

fires, explosions, natural disasters, physical or sexual attacks, battlefield experiences, imprisonment, torture, deadly disease, and the sudden and unexpected death of someone close, among others. Respondents are asked to check the items that apply to them individually, given their entire life so far.

Statistical Analysis

The statistical analyses were made using the IBM SPSS version 21.0 (IBM Corp. Released 2012. Armonk, NY, USA) software package. Descriptive statistics were expressed as mean, standard deviation, median, and minimum and maximum values, frequencies and percentages. Discrete variables (presence of depression, anxiety and PTSD) were compared with Pearson's Chi-square test; and a Kolmogorov-Smirnov test was used to ascertain whether the continuous variables had a normal distribution. BDI, BAI, TSSC, WURS scores did not distribute normal for Kolmogorov test ($p < .05$). Between-group comparisons for continuous variables (BDI, BAI, TSSC scores) were made using a Kruskal-Wallis test, and post hoc Bonferroni corrected Mann Whitney U test. The linear associations between the variables (BDI, BAI, TSSC, WURS) were evaluated with a Spearman correlation test. A binary logistic regression analysis was used to identify the independent variables that predict the presence of depression, anxiety or trauma in mothers, and depression, anxiety or ADHD in adolescents. Variables with p values lower than 0.25 in a univariate logistic regression analyses were considered candidate variables, and were included in the multivariate logistic regression analyses. Multivariate logistic regression analyses were carried out using the forward likelihood ratio method. The level of statistical significance was set at $p < 0.05$.

RESULTS

i) Sociodemographic Characteristics of Mothers and Adolescents and findings relating to the course of pregnancy and birth outcomes

Data on the mothers' pregnancy, birth and neonatal outcomes are reported in Table 1.

The study was conducted with the participation of 407 mothers and 407 adolescents. The mothers had a mean age of 43.3 ± 5.2 at the time of the study, and a mean age of 26.3 ± 5.2 at the time of birth. During the earthquake, 25.7% of the mothers were in the first trimester, 31.4% were in the second trimester and 42.9% were in the third trimester of pregnancy. Based on their place of residence at the time of the earthquake, 45.5% of the mothers were in Group 1, 30.7% were in Group 2, 7.6% were in Group 3 and 16.2% were in Group 4 [Table 1]. The adolescents had a mean age of 17.5 ± 0.5 years, and 66.7% were female and 33.3% were male.

ii) Analysis of depression, anxiety, and trauma scales by gestational age and earthquake region

Table 1. Demographic data on mothers and infants, pregnancy and birth outcomes

	Mean±SD	Median (min-max)
Age at the time of the study (years)	43.3±5.2	43 (31-62)
Age at the time of giving birth (years)	26.3±5.2	26 (14-45)
Birth weight of the newborn (grams)	3,199±649	3,250 (800-5500)
	N	%
Economic Status (TRY)		
Less than 1,300	101	28.1
1,300-2,499	176	48.8
2,500-3,999	56	15.6
4,000-5,999	17	4.7
6,000 or above	10	2.8
Place of Residence at the Time of the Earthquake		
Group 1	179	45.5
Group 2	121	30.7
Group 3	30	7.6
Group 4	64	16.2
Financial Loss during the Earthquake		
Yes	66	16.4
No	337	83.6
Loss of Someone Close in the Earthquake		
No losses	363	91.4
Loss of relatives (2nd and 3rd degree)	15	3.8
Loss of acquaintances	15	3.8
Loss of friends	3	0.8
Other	1	0.2
Smoking During Pregnancy		
Yes	26	6.5
No	371	93.5
Gestational Age at the Time of the Earthquake		
1st Trimester	100	25.7
2nd Trimester	122	31.4
3rd Trimester	167	42.9
Obstetric Complications		
Yes	45	11.8
No	336	88.2
Mode of Delivery		
Vaginal	285	70.7
CS	118	29.3
Delivery Complications		
Yes	36	9.3
No	353	90.7

*The percentages were calculated based on the data provided by the participants who responded to all items. TRY: New Turkish Lira; CS: Cesarean section

