

# PTSD Score, Circadian Typology and Sleep Habits of People who Experienced the Great Hanshin-Awaji Earthquake 17 Years Ago

Hiroko Kuroda, Kai Wada, Hitomi Takeuchi, Tetsuo Harada\*

Laboratory of Environmental Physiology, Graduate School of Integrated Arts and Sciences,  
Kochi University, Kochi, Japan

Email: [hks-sien-net@h8.dion.ne.jp](mailto:hks-sien-net@h8.dion.ne.jp), [spitz\\_czech@yahoo.co.jp](mailto:spitz_czech@yahoo.co.jp), [rhythmsyn@hotmail.co.jp](mailto:rhythmsyn@hotmail.co.jp),  
[haratets@kochi-u.ac.jp](mailto:haratets@kochi-u.ac.jp)

Received September 4<sup>th</sup>, 2012; revised October 10<sup>th</sup>, 2012; accepted November 19<sup>th</sup>, 2012

This study aims to determine the relationship between Post Traumatic Stress Disorder (PTSD) and current circadian typology and sleep habits of adults who experienced the Great Hanshin-Awaji Earthquake (on 17th January 1995) after becoming adults. An integrated questionnaire was administered in August, 2011 to 467 people aged 38 - 92 (mean age: 64.8 years) in Hyogo Prefecture, Japan, with responses received from 223 people (females: 142, males: 78, unknown: 3). The questionnaire consisted of basic questions about attributes such as age and sex, questions on sleep habits and sleep quality (Subjective Sleep Quality Scale), the Torsvall-Åkerstedt Diurnal Type Scale and the Impact of Event Scale-Revised (IES-R) which dealt with PTSD scores. The participants were divided into a High Damage Group (HDG) and Low Damage Group (LDG) based on public statistical information on the extent of damage to buildings and number of casualties in the smaller districts of Kobe City in which participants experienced the disaster. HDG participants exhibited significantly higher IES-R scores than LDG participants ( $p = .002$ ). Only in HDG participants, there was significantly negative correlation between Diurnal-Type scale scores and IES-R scores (high PTSD scores correlated with greater evening type [low scores of Diurnal-Type scale]) ( $p = .001$ ) ( $p = .920$  in LDG participants). In both the HDG and LDG, there was a significant positive correlation between the Subjective Sleep Quality Scale (higher score meaning lower sleep quality) and IES-R score (high PTSD scores correlated with low quality of sleep) ( $p < .001$  in HDG;  $p = .001$  in LDG). These results suggest that people who suffered severe damage from a disaster and who currently show severe PTSD symptoms are more evening-typed and have a lower quality of sleep. Intervention to improve their quality of sleep and promote a morning-typed lifestyle may be an effective way to reduce PTSD symptoms.

**Keywords:** PTSD; Intrusion; Hyper-Arousal; Avoidance-Numbing; The Impact of Event Scale-Revised (IES-R); Current Circadian Typology

## Introduction

A tremendous number of studies have been reported on Post-traumatic stress disorder (PTSD), especially in the last decade.

### Disasters and PTSD

An epidemiological study was performed on a total of 271 adolescents who had been evacuated from their homes 3 months after Typhoon Morakot in Taiwan (Young et al., 2011). The prevalence of PTSD related to the typhoon was 25.8% and adolescents with PTSD had more severe depression and internalizing, externalizing, social, thought and attention problems than those without PTSD (Young et al., 2011). Even 4 years after the Parnitha earthquake in Greece, 22% of survivors reported subjective distress and intense fear during the earthquake and participation in rescue operations positively correlated with greater post-earthquake psychological stress (Livanou et al., 2004). The psychological consequence of earthquakes may be serious and long-lasting even when the magnitude of the earthquake is moderate (Livanou et al., 2004).

At .5 and 3 years after a severe earthquake (7.3 on the

Richter scale) in Taiwan, the estimated rate of victims with posttraumatic stress symptoms (PTSS) was 23.8% and 4.4%, respectively, and PTSS scores were tightly correlated with QOL scores (with less severe symptoms linking to higher QOL) (Tsai et al., 2007).

### PTSD Related to Combat and Violence

In 20 Vietnam veterans diagnosed with combat-related PTSD, urine collections in three 8 hours (8:00-16:00, 16:00-24:00, 24:00-8:00) to measure catecholamine levels showed that noradrenaline activity was undiminished at night and sleep was disturbed in comparison with 8 non-combat-exposed controls (Mellman et al., 1995). In the case of victims of violent crimes with PTSD, posttraumatic nightmares and insomnia improved and daytime PTSD symptom severity was reduced after a single, 90 min intervention which used cognitive-behavioral techniques aimed at reducing post-traumatic nightmares and insomnia (Germain et al., 2007).

