BRIEF REPORT

Association of Objective Measures of Trauma Exposure From Motor Vehicle Accidents and Posttraumatic Stress Symptoms

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Associations of objective measures of trauma exposure with psychological sequelae following motor vehicle accidents (MVA) were examined in a Japanese population. Impact and injury severity of 93 MVA victims was assessed using on-the-scene in-depth investigations measured by the Injury Severity Score (ISS), barrier equivalent speed (BES), and change in velocity during the impact (Delta-v). Results showed that ISS, BES, and Delta-v were not related to posttraumatic stress symptoms (PTSS) or psychiatric symptoms at 5 and 14 months after the MVA. Subjective measures (e.g., perceived life risk, persistent medical problems) were significantly related to psychological sequelae. These findings suggest that the objective measures of trauma exposure are not associated directly with PTSS or psychiatric symptoms after an MVA.

A number of risk factors have been identified that can increase an individual's vulnerability to psychological sequelae, such as developing posttraumatic stress symptoms (PTSS) or posttraumatic stress disorder (PTSD), following a motor vehicle accident (MVA).

In terms of objective measures, severe MVA is often used as an example of trauma that leads to PTSD. However, the research findings are inconsistent about the association of objective measures of accident severity with psychological sequelae.

Most studies with objective measures of victim trauma have used the Injury Severity Scale (ISS) and the Abbreviated Severity Scale (AIS). The AIS is the sum of ratings of the severity of injury to each of seven regions of the body. The ISS is computed by summing the squared values of the patient's three highest AIS ratings (Baker, O'Neill, Haddon, & Long, 1974). A number of studies have examined correlations between AIS or ISS scores and psychological sequelae, and found mixed results. Some studies found a relationship between injury severity and PTSD (Blanchard et al., 1996; Hamanaka et al., 2006), whereas others did not (Bryant & Harvey, 1996).

Another objective measure of MVA severity is the crash impact. In automotive engineering studies, the impact severity of a crash is determined using barrier equivalent speed (BES) and Delta-v (cf. Brach & Brach, 2005). Barrier equivalent speed is the equivalent impact velocity of a vehicle into a fixed rigid barrier that would result in the same magnitude of the crash observed. Delta-v is the actual change in velocity during the impact phase of a collision. Many studies have shown positive correlations of BES and Delta-v with ISS scores for victim injury (Evans, 1994). However, no study to date has investigated the associations of BES or Delta-v with psychological consequences of MVAs.

Although it is widely known that the severity of an event is one of the main risk factors for PTSD, it is difficult to assess the severity of the event objectively. Therefore, it is meaningful to investigate the association between BES or Delta-v and psychological sequelae. The aim of this study was to investigate the association between objective measures of trauma exposure and psychological sequelae following MVAs.

METHOD

Participants and Procedure

Participants were recruited from the Institute for Traffic Accident Research and Data Analysis (ITARDA). ITARDA is a nonprofit, independent institute sponsored by the Japanese government, automobile manufacturers, and other lobbies. ITARDA conducts on-the scene in-depth investigations to obtain detailed information about MVAs with the cooperation of police and hospitals in the Tsukuba region, which is located in suburban Tokyo. ITARDA investigates approximately 8% of accidents occurring in the Tsukuba area. Approximately, 15% of investigations by ITARDA are fatal accidents, 35% result in severe injuries, and 50% result in mild injuries. Selection of the accidents investigated in this study was conducted using convenience sampling without the intention of bias.

Participants were referred and contacted by trained investigators of ITARDA. Potential participants had to meet several criteria, including being injured occupants (drivers or passengers) of a 4-wheel passenger vehicle involved in a car-to-car or single car accident, and available to complete objective measures of the MVA. One hundred twenty-one drivers and passengers agreed to participate in our study.

At an average of 5 months after the MVA ($M = 142$ days, $SD = 67$), participants were asked to complete a questionnaire, including the scales of psychological sequelae. Ninety-three participants completed the questionnaire, and returned it by mail, providing a 76.9% response rate. Approximately 14 months after the accident ($M = 419$ days, $SD = 10$), participants were asked to complete a follow-up questionnaire with the same content. Forty-nine participants completed and returned the questionnaire providing a response rate of 52.7%.

Measures

Injury severity was measured using the previously described ISS. Most ISS scores were calculated based on the medical records of the hospitals, and a few ISS scores were calculated based on medical certificates.

Impact severity was measured using the previously described BES and Delta-v. With a computer simulation program using the data of the damage of the vehicles involved in the MVA, estimations of BES and Delta-v values were developed by the collision investigation unit of ITARDA. A higher score of BES or Delta-v is interpreted as a harder crash impact. Responsibility for the accident was also determined by the investigation unit; scored 0 or 1 (1 = *at-fault driver*, 0 = *not at-fault driver or passenger*).