In terms of the mothers' depression scores in the first week following the earthquake, the proportion above the BDI cutoff value was statistically significantly higher among the women in the 3rd trimester of pregnancy than in those in other trimesters (1st trimester: %21, 2nd trimester: %11,5, 3rd trimester: %28,7, $p=0,002$). A comparison of the BAI scores, on the other hand, did not reveal any statistically significant differences between the trimester groups in terms of proportion above the cutoff value ($p>0,05$). For PTSD, mothers were evaluated using the Traumatic Stress Symptom Checklist, both for the period immediately after the earthquake (TSSC-past) and the present period (TSSC-now). The proportion of women with TSSC-past scores above the cutoff value was found to be statistically significantly higher in the 3rd trimester group than in the 2nd trimester group (first tr: %30 second tr: %21,3, third tr: %37,7, $p=0,011$). The severity of depression, on the other hand, was

found to be statistically significantly lower in the 2nd trimester group ($p=0,009$).

In an analysis if the BAI-past scores by earthquake region, the proportion of those above the cutoff value was found to be statistically significantly higher in the first three groups, and especially in Groups 1 and 2, than in Group 4 ($p=0,015$). No statistically significant differences were found between the groups in the presence of depression ($p>0,05$). In terms of the presence of PTSD-past, the women who experienced the earthquake in the first three regions reported higher scores than those who experienced the earthquake in region four (Group 1: %39,1, Group 2: %28,1, Group 3: %30, Group 4: %15,6, $p=0,005$). In terms of PTSD-now, on the other hand, the participants who lived in region one had statistically significantly higher scores than those who lives in the other regions ($p=0,001$).

Table 2 and Table 3 show proportion of mothers that have depression, anxiety and trauma symptoms by gestational age and earthquake region.

In terms of the mothers' depression scores in the first week following the earthquake, the proportion above the BDI cutoff value was statistically significantly higher among the women in the 3rd trimester of pregnancy than in those in other trimesters (1st trimester: %21, 2nd trimester: %11,5, 3rd trimester: %28,7, $p=0,002$). A comparison of the BAI scores, on the other hand, did not reveal any statistically significant differences between the trimester groups in terms of proportion above the cutoff value ($p>0,05$). For PTSD, mothers were evaluated using the Traumatic Stress Symptom Checklist, both for the period immediately after the earthquake (TSSC-past) and the present period (TSSC-now). The proportion of women with TSSC-past scores above the cutoff value was found to be statistically significantly higher in the 3rd trimester group than in the

2nd trimester group (first tr: %30 second tr: %21,3, third tr: %37,7, $p=0,011$). The severity of depression, on the other hand, was found to be statistically significantly lower in the 2nd trimester group ($p=0,009$).

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Table 2. Analysis of mental status of mothers according to trimester with Pearson Chi-Square test

	First Trimester n (%)	Second Trimester n (%)	Third Trimester n(%)	P value*
Depression				
No	79 (79,0)	108 (88,5)	119 (71,3)	0,002
Yes	21 (21,0)	14 (11,5)	48 (28,7)	
Depression severity				0,009
None	56 (56,0)	83 (68,1)	96 (57,4)	
Mild	23 (23,0)	25 (20,5)	23 (13,8)	
Moderate	19 (19,0)	12 (9,8)	37 (22,2)	
Severe	2 (2,0)	2 (1,6)	11 (6,6)	
Anxiety				0,057
No	71 (71,0)	94 (77,0)	107 (64,1)	
Yes	29 (29,0)	28 (23,0)	60 (35,9)	
Anxiety severity				0,329
None	49 (49,9)	62 (50,8)	72 (43,1)	
Mild	22 (22,0)	32 (26,2)	35 (21,0)	
Moderate	13 (13,0)	16 (13,1)	33 (19,8)	
Severe	16 (16,0)	12 (9,8)	27 (16,2)	
PTSD(past)				0,011
No	70 (70,0)	96 (78,7)	104 (62,3)	
Yes	30 (30,0)	26 (21,3)	63 (37,7)	
PTSD(now)				0,123
No	89 (89,0)	111 (91,0)	139 (83,2)	
Yes	11 (11,0)	11 (9,0)	28 (16,8)	

*Pearson Chi-Square test

Comparing the earthquake regions in terms of severity on the basis of the evaluations conducted using BAI and BDI, the severity of BAI-past was found to be statistically significantly higher in the first three groups, especially in Group 1, when compared to Group 4 ($p=0,021$). No statistically significant differences were found between the groups in terms of the severity of BDI-past.

