*Research Article*

Clinical Nursing Research
1–15

DOI: 10.1177/1054773818793599
journals.sagepub.com/home/cnr
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# A Correlational Study of Acute Stress and Resilience Among Hospitalized Burn Victims Following the Taiwan Formosa Fun Coast Explosion

**Ya-Lin Chen, MSN, RN[1], Ming-Hsiu Lu, MSN, RN[1], Ling-Tzu Weng, MSN, RN[1], Chin Lin, PhD[1], Ping-Wei Huang, MS[2], Chih-Hsin Wang, MD[1], and Hsueh-Hsing Pan, PhD, RN[1]**

## Abstract

Although the survival rate of burn patients in the Formosa Fun Coast Explosion disaster increased significantly, for patients facing long-term rehabilitation, there remained great stress. Therefore, the aim of this study was to explore the predictors of resilience among burn patients in this major disaster. We conducted a cross-sectional, descriptive study in a medical center in northern Taiwan, with a total of 30 burn patients enrolled. Patients' demographics were collected, and the Resilience Scale and Perceived Stress Scale were administered. Multivariate statistical analysis by stepwise and linear regression was used to test these predictors of resilience. The results showed that perceived stress was the key predictor of resilience in the stepwise regression analysis and by adjusting variables including stress level,

[1]Tri-Service General Hospital, National Defense Medical Center, Taipei City, Taiwan, ROC
[2]Taipei Medical University, Taipei City, Taiwan, ROC

**Corresponding Author:**
Hsueh-Hsing Pan, Associate Professor, National Defense Medical Center, No. 161, Sec. 6, Minquan East Road, Neihu District, Taipei City 11490, Taiwan, ROC.
Email: pshing2001@gmail.com

gender, and education level. These results indicate that the stress level of burn patients should be determined first to provide more targeted methods for reducing stress and improving resilience.

**Keywords**
burn patient, stress, resilience, disaster

## Introduction

On June 27, 2015, a dust explosion occurred in Formosa Fun Coast, which has since been named the Formosa Fun Coast Explosion (FFCE). This resulted in nearly 500 burn casualties in young individuals. This is the first incident worldwide where multiple burn injuries were caused by a cornstarch explosion, which brought it to international attention. In this incident, 257 patients suffered more than 40% burns, with an average body surface area (BSA) of about 45%. Among these, 24 patients suffered more than 80% burns, which resulted in 11 fatalities. The average age of the casualties was between 18 and 24 years; the majority of these patients were all future productive workers in society (Ministry of Health and Welfare, 2015).

Although current medical care has been continuously improving and survival rates for burn victims have increased drastically, the suddenness of this unexpected and fatal major incident may affect patients in other aspects of their lives. This includes factors such as interpersonal relationships, overall functioning, quality of life, and social support, as well as increased medical expenses and social and economic losses (Martin, Byrnes, McGarry, Rea, & Wood, 2017). Furthermore, these burn patients also face physiological and psychological impacts during their long-term rehabilitation (Dahl, Wickman, & Wengstrom, 2012; Nicolosi, de Carvalho, Sabates, & Paggiaro, 2013).

Resilience refers to flexibility, toughness, and resistance to stress in humans or objects, which can rapidly recover to their original state after undergoing external stresses (Aburn, Gott, & Hoare, 2016). Not only a personality trait, resilience can be viewed as a process of actively adapting to adversity. It is also a type of ability, potential, or capacity to return to original life after encountering stress, danger, or disaster (Khanlou & Wray, 2014). Resilience is viewed as a driving force for positive development, a positive characteristic exhibited by individuals during adversity, and a successful dynamic adaptive capacity and process. It endows people with the ability to overcome hardships, handle stress, recover from trauma, regain self-control, or develop healthy response behaviors (Aburn et al., 2016; Davydov, Stewart, Ritchie, & Chaudieu, 2010; Khanlou & Wray, 2014).

Previous studies have found that patients with good resilience can effectively increase their adaptability and quality of life (Kool, Geenen, Egberts, Wanders, & Van Loey, 2017). Many factors may affect resilience, such as gender, subjective well-being, self-concept, self-esteem, and family resources (He, Cao, Feng, Guan, & Peng, 2013; Jang, Park, Chong, & Sok, 2017; Khanlou & Wray, 2014; Masood, Masud, & Mazahir, 2016; Wu, Chang, Tsai, & Liang, 2018). There are many studies on resilience, but these have mainly been focused on chronic disease patients such as dialysis (Freire de Medeiros et al., 2017), Parkinson's disease (Robottom et al., 2012), cancer (Wu et al., 2018; Wu, Liu, Li, & Li, 2016), and major trauma (Teche et al., 2017), as well as on caregivers (Inci & Temel, 2016; Palacio, Krikorian, & Limonero, 2018; Saria et al., 2017). However, little is known about the resilience of burn patients who have suffered major burn accidents in the past. Therefore, this study intended to explore the relevant factors affecting resilience in burn patients who had experienced the FFCE. This study found relevant factors that effectively predicted the resilience of these burn patients, which can provide possible approaches for improving the resilience of patients and assist patients in adapting to adversity, so that they can return to society and work earlier.