Persistent medical problems were assessed at 5 months. If the participants suffered any medical problems of loss of body parts, physical dysfunction, pain or physical scars, the value 1 was assigned, if not, the value 0 was assigned. Perceived life risk was assessed by the question, "During the accident, how much danger did you feel you were in?" on a 6-point scale (5 = *life-threatening*, 0 = *none*). At the 5-month assessment, participants were also asked to report about social support by the question, "How do your family members or surroundings understand your physical, psychological, or economical damage caused by the accident?" on a 5-point scale (4 = *very much*, 0 = *not at all*); complaint about compensation by the question, "How are you satisfied with the result of compensation after the accident?" on a 6-point scale (5 = *have or planning litigation*, 0 = *very much*); and daily life problems by the question, "How does the accident negatively affect on your job, housekeeping or school activity?" on a 5-point scale question (4 = *very much*, 0 = *not at all*).

Posttraumatic stress symptoms (PTSS) were assessed by the Japanese version of the Impact of Event Scale–Revised (IES-R; Asukai et al., 2003; Weiss & Marmar, 1996). We used the sum of the 22 items as the PTSS (score 0–88). Mental illness symptoms were assessed by the Japanese version of the General Health Questionnaire (GHQ; Goldberg, 1972; Nakagawa & Taibou, 1985). For the study, we used a 20-item version of the GHQ (GHQ20; score 0–20).

RESULTS

Participant Characteristics

Table 1 provides the demographic and objective variables of the MVA, PTSS, and mental illness symptom scores of participants who completed assessments and participants who dropped out at the 5-month and 14-month assessments. At the 5-month assessment, there was no difference in any variables listed in Table 1 between respondents and dropouts. At the 14-month assessment, relatively more women were respondents than dropouts, χ^2 (1, $N = 93$) = 7.62, $p < .01$. The mean ISS of respondents was greater than that of dropouts at the 14-month assessment, $F(1, 91)$ = 11.04, $p < .01$. At the 14-month assessment, 10 of 23 participants whose ISS was more than the 75th percentile, dropped out. Distribution of ISS at both 5-month and 14-month assessments were skewed; thus, we conducted a log transformation on ISS. In other variables, there were no significant differences between respondents and dropouts at the 14-month assessment.

Correlations

Tables 2 and 3 provide Pearson correlations of independent variables with the four dependent variables. There were no significant relationships of objective injury severity and impact severity to the total scores of the IES-R and GHQ20 at 5 months or 14 months. However, subjective persistent medical problems were significantly related to IES-R and GHQ20 at both 5 months and 14 months. The responsibility for the MVA was also significantly related to both IES-R and GHQ20 at 5 months. Perceived life risk and

Table 1. Means or Percentages for Demographic Variables, Objective Measures, Posttraumatic Stress Symptoms, and Mental Illness Symptoms at 5 Months and 14 Months After the Motor Vehicle Accident

		Age	Female[a]	BES	Delta–V	ISS	At fault[a]	IES–R	GHQ20
5 months	Completers (*n* = 93)	39.0	39.8	28.2	31.8	6.1	45.2	21.0	7.2
		(15.2)	–	(13.4)	(18.3)	(7.8)	–	(15.7)	(6.30)
	Dropouts (*n* = 28)	35.3	35.7	29.8	34.7	5.4	57.1	–	–
		(12.1)	–	(11.7)	(16.7)	(6.2)	–	–	–
14 months	Completers (*n* = 49)	42.8	53.1	26.2	31.9	3.7	36.7	21.1	7.5
		(15.5)	–	(13.4)	(19.2)	(3.7)	–	(16.0)	(6.8)
	Dropouts (*n* = 44)	34.8	25.0	30.4	31.8	8.9	54.5	21.0	6.8
		(13.8)	–	(13.3)	(17.4)	(10.1)	–	(15.6)	(5.8)

Note. Figures in parenthesis are standard deviations. BES = Barrier equivalent speed; ISS = Injury Severity Score; IES-R = Impact of Event Scale–Revised; GHQ20 = 20-item version of General Health Questionnaire.
[a]Figures are percentages.

Table 2. Summary Table of Stepwise Multiple Regression of Independent Variables with Posttraumatic Stress Symptoms (IES-R) and Mental Illness Symptoms (GHQ20) at 5 Months as Dependent Variables (*n* = 93)

Independent variables	IES-R[a]				GHQ20[b]			
	B	*SE*	β	*r*	*B*	*SE*	β	*r*
Age	–	–	.14	.11	–	–	.15	.11
Female	–	–	.13	.21*	–	–	−.02	.10
BES	–	–	−.15	−.15	–	–	−.04	−.07
Delta–v	–	–	−.11	−.10	–	–	−.05	−.03
ISS	–	–	−.09	−.11	–	–	.01	−.02
Persistent medical problem	12.14	2.83	.39***	.34**	4.86	1.13	.39***	.38**
Responsibility	−6.50	2.93	−.21**	−.25*	−2.45	1.26	−.19*	−.30**
Perceived life risk	3.13	0.95	.31*	.32**	0.87	0.37	.21*	.25*
Social support	–	–	.07	.09	–	–	.08	.10
Complaint about compensation	–	–	.14	.29**	0.86	0.42	.20*	.37**
Daily life problem	–	–	−.05	.15	–	–	.12	.34**

Note. *B* and *SE* are shown if the variable was in the equation. β of excluded variables is the size of the standardized regression weight if the variable had been entered into the model by itself in the next stage. IES-R = Impact of Event Scale–Revised; GHQ20 = 20-item version of General Health Questionnaire; BES = barrier equivalent speed; ISS = Injury Severity Score.
[a]Adjusted R^2 = .26. [b]Adjusted R^2 = .30.
* $p < .05$. ** $p < .01$. *** $p < .001$.

complaint about compensation showed a significant correlation to the IES-R at both 5 months and 14 months and to the GHQ20 at 5 months. Daily life problems also showed a significant correlation with GHQ20 at 5 months.