The mothers who were in the 3rd trimester at the time of the earthquake were found to report statistically significantly higher levels of mental complaints following delivery ($p<0,05$). Of those who reported having mental complaints

after delivery, 47.8% had depression, 60.9% had anxiety and 65.2% had PTSD ($p\leq 0,001$). In terms of regions, the proportion who had psychological complaints following the earthquake was found to be statistically significantly higher in Group 1 (21.8%, $p=0,012$). The women who reported having mental complaints prior to pregnancy and during pregnancy in the pre-earthquake period reported statistically significantly higher scores for the presence and severity of depression and anxiety, and for the presence of PTSD symptoms after the earthquake, than the women who did not report mental complaints during pregnancy ($p<0,05$).

Table 3. Analysis of mental status of mothers by earthquake regions with Pearson Chi-Square test

	First Group n (%)	Second Group n (%)	Third Group n (%)	Fourth Group n (%)	P value*
Depression					
No	136 (76,0)	95 (78,5)	25 (83,3)	53 (82,8)	0,617
Yes	43 (24,0)	26 (21,5)	5 (16,7)	11 (17,2)	
Depression severity					
None	102 (57,0)	72 (59,5)	23 (76,7)	44 (68,7)	0,357
Mild	34 (19,0)	23 (19,0)	2 (6,7)	9 (14,1)	
Moderate	34 (19,0)	21 (17,4)	3 (10,0)	11(17,2)	
Severe	9 (5,0)	5 (4,1)	2 (6,7)	0 (0,0)	
Anxiety					
No	117 (65,4)	80 (66,1)	22 (73,3)	55 (85,9)	0,015
Yes	62 (34,6)	41 (33,9)	8 (26,7)	9 (14,1)	
Anxiety severity					
None	76 (42,4)	48 (39,7)	16 (53,3)	44 (68,7)	0,021
Mild	41 (22,9)	32 (26,4)	6 (20,0)	11 (17,2)	
Moderate	32 (17,9)	20 (16,5)	6 (20,0)	5 (7,8)	
Severe	30 (16,8)	21 (17,4)	2 (6,7)	4 (6,3)	
PTSD(past)					
No	109 (60,9)	87 (71,9)	21 (70,0)	54 (84,4)	0,005
Yes	70 (39,1)	34 (28,1)	9 (30,0)	10 (15,6)	
PTSD (now)					
No	143 (79,9)	110 (90,9)	28 (93,3)	62 (96,9)	0,001
Yes	36 (20,1)	11 (9,1)	2 (6,7)	2 (3,1)	

*Pearson Chi-Square test

The women who experienced obstetric complications during pregnancy were found to report statistically significantly higher scores for depression, severity of anxiety, and the presence of PTSD (past and present) than those who had no obstetric complications ($p < 0.05$). Of the participants, 6.5% reported smoking during pregnancy, and smokers reported statistically significantly higher scores for severity of anxiety ($p = 0.007$), presence of PTSD during pregnancy ($p = 0.001$) and presence of PTSD-now ($p = 0.043$) than non-smokers. The participants that suffered financial loss from the earthquake scored statistically significantly higher for presence of anxiety and PTSD-past ($p = 0.001$ and $p = 0.011$, respectively) than the participants who did not experience financial loss, although the two groups did not differ significantly in terms of the presence or severity of depression ($p > 0.05$).

iii) Analysis of the Data on Adolescents

In terms of gender, the proportion of females with depression and anxiety was found to be significantly higher than in males (depression F:34.7% M:22.4%; anxiety F:39.2% M:20.1%), whereas attention deficit-hyperactivity disorder (ADHD) was more common among males, but not significantly (M:14.2% F:12.7%). Of the adolescent participants, 41.4% reported traumatic experiences. The respondents who had suffered traumatic experiences, who smoked and who had current mental complaints had statistically significantly higher rates of depression, anxiety and ADHD than those without such case histories ($p < 0.05$).