### Circadian Typology and Sleep Habits

Morningness-Eveningness preference shows the phase relationship of circadian clocks to the environmental zeitgebers and

\*Corresponding author.

can be an appropriate indicator of circadian phase in human circadian clocks in ordinary life (Ishihara, 1991; Harada, 2008). In general, evening-typed diurnal rhythms are linked to the shortage of sleep due to late bedtimes and also poor quality of sleep (Macacci & Zani, 1983; Hayashi & Hori, 1987; Tanaka et al., 1997; Ishihara et al., 1988; Harada & Takeuchi, 2001; Harada & Takeuchi, 2011).

### PTSD, Sleep Disturbance and Circadian Typology

Sleep disturbance is one of 4 factors indicating PTSD symptoms as assessed by the Impact Event Scale-Revised (IES-R) and the main symptom exhibited in PTSD (Germain et al., 2005; Mellman, 2008; Wang, 2011). However, there have been no studies on the relationship between PTSD symptoms and circadian typology. This study tries to examine this relationship from an epidemiological point of view.

## Participants and Methods

### Questionnaire Study

An integrated questionnaire was administered to 467 people aged 38 - 92 (mean age: 64.8 years) in Hyogo Prefecture (35°N), Japan in August 2011, with responses received from 223 people (females: 142, males: 78, unknown: 3) which were all usable for analysis. The questionnaire consisted of basic questions about attributes such as age and sex, questions on sleep habits and sleep quality (Subjective Sleep Quality Scale), the Torsvall-Åkerstedt Diurnal Type Scale (1980) and a Japanese version (Kasugai, 1998) of the Impact of Event Scale-Revised (IES-R) which has been usually used as PTSD scores (Wilson & Keane, 2004) composed of 22 questions, 8 questions related to intrusion, 6 on hyper-arousal and 8 on avoidance-numbing (**Table 1**). The original questions on sleep habits which Harada et al. (1998) originally constructed have been used in several papers (Takeuchi et al., 2001a; Takeuchi et al., 2001b; Harada et al., 2002; Takeuchi et al., 2003; Harada et al., 2004; Shinomiya et al., 2004; Harada et al., 2007).

**Table 1.**

Examples of questions of the Impact of Event Scale-Revised (IES-R) (Wilson & Keane, 2004).

<i>One example of 8 questions on avoidance-numbing</i>	
Q:	How extent do you avoid something to make you remember the disaster?
A:	(0) Never, (1) a little, (2) medium, (3) much, (4) extreme
<i>One example of 8 questions on intrusion</i>	
Q:	How extent do something on the disaster appear suddenly in your brain?
A:	(0) Never, (1) a little, (2) medium, (3) much, (4) extreme
<i>One example of 6 questions on hyper-arousal</i>	
Q:	Are you enough nervous to be in high tension triggered with a small thing?
A:	(0) Never, (1) a little, (2) medium, (3) much, (4) extreme

**Table 2.**

Damage due to the Great Hanshin-Awaji Earthquake (Kobe City Administrative Office, 1995). DP: Dead person; CCB: Completely Collapsed Building; HCB: Half Collapsed Building; CBB: Completely Burned Building.

Districts	Higashinada	Nada	Chuo	Hyogo	Nagata	Suma	Tarumi	Nishi	Kita	Total
DP (n)	1471	933	244	555	919	401	25	11	12	4571
CCB (n)	13,687	12,757	6344	9533	15,521	7696	1176	436	271	67,421
HCB (n)	5538	5675	6641	8109	8282	5608	8890	3262	3140	55,145
CBB (n)	327	465	65	940	4759	407	1	0	1	6965

### Statistical Analysis

The data was statistically analyzed using Mann-Whitney U-tests and Pearson's correlation analysis with SPSS 20.0 statistical software. Diurnal Type scale scores were expressed as means plus or minus the standard deviation (Mean  $\pm$  SD).

