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Lessons Learnt from Influences of the Marmara Earthquake on Glycemic Control and Quality of Life in People with Type 1 Diabetes

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Abstract. To examine the short- and long-term influences of the Marmara earthquake, which occurred on August 17, 1999 in Turkey, on glycemic control and quality of life (QOL), $HbA_{1c,}$ insulin requirement and QOL of 88 people with type 1 diabetes living in the quake zone were evaluated one year before (PreE), 3 months after (PostE) and one year after (FE) the earthquake. HbA_{1c} levels and daily insulin requirements increased significantly at PostE (HbA_{1c} from 7.4 ± 1.3% to 8.5 ± 1.8%, $p<0.05$; insulin from 0.58 ± 0.2 IU/kg/day to 0.77 ± 0.2 IU/kg/day, $p<0.05$). Mean total QOL scores at PostE were significantly lower than the scores obtained at PreE (62.7 ± 17.3 vs 74.2 ± 13.4, $p<0.001$). There were no significant differences between HbA_{1c} levels and total QOL scores at PreE and FE. People with type 1 diabetes living in the same house after the earthquake and not having enough food supply were reported to have lower QOL than people moving to another house and having enough food supply after the earthquake ($p = 0.014$, $p<0.0001$, respectively). The Marmara Earthquake had a negative impact on the glycemic control and QOL of the subjects with type 1 diabetes for the short term but prequake scores might be achieved after a long period.

Key words: Earthquake, Glycemic control, Quality of life

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ON the night of August 17, 1999, a massive earthquake of magnitude 7.8 on the Richter scale hit the northwestern part of Turkey. The epicenter of the Marmara Earthquake was in Izmit, an industrial town about 60 km from Istanbul. The quake caused extensive damage to Turkey's heartland, and 20,000 lives were lost and and approximately 40,000 people were injured. About 100,000 people lost their property, homes, etc. Medical facilities were also greatly damaged. Many of the hospital staff opted to take care for their close relatives instead of working at the hospital. Thus, the last disaster of the century struck the modern healthy urban life of Turkey in a moment. Three months after the Marmara earthquake, a new earthquake of magnitude 7.2 on the Richter scale hit the same region, leaving 828 people dead and 5000 injured.

In recent years many of the published medical studies on the effects of earthquakes are observational reports [1–4], and evidence-based methodological and scientific analysis [5–30]. Such kind of information turns out to be vital for countries located in high-risk earthquake zones that anticipate such disasters and are in need of data for developing their own emergency aid and action plans.

Life-threatening disasters such as earthquakes cause

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not only death but also physical destruction and emotional trauma to the population living in the destruction area. The impact of the earthquake affects many patients in various ways [5–22], with morbidity and mortality from chronic diseases increasing following an earthquake [5–9, 12, 23]. Diabetes mellitus is affected negatively after a lengthy duration in an unfavorable environment [5]. Glycemic control of people with diabetes becomes worse [5, 24–26]. Such worsened glycemic control results simply from inadequate food intake [5, 25]. Supplies of insulin and other drugs for people with diabetes run out, and there is rapidly increased anxiety among diabetics [1, 24].

Among the earthquake studies published between 1995 and 2000, few studies are involved with the impact of earthquakes on the quality of life (QOL) [26, 29, 30]. Wang *et al*. [29] examined longitudinal change of QOL and psychological well-being in the aftermath of an earthquake. Lin *et al*. [30] observed the impact of earthquake on QOL among elderly survivors. However, one serious deficit of earthquake research is failure to assess the impact on QOL of people with diabetes. There is only one published study showing the effects of earthquake on well-being of people with type 1 diabetes [26].

In this study, we aimed 1) to evaluate the short- and long-term impacts of the Marmara earthquake on both glycemic control and QOL 2) to identify the effective determinants of QOL of people with type 1 diabetes living in the earthquake zone in Turkey. Therefore, we compared hemoglobin (Hb) A_{1c} levels, body mass index (BMI), insulin requirements and QOL scores of people with type 1 diabetes before and in the short- and long-term periods after the earthquake. Also QOL scores were compared according to the responses of a self-administered questionnaire.