Presence of Depression, Anxiety and ADHD Among Adolescents By Mother's Mental Status

The adolescents whose mothers had mental complaints prior to pregnancy and during pregnancy in the pre-earthquake and post-earthquake periods were found to have statistically significantly higher levels of depression, mental complaints from childhood onwards and current mental complaints than those whose mothers had no mental complaints in their case histories ($p < 0.05$). The ADHD rate, on the other hand, was found to be statistically significantly higher among children with mothers who had mental complaints following the earthquake ($p = 0.003$). The adolescents whose mothers had depression, anxiety and PTSD (past and present) were found to score statistically significantly higher in the presence of ADHD ($p < 0.05$). The adolescents whose mothers developed mental complaints after delivery were found to have statistically significantly higher rates of mental complaints from childhood onwards, current mental complaints, depression and smoking ($p < 0.05$).

Logistic Regression Analyses of Data on Adolescents

In univariate logistic regression analyses, smoking and having traumatic experiences were found to be statistically significant predictors of depression, anxiety and ADHD among adolescents ($p < 0.05$). Being female was found to be a statistically significant predictor of depression and anxiety among adolescents, while the presence of anxiety and depression was found to be a significant predictor of ADHD ($p < 0.05$). In multivariate logistic regression analyses,

having traumatic experiences, smoking and being female were found to be statistically significant predictors of depression and anxiety, while the presence of depression was found to be a significant predictor of ADHD ($p < 0.05$).

Tables 4, 5 and 6 show the findings of predictor factors of depression, anxiety and ADHD among adolescents

Logistic regression analyses were also conducted, with depression, anxiety and ADHD among adolescents as the dependent variables, and the reports of mental complaints prior to pregnancy and during pregnancy in the pre-earthquake and post-earthquake periods in mothers as the independent variables, along with presence of depression, anxiety and PTSD (past and present) in mothers. In the univariate logistic regression analyses, the mothers' mental complaints during pregnancy in the post-earthquake period, and the presence of depression, anxiety and PTSD in mothers were found to be statistically significant predictors of depression, anxiety and ADHD among adolescents ($p < 0.05$). Multivariate logistic regression

analyses, on the other hand, identified the presence of anxiety in mothers during pregnancy as a statistically significant predictor of depression and anxiety among adolescents, while the presence of PTSD in mothers during pregnancy was a statistically significant predictor of ADHD among adolescents ($p < 0.05$) (Tables 2, 3 and 4).

iv) Correlations between scales scores of Mothers' and Adolescents'

Table 7 shows correlations between scales scores of Mothers' and Adolescents'.

The correlations between the scores of the mothers in the BDI, BAI and TSSC scales and those of the adolescents in the BDI, BAI and ADHD scales were examined. The mothers' scores in each of BDI, BAI, TSSC-past and TSSC-present scales were found to have positive and statistically significant correlations with the adolescents' scores in the BDI, BAI and ADHD scales ($p < 0.001$).

Table 4. Results of logistic regression analyses to predict depression among adolescents

Variable	Univariate Logistic Regression Analysis			Multivariate Logistic Regression Analysis		
	Unadjusted OR	95% Confidence Interval	P value	Adjusted OR	95% Confidence Interval	P value
Gender of the Adolescent						
Male	Reference					
Female	1.84	1.14-2.97	0.012	1.82	1.10-3.02	0.020
Psychological Complaints prior to Pregnancy						
No	Reference					
Yes	2.40	1.08-5.33	0.032			
Psychological Complaints during Pregnancy in the Pre-Earthquake Period						
No	Reference					
Yes	2.37	1.00-5.63	0.050			
Psychological Complaints During Pregnancy in the Post-Earthquake Period						
No	Reference					
Yes	1.77	1.02-3.05	0.042			
Psychological Complaints After Delivery						
No	Reference					
Yes	2.29	1.23-4.29	0.009			
Depression in the Mother						
No	Reference					
Yes	2.05	1.25-3.36	0.005			
Anxiety in the Mother						
No	Reference					
Yes	3.01	1.92-4.73	<0.001	2.67	1.67-4.28	<0.001
PTSD past in the mother						
No	Reference					
Yes	2.30	1.47-3.60	<0.001			
PTSD present in the mother						
No	Reference					
Yes	1.69	0.93-3.09	0.087			
Adolescent smoking						
No	Reference					
Yes	2.85	1.60-5.06	<0.001	2.82	1.52-5.24	0.001
Traumatic Experience of the Adolescent						
No	Reference					
Yes	2.10	1.37-3.23	0.001	1.94	1.23-3.06	0.004