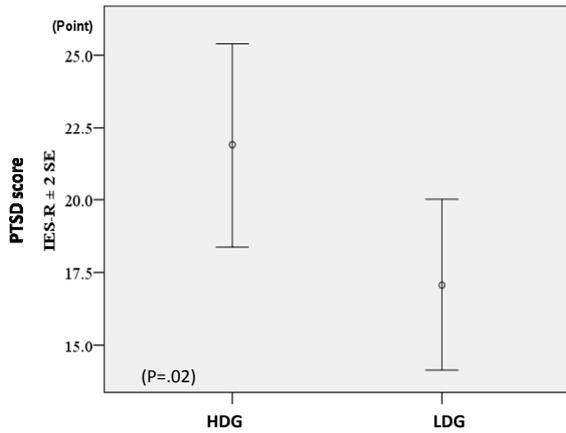
### Criterion for High and Low Damage Groups

Participants were divided into a High Damage Group (HDG) and a Low Damage Group (LDG) based on public statistical information on the extent of damage to buildings and number of casualties in the smaller districts of Kobe City in which participants experienced the disaster (**Table 2**). The criterion for the HDG and LDG was more than 100 dead persons or more than 1000 buildings collapsed completely. According to this criterion, participants living in the 7 districts of Higashinada, Nada, Chuo, Hyogo, Nagata, Suma and Tarumi were included in HDG and those in Nishi and Kita were in the LDG (**Table 2**).

The study followed the guidelines established by the Chronobiology International Journal for the conduct of research on human subjects (Portaluppi et al., 2010). Before administrating the questionnaires, each participant was given a written explanation that detailed the concepts and purposes of the study and stated that their answers would be used only for academic purposes. After the above explanation, all participants agreed completely with the proposal. The study was also permitted by the ethic committee in the Laboratory of Environmental Physiology, Graduate School of Integrated Arts and Sciences, Kochi University which carried out an ethical inspection of the contents of the questionnaire

## Results

PTSD scores (21.9 points on average) were significantly higher in the High Damage Group (HDG) than those (17.1) in the Low Damage Group (LDG) (Mann-Whitney U-test:  $z = -2.270$ ,  $p = .02$ ) (**Figure 1**). Scores of HDG participants tended



**Figure 1.** Comparison of current (Aug 2011) PTSD scores of participants of a High Damage Group (HDG) and a Low Damage Group (LDG) of the Hanshin-Awaji Great Earthquake (Jan 1995).

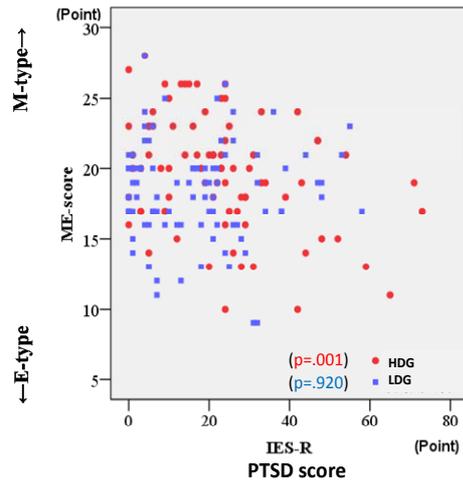
to be higher in all three categories of intrusion, hyper-arousal and avoidance-numbing than those of LDG participants (Mann-Whitney U-test, intrusion:  $z = -2.304, p = .02$ ; hyper-arousal:  $z = -1.807, p < .01$ ; avoidance-numbing:  $z = -2.752, p = .006$ ). The ratio of participants who showed 25 or more points was 34.8% in HDG and tended to be higher than the 24.5% in LDG ( $\chi^2$ -test:  $df = 1, \chi^2$ -value = 2.443,  $p = .118$ ).

Only in HDG participants, there was a significant negative correlation between Diurnal-Type scale scores and IES-R scores (high PTSD scores correlated with greater evening type [low scores of Diurnal-Type scale]) (Pearson's correlation test:  $r = -.353, p = .001$  in HDG;  $r = .010, p = .920$  in LDG) (Figure 2). In both HDG and LDG, there was a significantly positive correlation between the Subjective Sleep Quality Scale (higher score meaning lower sleep quality) and the IES-R scores (higher PTSD scores correlated with lower quality of sleep) ( $r = .536, p < .001$  in HDG;  $r = .319, p = .001$  in LDG) (Figure 3).