Materials and Methods

This study protocol was planned on December 1999. Ninety-seven people with type 1 diabetes, who were involved in another study in August 1998 [26] and interviewed for QOL, and who were living in the earthquake zone at the time were invited to participate in the study after the earthquake. Of those, 88 people were enrolled in the study. Thus, the study population was composed of 42 female and 46 male young subjects with type 1 diabetes. Characteristics of the subjects are summarized in Table 1. All were free of chronic complications. Subjects who were exposed to any other event that may have affected his/her QOL within the first year following the earthquake were excluded from the study.

Table 1. Characteristics of subjects

Type 1 diabetic patients	
N	88
Age (years)	21.9 ± 4.9 (14–30)
Sex (%) (Female/Male)	47.3/52.7
Diabetes duration (years)	4.9 ± 1.8 (2–8)
Insulin regimens	
Total daily dose (IU/kg/day)	0.58 ± 0.2 (0.21–1.25)
Injections 2 times/day (%)	10.2
Injections ≥3 times/day (%)	89.8
BMI (kg/m^2)	23.2 ± 1.4 (20–26)
HbA_{1c} (%)	7.4 ± 1.4 (5.0–10.3)

Data are means ± SD (range) unless otherwise indicated.

Subjects responding to our invitation were informed about the procedure of the study individually. Relative information about the severity of damage to house, school or work, the presence of injuries or death within patients' families or among relatives, living condition after earthquake (same house or another house), and diabetes-related problems due to earthquake was obtained by a self-administered questionnaire. The self-administered questionnaire and the DQOL questionnaire were filled-in by all subjects after three months and one year of the earthquake.

HbA_{1c} levels, BMI and insulin requirement, which were known before the earthquake, were checked and psychosocial data were obtained on the same days at 3 months after and one year after the earthquake. HbA_{1c} was performed using the Bayer DCA 2000 analyzer (normal range: 4.2–6.2%).

Quality of life measure

DQOL was developed in the early 1980s for use in the Diabetes Control and Complication Trial (DCCT) [31]. Prior to the development of the DQOL, there was no available diabetes-specific measurement. Four separate areas are addressed by the measure: satisfaction with treatment, impact of treatment, worry about the future effects of diabetes, and worry about social/vocational issues [32]. We used the Turkish version of DQOL. Reliability and validity of the Turkish version of DQOL had been tested and approved by Şengül *et*

al. [33]. All the patients were asked to fill-in the DQOL in the diabetes unit.

The DQOL has 46 core items rated by the respondent on a 5-point Likert-type scale that ranges from 1 to 5. A score of 1 represents no impact or worries and always satisfied. A score of 5 represents always affected, worried, or never satisfied. A low score indicated good QOL. In this study, DQOL scores were arithmetically transformed to a 100-point scale. This scoring approach is described in detail elsewhere [31]. According to this scoring approach the subscale scores and total QOL score range from zero representing worst possible QOL to 100 representing best possible QOL on each subscale and on the total score.

Statistical analyses

Statistical analysis was performed using the statistical package SPSS version 10.0 (SPSS, Chicago, IL). Data are presented as mean ± SD unless otherwise indicated. The differences were considered significant if $p \leq 0.05$.

The QOL scores and subscale scores, HbA_{1c} levels, BMI and insulin requirements were already checked a year before the earthquake (PreE) and again determined at the 3rd month after (PostE) and one year after the earthquake (FE/Follow up). Changes in total scores and each subscale scores of DQOL, HbA_{1c} levels, BMI and insulin requirements over time were assessed by repeated-measure analysis of variance. Bivariate correlation was performed by Pearson's correlation. According to answers of self-administered questionnaire, the differences of QOL were checked with Student's-t test and ANOVA. Multiple logistic regression analysis was used to identify significant independent determinants of better QOL. Total QOL scores were dichotomized at their mean values and analyzed as dependent variables and odds ratios (ORs) were calculated in multiple logistic regression analysis.

Results

Table 2 compares BMI, insulin requirements, and HbA_{1c} levels of the study population one year before, at the 3rd month after, and one year after the earthquake. HbA_{1c} levels and insulin requirements significantly increased at PostE. Insulin requirement remained unchanged in FE. However, there were no significant differences between HbA_{1c} levels at preE and FE. Compared to the levels in PostE, mean HbA_{1c} values in FE were decreased by 4.3%, whereas compared to HbA_{1c} values in PreE, the levels were increased by 9.5%. BMI values were not changed at postE and FE. There were no significant correlations between the change of insulin requirements and BMI, HbA_{1c} levels, total QOL scores at any stage of the study.