Model Summary : - 2 Log likelihood= 436,684; Cox&Snell $R^2=0,165$; Nagelkerke $R^2=0,229$

Table 5. Results of logistic regression analyses to predict anxiety among adolescents

Variable	Univariate Logistic Regression Analysis			Multivariate Logistic Regression Analysis		
	Unadjusted OR	95% Confidence Interval	P value	Adjusted OR	95% Confidence Interval	P value
Gender of the Adolescent Male Female	Reference 2.55	1.57-4.16	<0.001	2.58	1.53-4.36	<0.001
Psychological Complaints prior to Pregnancy No Yes	Reference 2.56	1.15-5.71	0.021			
Psychological Complaints during Pregnancy in the Pre-Earthquake Period No Yes	Reference 1.77	0.74-4.21	0.197			
Psychological Complaints During Pregnancy in the Post-Earthquake Period No Yes	Reference 1.84	1.07-3.16	0.027			
Psychological Complaints After Delivery No Yes	Reference 1.52	0.81-2.85	0.192			
Depression in the Mother No Yes	Reference 1.81	1.11-2.96	0.018			
Anxiety in the Mother No Yes	Reference 3.53	2.26-5.54	<0.001	3.14	1.94-5.06	<0.001
PTSD past in the mother No Yes	Reference 1.99	1.28-3.09	0.002			
PTSD present in the mother No Yes	Reference 1.38	0.76-2.53	0.294			
Adolescent smoking No Yes	Reference 2.34	1.32-4.14	0.004	2.35	1.23-4.48	0.010
Traumatic Experience of the Adolescent No Yes	Reference 2.95	1.92-4.54	<0.001	2.93	1.85-4.65	<0.001

Model Summary : - 2 Log likelihood= 436,684; Cox&Snell R²=0,165; Nagelkerke R²=0,229

Table 6. Results of logistic regression analyses to predict adhd among adolescents

Variable	Univariate Logistic Regression Analysis			Multivariate Logistic Regression Analysis		
	Unadjusted OR	95% Confidence Interval	P value	Adjusted OR	95% Confidence Interval	P value
Gender of the Adolescent						
Male	Reference					
Female	0.88	0.48-1.61	0.677			
Gestational Age						
2nd trimester	Reference					
1st trimester	1.25	0.52-3.01	0.623			
3rd trimester	2.12	1.01-4.43	0.046			
Psychological Complaints prior to Pregnancy						
No	Reference					
Yes	2.11	0.81-5.51	0.129			
Psychological Complaints during Pregnancy in the Pre-Earthquake Period						
No	Reference					
Yes	2.67	0.99-7.15	0.052			
Psychological Complaints During Pregnancy in the Post-Earthquake Period						
No	Reference					
Yes	2.66	1.37-5.14	0.004			
Psychological Complaints After Delivery						
No	Reference					
Yes	4.06	2.01-8.20	<0.001			
Pregnancy Complications						
No	Reference					
Yes	2.54	1.19-5.42	0.016			
Fetal Complications						
No	Reference					
Yes	2.02	0.90-4.51	0.087			
Depression in the Mother						
No	Reference					
Yes	2.66	1.43-4.93	0.002			
Anxiety in the Mother						
No	Reference					
Yes	3.10	1.72-5.58	<0.001			
PTSD past in the mother						
No	Reference					
Yes	4.27	2.35-7.78	<0.001	4.08	2.00-8.36	<0.001
PTSD present in the mother						
No	Reference					
Yes	3.89	1.97-7.70	<0.001			
Adolescent Smoking						
No	Reference					
Yes	2.98	1.51-5.88	0.002			
Traumatic Experience of the Adolescent						
No	Reference					
Yes	2.22	1.23-3.99	0.008			
Depression in the Adolescent						
No	Reference					
Yes	19.30	8.73-42.63	<0.001	15.06	6.62-34.25	<0.001
Anxiety in the Adolescent						
No	Reference					
Yes	7.70	4.00-14.82	<0.001			