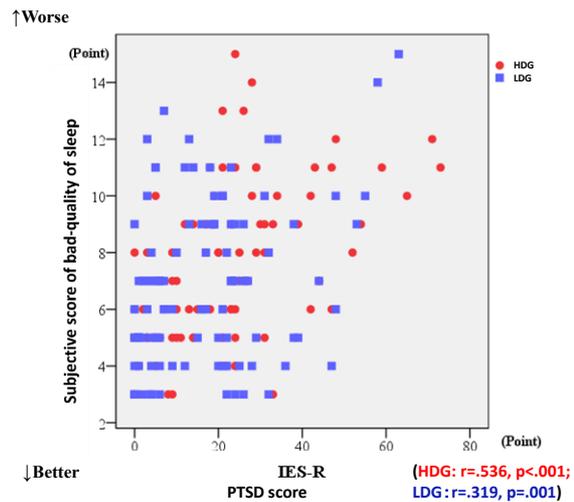
### Discussion

Even 17 years after the Hanshin-Awaji Great Earthquake (magnitude: 7.3), PTSD symptoms due to the earthquake remains. People who suffered severe damage from a disaster and who currently show severe PTSD symptoms are more evening-typed and have a lower quality of sleep. This study is the first to indicate a positive correlation between evening-typed lifestyle and PTSD symptoms (morning-type lifestyle and reduced PTSD symptoms).

What are the mechanisms underlying this relationship? Three hypothetical pathways are possible. The first is that dreaming during REM sleep consolidates the memorizing system in the brain (Karni et al., 1994; Hornung et al., 2007) and may delete the scarce memory of the earthquake. The second is via a high amount of serotonin synthesis in the morning due to a rich-protein breakfast (Harada et al., 2007; Nakade et al., 2009, 2012). Diminished 5-HT<sub>2A</sub> receptor signaling in the brain appears to be associated with the cognitive syndrome observed in PTSD and certain subgroups of depressive illness (Van Praag, 2004a, 2004b). Therefore, a higher amount of serotonin synthesis in the pineal gland could compensate, partially, the shortage of 5-HT<sub>2A</sub> receptors.



**Figure 2.** Negative correlation between current scores of Diurnal Type scale scores and PTSD scores which was shown only for participants in a High Damage Group (HDG) of the Hanshin-Awaji Great Earthquake even after 17 years after the disaster.



**Figure 3.** Positive correlation between current values of poor quality sleep scores and PTSD scores which was shown both for participants in a High Damage Group (HDG) and those in a Low Damage Group (LDG) of the Hanshin-Awaji Great Earthquake even after 17 years after the disaster.

The third possible mechanism is better inner synchronization of the main and slave clocks (Honma & Honma, 1988) shown by morning-type people whose clocks are well entrained to zeitgebers such as light, temperature and social cues. The second and third pathways can both improve mental health (Takeuchi et al., 2002; Harada, 2008; Harada et al., 2012) and this improvement could reduce the symptoms of PTSD. However, these hypotheses remain to be tested in the future. Intervention to improve their quality of sleep and promote a morning-typed lifestyle may be an effective way to reduce PTSD symptoms.

### Conclusion and Limitation

This study could imply the shifting to “morning-typed life”

might reduce the symptoms of PTSD for the victims who suffered from great disaster. The limitation of this study is that the questionnaire study cannot say the causal relationship between morning-typology and reduced PTSD. Some experimental study for the causal relationship is remained in the future.

### Acknowledgements

We thank all the participants of this study. Thanks are also due to the Kochi University President Foundation for Support of Research (2009-2012: to T. Harada) and Research Funds by JSPS (Fund No: 22370089: 2010-2013: to T. Harada; Fund No: 23-10971: 2011-2014: to K. Wada) for financial support. Thanks are also due to Mis Laura Sato who is professional English editor and supported us from linguistic point of view.