Total QOL scores and subscale scores of the study population at PreE, PostE and FE are shown in Table 3.

Table 2. The results of BMI, insulin requirement and HbA_{1c} during the study period

	1 year before earthquake (PreE)	3 months after earthquake (PostE)	1 year after earthquake (FE)	P PreE versus PostE	P PreE versus FE	P Overall
BMI (kg/m^2)	23.2 ± 1.4	23.05 ± 3.0	23.5 ± 2.7	0.607	0.393	0.129
Insulin requirement (IU/kg/day)	0.58 ± 0.2	0.74 ± 0.2	0.75 ± 0.2	<0.0001	<0.0001	<0.0001
HbA_{1c} (%)	7.4 ± 1.4	8.5 ± 1.8	8.1 ± 2.7	0.007	0.134	0.026

Data are means ± SD unless otherwise indicated.

Table 3. Mean QOL scores in the study population

	1 year before earthquake (PreE)	3 months after earthquake (PostE)	1 year after earthquake (FE)	P PreE versus PostE	P PreE versus FE	P Overall
Total score	74.2 ± 13.4	62.7 ± 17.3	70.0 ± 9.9	<0.001	0.066	0.004
Satisfaction	73.1 ± 14.7	67.4 ± 16.9	71.7 ± 21.2	0.062	0.742	0.166
Impact	79.2 ± 12.3	70.7 ± 14.0	68.6 ± 10.5	<0.0001	<0.0001	<0.0001
Diabetes worry	71.1 ± 19.3	60.8 ± 25.4	69.2 ± 18.5	0.034	0.705	0.044
Social worry	73.6 ± 14.8	62.9 ± 13.4	64.1 ± 13.0	<0.001	<0.001	<0.001

Data are means ± SD unless otherwise indicated.

In general, the Marmara earthquake had an influence on QOL in short term, but its negative effect on QOL did not continue in long term. Mean total QOL scores, impact, diabetes and social worry scores were lower at PostE than they were at PreE ($p<0.001$, $p<0.0001$, $p = 0.034$, $p<0.001$, respectively). Earthquake did not influence satisfaction either in short term or long term.

In the PostE period, total QOL scores and diabetes worry scores decreased from baseline, but both increased in the FE period. However, they did not reach levels as high as the PreE. The negative influence of earthquake on impact and social worry subscale scores remained unchanged from PostE at FE but still lower than PreE ($p<0.0001$, $p<0.001$). Mean total QOL scores and diabetes worry subscale scores at FE were nearly the same as at PreE (for both $p>0.05$). The change of insulin requirements, BMI and HbA_{1c} levels did not influence QOL measures in any stage of the study.

According to the different answers given to the self-administered questionnaire at PostE, we reevaluated the QOL scores of subjects with type 1 diabetes at

Table 4. QOL scores according to the responses of self-administered questionnaire at 3 months after the Marmara earthquake

	n (%)	QOL PreE	QOL PostE	QOL FE
Did you feel the earthquake?				
I was slightly aware of the quake.	13.6	81.8 ± 11.3	71.7 ± 16.6	72.0 ± 5.44
I was strongly aware of the quake.	86.4	73.0 ± 13.4	61.8 ± 17.3	69.7 ± 10.4
Have you been injured during the earthquake				
No	100	74.2 ± 13.4	62.7 ± 17.3	70.0 ± 9.9
Yes				
Do you have any relative/friend who died during the earthquake?				
Absent	72.7	73.6 ± 13.6	61.3 ± 19.1	69.6 ± 10.5
Present	27.3	75.8 ± 13.1	67.3 ± 8.6	71.2 ± 8.4
Have you had any relative whose health was affected due to the earthquake?				
Absent	61.4	75.6 ± 14.8	62.1 ± 10.7	71.5 ± 9.6
Present	38.6	72.1 ± 10.8	63.9 ± 9.4	67.7 ± 10.2
Was there any damage to the place where you were living?				
Absent	50	75.5 ± 13.0	64.2 ± 14.6	71.2 ± 9.3
Present	50	72.9 ± 13.9	61.4 ± 19.6	68.8 ± 10.5
Where did you live after the earthquake?				
In the same house	79.5	73.7 ± 13.5	60.5 ± 17.8*	68.2 ± 9.6**
Another house	20.5	76.3 ± 13.3	74.0 ± 7.9	77.1 ± 8.0
Have you had any problem with your school/workplace because of the quake?				
Absent	52.3	75.3 ± 13.6	64.9 ± 17.9	70.9 ± 10.2
Present	47.7	73.0 ± 13.4	60.0 ± 16.5	67.4 ± 9.7
Did you face any problem with glycemic control during the first days following the earthquake?				
Absent	54.5	74.9 ± 15.0	65.5 ± 9.8	70.3 ± 9.9
Present	45.5	73.4 ± 11.3	60.7 ± 21.2	69.6 ± 10.0
What kind of diabetes-related problems did you face after the earthquake?				
I had no problem.	27.3	80.7 ± 9.4	76.2 ± 9.7#	75.2 ± 7.4
Insulin supply	13.6	75.2 ± 10.7	64.7 ± 6.7	70.0 ± 10.6
Food supply	59.1	71.0 ± 14.6	55.5 ± 18.1	67.6 ± 10.1
How did the earthquake affect you?				
I was not affected at all.	15.9	76.3 ± 13.2	65.29 ± 15.8	71.0 ± 11.7
I had mostly emotional problems such as fear and worry.	70.5	74.5 ± 13.5	60.6 ± 18.3	69.2 ± 10.3
I had mostly been affected economically.	13.6	70.5 ± 14.6	71.8 ± 10.2	73.2 ± 5.1