Model Summary : - 2 Log likelihood= 198,946; Cox&Snell R²=0,200; Nagelkerke R²=0,375

Table 7. Correlations between scales scores of mothers' and adolescents'

		Adolescents' BDI	Adolescents' BAI	Adolescents' WURS
Mothers' BDI (past)	r_s	0,271	0,254	0,236
	p	<0,001	<0,001	<0,001
Mothers' BAI (past)	r_s	0,284	0,326	0,291
	p	<0,001	<0,001	<0,001
Mothers' TSSC (past)	r_s	0,263	0,233	0,255
	p	<0,001	<0,001	<0,001
Mothers' TSCC (now)	r_s	0,266	0,280	0,268
	p	<0,001	<0,001	<0,001

BDI:Beck Depression Inventory; BAI:Beck Anxiety Inventory; TSSC: Traumatic Stress Symptom Checklist; WURS: Wender Utah Rating Scale; r_s = Spearman correlation coefficient

DISCUSSION

Defining mental problems as a stress factor is important in gaining an understanding of their potential negative effects on the infant, and in selecting the required interventions. Natural disasters are stress factors in themselves, but considering their interaction with mothers' mental health issues, regardless of whether they were present at the time of the disaster or developed thereafter, is also important. A review of literature on exposure to natural disasters revealed few studies examining the mental health of mothers, with most examining the effects of exposure to natural disasters on birth outcomes and on infant development. It is reported that, following a natural disaster, the mental status of the mother has a greater effect on infant development than the direct effect of the disaster [32,33]. Accordingly, the present study examines the mental status of mothers during an earthquake, and its long-term effects on the offspring.

Mothers' mental status by gestational age and earthquake region

In a mental status evaluation by gestational age, based on the BDI inventory, the 3rd trimester group was found to have the highest proportion of pregnant women with moderate to severe depression. In a recent study of the effects of stress on the temperament of infants evaluating the depression status of mothers exposed to a storm during pregnancy. The study reported that maternal depression was associated with decreased emotional regulation and increased distress in infants, and that natural disasters exacerbated this negative effect [34]. Different from the present study, however, the authors did not examine the effects of gestation age. In a study of post-earthquake emotional response and the effect on birth outcomes, the psychological responses of pregnant women to an earthquake were evaluated using the Life Events Inventory at week 32 of pregnancy, and those exposed to the earthquake in the 1st trimester were found to have higher levels of stress [35]. Different from the present study, which examined depression status, the study evaluated emotional response using the Life Events Inventory. In a

study of minor psychiatric morbidities among pregnant women exposed to earthquakes in Taiwan, the prevalence of minor psychiatric morbidities was found to be 29.2% in an evaluation carried out 6 months after an earthquake. Pregnant women with psychiatric morbidity were found to score significantly higher in PTSD symptoms [36], although the study did not report on gestational age. In the present study, evaluations carried out using the TSSC (past) to examine trauma symptoms after the earthquake showed that the 3rd trimester group had significantly higher mean TSSC scores than the 2nd trimester group. In a study examining the risk of PTSD and depression among pregnant women exposed to Hurricane Katrina, the frequencies of PTSD and depression were found to be higher among women with high exposure to the hurricane than in those without high exposure [37]. Similar to the present study, the authors evaluated pregnant women in terms of depression and PTSD following the natural disaster, but unlike the present study, made no evaluations taking into account gestational age. In another study examining birth outcomes, taking into account gestational age at the time of earthquake exposure [38], the mental status of the mothers was not evaluated, unlike in the present study. This study reported that mothers who were in the 3rd trimester when they experienced the earthquake gave birth to babies of lower birth weight. The present study found that women in the 3rd trimester group had been affected by the earthquake, as the stress factor in this study, to a greater extent. This may be attributed to the likelihood that the mothers in the 3rd trimester, who are closer to giving birth, would be more worried about labor and the health of their baby.