### REFERENCES

- Germain, A., Shear, M. K., Hall, M., & Buysse, D. J. (2007). Effects of a brief behavioral treatment for PTSD-related sleep disturbances: A pilot study. *Behaviour Research and Therapy*, *45*, 627-632. doi:10.1016/j.brat.2006.04.009
- Harada, T. (2008). Diurnal rhythm and sleep habit of infants, school pupils and students—Focusing on environmental factors in life including 24 hours commercialization society in Japan. *Chronobiology*, *14*, 36-43.
- Harada, T., & Takeuchi, H. (2001). Epidemiological study on students' daily rhythms and sleeping habits. *Journal Japanese Society for Chronobiology*, *7*, 36-46.
- Harada, T., & Takeuchi, H. (2011). Rhythm in life habit of Japanese infants, children and students (Chapter 25, pp. 204-217). In S. Shibata (Ed.), *Chronobiology and industrial applications*. Tokyo: CMC Co. Ltd.
- Harada, T., Morikuni, M., Yoshii, S., Yamashita, Y., & Takeuchi, H. (2002). Usage of mobile phone in the evening or at night makes Japanese students evening-typed and night sleep uncomfortable. *Sleep and Hypnosis*, *4*, 150-154.
- Harada, T., Hirotsu, M., Maeda, M., Nomura, H., & Takeuchi, H. (2007). Correlation between breakfast tryptophan content and morningness-eveningness in Japanese infants and students aged 0 - 15 years. *Journal of Physiological Anthropology*, *26*, 201-207. doi:10.2114/jpa.26.201
- Harada, T., Nakade, M., Wada, K., Kondo, A., Maeda, M., Noji, T., & Takeuchi, H. (2012). Mental health of children from a chronobiological and epidemiological point of view (Chapter 22) (pp. 439-458). In V. Ollisah (Ed.), *Essential notes in psychiatry* (p. 580), INTECH, Rijeka.
- Harada, T., Inoue, M., Takeuchi, H., Watanabe, N., Hamada, M., Kadota, G., & Yamashita, Y. (1998). Study on diurnal rhythms in the life of Japanese university, junior high and elementary school students including morningness-eveningness preference. *Bulletin of the Faculty of Education, Kochi University Series 1*, *56*, 1-91.
- Hayashi, M. & Hori, T. (1987). Survey on a sleep habits for university and high school students. *Hiroshima University Faculty of Integrated Arts and Sciences Bulletin III*, *11*, 53-63.
- Honma, K., & Honma, S. (1988). A Human phase-response curve for bright light pulses. *Japanese Journal of Psychiatry Neurology*, *42*, 167-168.
- Hornung, O. P., Regen, F., Danker-Hopfe, H., Schredl, M., & Heuser, I. (2007). The Relationship between REM sleep and memory consolidation in old Age and effects of cholinergic medication. *Biological Psychiatry*, *61*, 750-757. doi:10.1016/j.biopsych.2006.08.034
- Ishihara, K. (1991). Morningness-eveningness. In Y. Chiba, & K. Takahashi (Eds.), *Handbook of chronobiology* (pp. 269-274). Asakura-Shoten, Tokyo.
- Ishihara, K., Miyake, S., Miyashita, A., & Miyata, Y. (1988). Comparisons of sleep-wake habits of morning and evening types in Japanese worker sample. *Journal of Human Ergology*, *17*, 111-118.
- Karni, A., Tanne, D., Rubenstein, B. S., Askenasy, J. J., & Sagi, D. (1994). Dependence on REM sleep of overnight improvement of a perceptual skill. *Science*, *265*, 679-682. doi:10.1126/science.8036518
- Kasugai, N. (1999). Anxiety disorders and posttraumatic stress disorder (PTSD). *Psychiatry*, *28*, 171-177.
- Kobe City (1995). Report on damage due to the Great Hanshin-Awaji Earthquake. (in Japanese)
- Livanou, M., Kasvilis, Y., Başoğlu, M., Mytskidou, P., Sotiropoulou, V., Spanea, E., Mitsopoulou, T., & Voutsas, N. (2005). Earthquake-related psychological distress and associated factors 4 years after the Pamitha earthquake in Greece. *European Psychiatry*, *20*, 137-144. doi:10.1016/j.eurpsy.2004.06.025
- Mecacci, L., & Zani, A. (1983). Morningness-eveningness preferences and sleep-waking diary data of morning and evening types in student and worker samples, *Ergonomics*, *26*, 1147-1153. doi:10.1080/00140138308963450
- Mellman, T. A., Kumar, A., Kulick-Bell, R., Kumar, M., & Nolan, B. (1990). Nocturnal/daytime urine noradrenergic measures and sleep in combat-related PTSD. *Biological Psychiatry*, *38*, 174-179. doi:10.1016/0006-3223(94)00238-X
- Nakade, M., Takeuchi, H., Taniwaki, N., Noji, T., & Harada, T. (2009). An integrated effect of protein intake at breakfast and morning exposure to sunlight on the circadian typology in Japanese infants aged 2 - 6 years. *Journal of Physiological Anthropology*, *28*, 239-245. doi:10.2114/jpa.28.239
- Nakade, M., Akimitsu, O., Wada, K., Krejci, M., Noji, T., Taniwaki, N., Takeuchi, H., & Harada, T. (2012). Can breakfast Tryptophan and Vitamin B6 intake and morning exposure to sunlight promote morning-typology in young children aged 2 - 6 years? *Journal of Physiological Anthropology*, *31*, 11. http://www.jphysiolanthropol.com/content/31/1/11
- Portaluppi, F., Smolensky, M. H., & Touitou, Y. (2010). Effects and methods for biological rhythm research on animals and human beings. *Chronobiology International*, *27*, 1911-1929. doi:10.3109/07420528.2010.516381
- Shinomiya, H., Takeuchi, H., Martoni, M., Natale, V., & Harada, T. (2004). Comparative study on circadian typology of Japanese and Italian students aged 12 - 18 years. *Sleep and Biological Rhythms*, *2*, 93-95. doi:10.1111/j.1479-8425.2003.00075.x
- Takeuchi, H., Oishi, T., & Harada, T. (2003). Morningness-eveningness preference, and mental and physical symptoms during the menstrual cycle of Japanese junior high school students. *Sleep and Biological Rhythms*, *1*, 245-247. doi:10.1046/j.1446-9235.2003.00042.x
- Takeuchi, H., Hino, N., Iwanaga, A., Hino, N., Matsuoka, A., & Harada, T. (2001a). Light conditions during sleep period and sleep-related lifestyle in Japanese students. *Psychiatry and Clinical Neurosciences*, *55*, 221-222. doi:10.1046/j.1440-1819.2001.00832.x
- Takeuchi, H., Inoue, M., Watanabe, N., Yamashita, Y., Hamada, M., Kadota, G., & Harada, T. (2001b). Parental enforcement of bedtime during childhood results in Japanese junior high school students preferring morningness to eveningness. *Chronobiology International*, *18*, 823-829. doi:10.1081/CBI-100107517
- Takeuchi, H., Morisane, H., Iwanaga, A., Hino, N., Matsuoka, A., & Harada, T. (2002). Morningness-eveningness preference and mood in Japanese junior high school students. *Psychiatry and Clinical Neurosciences*, *56*, 227-228. doi:10.1046/j.1440-1819.2002.00985.x
- Tanaka, H., Hayashi, M., & Hori, T. (1997). *The developmental feature of the sleep problems in adolescence: The approach for the application to educational stage* (pp. 141-154). Hiroshima: Memoirs of the Faculty of Integrated Arts and Sciences, Hiroshima University.
- Torsvall, L., & Åkerstedt, T. (1980) A diurnal type scale: Construction, consistency and validation in shift work. *Scandinavian Journal of Work, Environment & Health*, *6*, 283-290. doi:10.5271/sjweh.2608
- Tsai, K. Y., Chou, P., Chou, F. H.-C., Su, T. T.-P., Lin, S.-C., Lu, M.-K., Ou-Yang, W.-C., Su, C.-Y., Chao, S.-S., Huang, M.-W., Wu H.-C., Sun, W.-J., Su, S.-F., & Chen, M.-C. (2007). Three-year follow-up of the relationship between posttraumatic stress symptoms and quality of life among earthquake survivors in Yu-Chi, Taiwan. *Journal of Psychiatric Research*, *41*, 90-96. doi:10.1016/j.jpsychires.2005.10.004
- Usano, R. J., Zhang, L., Li, H., Johnson, H. L., Carlton, J., Fullerton, C.