Data are means ± SD unless otherwise indicated. *$p = 0.014$ vs another house, **$p<0.05$ vs another house, #$P<0.0001$ vs food supply

PreE, PostE and FE as shown in Table 4. QOL at PostE and FE of subjects living in the same house after the earthquake were significantly lower than subjects moving to another house ($p = 0.014$, $p = 0.05$, respectively).

Subjects not having adequate and appropriate food for medical nutrition therapy after the disaster reported the lowest levels QOL at PostE than the subjects not having the same problem at the same period ($p<0.0001$). Questionnaire items assessed and presented on Table 4 are analysed by multiple logistic analysis. The results of multiple logistic regression analysis revealed no correlation between QOL and the answers to self-administered questionnaire.

Discussion

Our results indicated that the Marmara earthquake affected glycemic control and QOL of people with type 1 diabetes in short term but its negative impact did not continue in long term. Our results showed that HbA_{1c} levels and insulin requirements increased at the 3rd month after the Marmara earthquake. Although insulin requirements remained unchanged for a long period after the earthquake, there were no significant differences between the HbA_{1c} levels before and after one year of the earthquake. This finding was also confirmed in previously published studies [5–7]. Inui *et al*. [24] showed that the HbA_{1c} levels peaked 3 to 4 months after the Kobe earthquake and returned to prequake levels 5–6 months later. Also Kirizuka *et al*. [25] reported that HbA_{1c} levels increased after the Hanshin-Awaji earthquake and declined gradually to the pre-earthquake levels one year later. We found no significant correlation between the change of insulin requirements and BMI, HbA_{1c} levels, and total QOL scores. The increase in insulin requirements may probably be derived from acute stress of the earthquake in these cases. On the other hand, inappropriate and inadequate food intake may also affect this result.

Diabetes requires compliance to medical therapy and medical nutrition therapy. However, not having adequate and appropriate food supply and/or insulin after the disaster may have affected glycemic control negatively. Recent published studies have also reported that inappropriate food intake is associated with high HbA_{1c} levels after the earthquake [5, 25]. In this study, according to the results of the self-administered questionnaire, 59.1% of the people reported that they could not find adequate and appropriate food to comply with nutrition therapy. During the weeks following the earthquake most of the supplied foods probably were carbohydrates consisting of only bread, rice, pasta, potato, sweet cake, crackers and simit (a ring-shaped bread covered by sesame seed). Our knowledge is not sufficient to answer this question: Do the patients know the carbohydrate-counting method for meal planning and individual carbohydrate/insulin ratio? There are several different ways people with diabetes can manage their food intake to keep their blood glucose as close to normal. One such method is carbohydrate counting. It is a meal planning approach calculating the grams of carbohydrate to match the amount of insulin with the food intake [34]. If people know this approach they should be able to adjust medical nutrition therapy according to their carbohydrate intake.