In an evaluation of mental status by earthquake region, carried out using the scales administered to the mothers, the BAI result was found to be significantly higher among the first three groups who lived in the regions most affected by the earthquake, and especially Groups 1 and 2; TSSC-past was found to be significantly higher in all three groups; and TSSC-present was found to be significantly higher in Group 1. The proportion of respondents who reported experiencing psychological complaints following the earthquake was found to be significantly higher in Group 1 (21.8%, $p=0.012$). In evaluations carried out based on the earthquake region, the present study found that participants who lived in regions that were more severely affected by the earthquake had more symptoms of anxiety and PTSD. In a study taking into account both gestational age and earthquake region, as in the present study, focus was on the secondary sex ratio and the birth outcomes, while the mothers' mental status was not examined [38]. To the best of our knowledge, there have to date been no studies evaluating the mental status of mothers by earthquake region.

Evaluating the mental health among women in the perinatal period is important in the prevention of the potential negative effects on pregnancy and complications in fetal development. There have to date been few studies analyzing the factors that contribute to the onset

or continuation of mental health issues among pregnant women. The present study examined the relationships between stressors and symptoms of depression, anxiety and trauma. In an evaluation of the mental statuses of the mothers who experienced complications in their pregnancies, it was found in the present study that they scored significantly higher in terms of severity of depression and anxiety, as well as for PTSD (past and present). Complications in pregnancies may lead to greater concerns about the pregnancy, which in turn can have a negative effect on fetal development. The 8-month old babies of women with heightened levels of anxiety related to their pregnancies were found to score lower in mental and motor development [39]. The present study found that women who described having psychological complaints prior to and during pregnancy in the pre-earthquake period scored significantly higher in the presence and severity of post-earthquake depression and anxiety, and the presence of trauma symptoms. The natural disaster can be expected to increase the risk of developing post-disaster mental health issues. The severity of a natural disaster is considered to be a predictor of mental health issues [37, 40]. Evaluating the mental status of mothers following a natural disaster can allow preventive measures to be taken, the timely identification of people at risk and rapid interventions.

Long-Term Effects of Exposure to Prenatal Maternal Stress

In addition to exposure to prenatal maternal stress, the present study examined factors related also to the offspring of the respondent mothers, including gender, smoking and traumatic experiences, which may constitute risk factors for the current mental status of adolescents. Evaluations based on the traumatic experiences scale for adolescents showed that 41.4% of those who participated in the present study described traumatic experiences. About half of the children in a community sample, and about two-thirds in a psychiatric sample were found to have witnessed or experienced trauma [41]. In the present study, traumatic experiences were found to be a predictor of depression, anxiety and ADHD among adolescents in univariate logistic regression analyses, and a predictor of depression and anxiety in multivariate logistic regression analyses. Previous studies in literature have reported a high prevalence of ADHD among traumatized children and adolescents [42]. In a study examining the relationship between PTSD and ADHD, post-traumatic stress symptoms were found to play a mediating role in the relationship between traumatic experiences and attention deficit among children exposed to the Bosnian war [43]. In a study examining predictors of depression among adolescents following exposure to earthquakes, trauma-related injuries and PTSD symptoms were found to be predictors of depression [44]. The univariate regression analyses conducted in the present study identified smoking as a predictor of depression, anxiety and ADHD among adolescents, while being female was found to be a predictor of depression and anxiety. In multivariate logistic regression analyses, on the other hand, smoking and the female gender were found to be

predictors of depression and anxiety among adolescents. In a recent study examining the relationship between smoking and depressive symptoms, cigarette smoking at the age of 14 was found to be a predictor of depressive symptoms by the age of 17 [45]. In another study examining the relationship between smoking and ADHD among children and adolescents, ADHD was found to be a risk factor for smoking from a young age [46]. When it comes to gender, studies similar to the present one report that being female carries a significantly higher risk for the development of future psycho-pathologies such as depression, affective disorders and childhood anxiety, which are also considered to be among the effects of exposure to prenatal maternal stress [47].