- S., & Benedek, D. M. (2009). PTSD and traumatic stress from gene to community and bench to bedside. *Brain Research*, 1293, 2-12. doi:10.1016/j.brainres.2009.03.030
- Van Praag, H. M. (2004a). Can stress cause depression? *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 28, 891-907. doi:10.1016/j.pnpbp.2004.05.031
- Van Praag, H. M. (2004b). The cognitive paradox in posttraumatic stress disorder: A hypothesis. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 28, 923-935. doi:10.1016/j.pnpbp.2004.05.011
- Wang, L., Zhang, J., Shi, Z., Zhou, M., Huang, D., & Liu, P. (2011). Confirmatory factor analysis of posttraumatic stress symptoms assessed by the impact of event scale-revised in Chinese earthquake victims: Examining factor structure and its stability across sex. *Journal of Anxiety Disorders*, 25, 369-375. doi:10.1016/j.janxdis.2010.10.011
- Wilson, J. P., & Keane, T. M. (2004). *Assessing psychological trauma and PTSD* (2nd ed., p. 668), New York: The Guilford Press.
- Young, P., Yen, C.-F., Tang, T.-C., Chen, C.-S., Yang, R.-C., Huang, M.-S., Jong, Y.-J., & Yu, H.-S. (2011) Posttraumatic stress disorder in adolescents after Typhoon Morakot-associated mudslides. *Journal of Anxiety Disorders*, 25, 362-386. doi:10.1016/j.janxdis.2010.10.010