The results of the studies showed that not only does diabetes control become worse after earthquake [5, 24, 25], but also an increase in the number of newly diagnosed patients occurs following the earthquake [3, 6]. Stress negatively affects either people with diabetes [24, 29, 35, 36] or without [17–22]. Positive life events were associated with improved glycemic control; on the other hand, recent severe stressors were associated with poorer glycemic control [35]. Fukuda *et al*. [19] reported that the psychological stress induced by the Hanshin-Awaji earthquake was associated with increased cortisol levels. People having high posttraumatic stress disorder (PTSD) scores have highest cortisol levels. After the earthquake in Turkey, the estimated rate of PTSD was 63% [37]. In this study, the effects of stress on metabolic control and QOL were not evaluated. However, Salman *et al.* [26] reported that depression and anxiety scores of people with type 1 diabetes increased after the Marmara earthquake. The trauma of the earthquake may aggravate glycemic control by elevating counter regulatory hormone levels. Moreover, compliance to therapy and nutrition guidelines may become worse due to behavior modification after the quake.

Many measures have been developed to assess QOL [38–40]. In the present study the effects of earthquake on QOL were assessed by DQOL. The DQOL is a disease-specific measure designed specifically for use in DCCT but with applicability to a wider range of people with type 1 diabetes [32]. The relation between QOL and metabolic control is controversial [13, 41–

44]. Some studies reported an association between QOL and metabolic control [41, 42], whereas others found no association [13, 43, 44]. This study confirmed previous studies reporting that no association was found between glycemic control and QOL in type 1 diabetes. Guttmann-Bauman *et al*. [41] reported that mean HbA_{1c} level over one year correlates more strongly with QOL than single HbA_{1c} level in adolescents with type 1 diabetes. It is reported that if there is wide fluctuation of HbA_{1c} levels at each visit, no correlation may be found. Hoey *et al*. [42] reported that the relation they found between DQOL and HbA_{1c} levels in adolescents with type 1 diabetes may be attributed to the size and international nature of their study. In our study, there was no correlation between the DQOL and HbA_{1c} levels determined before the earthquake and the subsequent 3rd and 12th months. This may be due to both the method of assessing the correlation with one HbA_{1c} level and the small number of the sample size. On the other hand, earthquake decreased the QOL of type 1 diabetic people independent of detoriation of glycemic control.

This is the first study reporting short- and long-term effects of life-threatening disasters such as earthquakes on QOL of people with type 1 diabetes. QOL was found to decrease at the 3rd month after the earthquake and returned to pre-earthquake levels after one year. However, impact and social worry subscale scores did not show any difference between the 3rd and 12th months after the earthquake. This implies that the daily lives of the patients concerning diabetes are affected at the short- and long-term periods compared with the pre-earthquake state. Although insulin requirement increases in order to achieve normal glycemic levels the impossibility of achieving suitable food supply may negatively affect the impact scores of DQOL. Furthermore, local medical organizations were affected by the event, and so people with type 1 diabetes or their family members could not reach their doctors and/or pharmacy. Even if they could reach them, pharmaceutical and medical equipments were often found to be destroyed. Baba *et al*. [1] reported that after the Great Hanshin earthquake, supplies of insulin and other drugs for diabetics ran out, and there was rapidly increased anxiety among diabetics because of their inability to reach their doctors and have their medication changed.

On the other hand, being exposed to two major earthquakes and the anxiety of having a stronger earthquake in the future, the inability to find appropriate and sufficient food to match the increasing need of insulin may negatively affect impact and social worry scores.

Evaluating the responses to the structured questionnaire, people with type 1 diabetes living in same house after the earthquake and not having enough food supply were reported to have lower QOL than people moving to another house and having enough food supply after the earthquake. People moving to another house may have felt themselves safer than the others, and so their post-disaster stress level may have been reduced. Our results are comparable with the studies of Wang *et al*. [20] and Lin *et al*. [30]. People whose residences were completely collapsed during the earthquake reported a higher QOL compared to others [30].

We confirmed that the earthquake aggravated glycemic control and QOL of people with type 1 diabetes in short term independently. To prevent the negative influence of earthquake on metabolic control and QOL, every country prone to earthquake must develop emergency aid and action plan for diabetics. Type 1 diabetics living in the quake region should be encouraged to learn the carbohydrate counting approach and to be aware of the importance of carbohydrate/insulin ratio. It may be useful under certain circumstances such as when diabetics do not have insulin or adequate food supply. Diabetes educators should add this item to their diabetes education program.

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