Regression Analysis

To identify predictors of posttraumatic stress symptoms and mental illness symptoms following a MVA, we conducted stepwise multiple regression analyses using 11 independent variables.

The summary results are provided in Tables 2 and 3. No objective measure of trauma exposure significantly predicted later psychological sequelae. Persistent medical problems were a significant independent variable in all four equations. Perceived risk was a significant variable in three equations except the equation with the GHQ20 scores at 14 months. Responsibility was a significant variable in the equation of both IES-R and GHQ20 at 5 months. Complaint about compensation was significant in the equation of GHQ20 at 5 months and IES-R at 14 months.

DISCUSSION

In this study, the ISS was objectively calculated based on medical records and was not found to be associated with psychological

Table 3. Summary Table of Stepwise Multiple Regression of Independent Variables With Posttraumatic Stress Symptoms (IES-R) and Mental Illness Symptoms (GHQ20) at 14 Months as Dependent Variables ($n = 49$)

Independent variables	IES-R[a]				GHQ20[b]			
	B	SE	β	r	B	SE	β	r
Age	–	–	−.17	.06	–	–	.06	.08
Female	–	–	.06	−.17	–	–	−.02	−.07
BES	–	–	.02	.00	–	–	−.18	−.01
Delta–v	–	–	.14	.07	–	–	−.14	−.04
Injury severity score	–	–	−.11	.02	–	–	.00	.07
Persistent medical problem	12.23	4.71	.32*	.31*	4.66	1.69	.37**	.37**
Responsibility	–	–	.17	−.02	–	–	.08	.13
Perceived life risk	5.86	1.79	.40**	.43**	–	–	.17	.13
Social support	–	–	.17	.23	–	–	.12	.17
Complaint about compensation	3.40	1.67	.25*	.40**	–	–	.21	.26
Daily life problem	–	–	−.09	.17	–	–	.13	.27

Note. B and SE are shown if the variable was in the equation. β of excluded variables is the size of the standardized regression weight if the variable had been entered into the model by itself in the next stage. IES-R = Impact of Event Scale–Revised; GHQ20 = 20-item version of General Health Questionnaire; BES = barrier equivalent speed; ISS = Injury Severity Score.
[a]Adjusted $R^2 = .33$. [b]Adjusted $R^2 = .12$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

sequelae. On the other hand, subjective measures of persistent medical problems were correlated to psychological sequelae. These results are consistent with previous findings (Delahanty, Raimonde, Spoonster, & Cullado, 2003), which suggested that objective measures of injury severity correlate poorly with victims' psychological sequelae.

We found that the ISS were positively correlated with the BES ($r = .58$) and Delta-v ($r = .40$), whereas the BES and Delta-v were not correlated with psychological sequelae. It has been considered that a heavier impact crash often resulted in more serious injuries, but according to our findings, the heavier impact crash did not necessarily result in more serious psychological sequelae.

The responsibility for the accident, which was measured in the on-the-scene in-depth investigations, was significantly correlated with the PTSS and mental illness symptoms at 5 months. This result is consistent with the Delahanty et al. (1997) study, where subjective responsibility was based on victims' self-report. In Japan, the words "kotsujiko higaisya" (victims of motor vehicle accidents) refer to individuals who were not at fault in the accidents. No-fault insurance is not common in Japan and damages from an accident are compensated based on the driver's responsibility. As a result, liability is one of the major concerns among MVA victims in Japan.

There are several limitations to the findings of the current study. Taking subjective measures concurrently with symptom measures, without taking objective measures, makes it difficult to compare the predictive power of the two measures fairly. In addition, the use of only a single self-reported question is problematic because of its low reliability. Also, objective factors other than speed, such as the position of the collision (e.g., frontal vs. rear), may have played a role. Interrater reliability of ISS scores may also be problematic. Moreover, the small sample size and the relatively high proportions of dropouts, especially in the 14-month assessment, might have resulted in the failure to identify possible relationships between the measured variables. Finally, the results of this study, in which most participants were mild or moderate injury victims may not generalize to injured victims with severe injuries.

Despite these limitations, the results of this study support the hypothesis that there is no direct association between objective measures of trauma and psychological sequelae following a life-threatening event, such as an MVA. Future research should focus on examining whether the objective factors of trauma predict the psychological sequelae following a life-threatening event under the mediation of cognitive (Ehring, Ehlers, & Glucksman, 2006) or physiological factors, such as cortisol levels (Delahanty et al., 2003).

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