In the present study, adolescents whose mothers had mental complaints prior to pregnancy and during pregnancy in the pre-earthquake and post-earthquake periods were found to have significantly higher rates of current mental complaints, mental complaints from childhood onwards and depression. The ADHD rate, on the other hand, was found to be significantly higher among children whose mothers had mental complaints after the earthquake. The adolescents whose mothers had depression, anxiety and PTSD were found to score significantly higher in the presence of ADHD. In univariate logistic regression analyses, the mothers' mental complaints during pregnancy in the post-earthquake period, and presence of depression, anxiety and PTSD in pregnancy, were found to be significant predictors of depression, anxiety and ADHD among the adolescents. Multivariate logistic regression analyses, on the other hand, showed that the presence of anxiety in mothers during pregnancy was a significant predictor of depression and anxiety among adolescents, while the presence of PTSD in mothers during pregnancy was a significant predictor of ADHD among adolescents. In a study examining the relationship between prenatal maternal anxiety and acting-out behavior, ADHD and anxiety, the presence of maternal anxiety in weeks 12-22 of pregnancy was found to be a predictor of acting-out behavior, ADHD and anxiety in the children aged 8-9 years who participated in the study [48]. In a study involving the long-term monitoring of mood disorders among children of women exposed to war during pregnancy, mood disorders were found to be more common among the children of mothers who were exposed to war in the first trimester, in particular [49]. In a study comparing the 14-year-old adolescent children of women who were exposed to the Chernobyl disaster during pregnancy with the children of women who were not exposed, the children of mothers who were exposed in the 2nd trimester were found to have twice the risk of developing lifelong depressive and ADHD symptoms [50]. In a recent study examining prenatal risk factors in adult patients diagnosed with ADHD and bipolar disorder, the patients' mothers were found to have high levels of psychosocial stress in the prenatal period, and reported experiencing more obstetric complications during pregnancy [51]. Consistent with literature, the present study also found that current mental complaints

were more common among children with mothers who described having experienced obstetric complications during pregnancy, compared to children with mothers who did not experience pregnancy complications.

The rate of smoking during pregnancy was found to be 6.5% among the participants of the present study. The women who smoked during pregnancy scored significantly higher in both the severity of anxiety ($p=0.007$) and post-earthquake TSSC (0.001). The present study could identify no statistically significant relationship between maternal smoking and the presence of depression, anxiety or ADHD among adolescents. That said, in a study examining the relationship between exposure to prenatal stress and smoking on the one hand, and ADHD symptoms on the other, children were monitored until the age of 7, and the exposure of the mother to stress and smoking were found to be independent factors associated with ADHD symptoms [52]. In another study, the mothers of children aged 7-18 who had been diagnosed with ADHD were evaluated, and found to have higher rates of smoking when pregnant and prenatal stress than the healthy controls [53].

The results should be considered taking into account several limitations. The evaluations of the mental status of the mother following earthquake exposure in pregnancy were conducted retrospectively using self-reported depression, anxiety and trauma scales. The trauma experienced during pregnancy was reported retrospectively, and so recall and reporting bias may be possible. The mental statuses of the mothers and adolescents were evaluated on the basis of cutoff values with scores calculated from self-reported scales, with no clinical evaluation meetings held. Though we were able to adjust for a number of important confounders, we lacked complete information on the utilization of prenatal care, which may be affected by stress levels or factors that contribute to stress, and may also be associated with adverse outcomes.

Setting aside these limitations, this study is the first of its kind to be conducted in Turkey analyzing the negative effects of exposure to earthquake-related prenatal maternal stress on the mental health of adolescents. Different to most studies examining disasters as a source of stress, the mental statuses of the mothers following exposure to stress were evaluated using various scales, and the results were analyzed. The results suggest that disaster-related objective and subjective prenatal maternal stresses are a potential pathway through which adolescent depression, anxiety and ADHD symptomatology may be impacted. It is important for health care professionals to identify the mental state and potential stressful life-events of the mother during pregnancy, especially when there has been exposure to a significant external trauma, as the first step toward tailored interventions. Given that these dimensions of maternal distress predict a risk of poor mental health outcomes in later life, pregnant women affected by a natural disaster should be targeted with interventions that reduce hardship and distress to optimize the long-term development of their offspring.

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