## Method

### *Study Design and Participants*

This study used a cross-sectional, descriptive study design to investigate the relevant factors for resilience in FFCE burn patients. Burn patients who were receiving medical treatment in the general ward of a medical center in northern Taiwan from August to December 2015 were selected as study participants. The inclusion criteria were patients who were aged over 18 years, had experienced burns due to the FFCE, had received medical treatment in general ward, were fully conscious, did not have a mental illness, had the permission of medical staff, could communicate with the researcher in Taiwanese or in writing, and agreed to participate in this study. The exclusion criteria were patients who were aged less than 18 years, had experienced burns not due to the FFCE, did not receive medical treatment in general ward, were unconscious, had a mental illness, did not have the permission of medical staff, could not communicate with the researcher in Taiwanese or in writing, or refused to participate in this study. Patients who met the inclusion criteria were provided with information about the objectives and procedures of the study. After written informed consent was gained from each patient, the researcher collected data via questionnaires. The data were anonymous and confidential. This study was reviewed and approved by the Research Ethics Committee of the Institutional Review Board (2-104-05-145). A flowchart

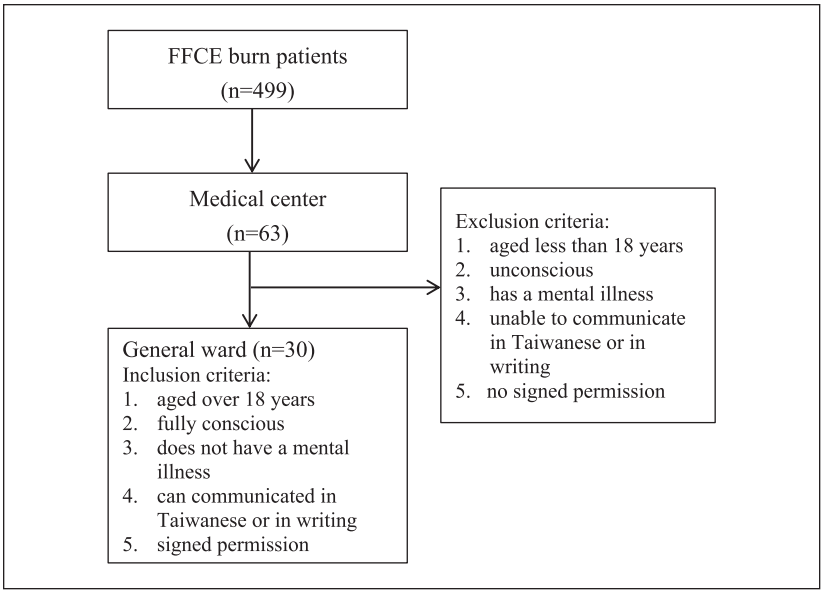


**Figure 1.** Flowchart of the enrollment of the study participant.
*Note.* FFCE = Formosa Fun Coast Explosion.

with the enrollment of the study participants is shown in Figure 1. A total of 30 patients provided informed consent and completed the questionnaires. The response rate was 100%. The power of this study was estimated to be 75% with an effect size of 0.5 and the $p$ value of .05.

## *Instruments*

The instruments used in this study included the patients' demographics, Resilience Scale (RS), and Perceived Stress Scale (PSS).

The patients' demographics included age, gender, education level (college, university/2-year technical school, master, or PhD), marital status (single, married, or other), religion (yes or no), occupation (student or nonstudent), income source (self-employed or other), BSA, depth of burn, other injury sustained in this accident (limb amputation, nerve damage, tendon injury, fractures, or inhalational burns).

RS was developed by Wagnild and Young (1993) and mainly measures the resilience of an individual's psychometric aspect. The scale is divided into two dimensions: "individual ability" and "self-acceptance and life," with a total of 25 questions. Each item is ranked on a scale of 1 to 7 (where 1 = "strongly

disagree," whereas 7 = "strongly agree"). The total score of the scale ranges from 25 to 175 points, with a higher score indicating better resilience. A score of ⩾147 indicates high resilience, a score of 121 to 146 indicates moderate resilience, and a score of ⩽120 indicates low resilience. The internal consistency reliability of RS, tested with Cronbach's alpha, was .91. Concurrent validity showed high correlations of RS with life satisfaction, morale, and depression (Wagnild & Young, 1993). This scale is widely used internationally (Bhamani, Pasha, Karmaliani, Asad, & Azam, 2015; Coelhoso, Garcia Del Castillo, Marzo, Dias, & Castillo-Lopez, 2017; Jang et al., 2017; Navarro-Abal, Lopez-Lopez, & Climent-Rodriguez, 2018) and has been translated into Taiwanese for use in trajectories of regenerating family resilience in 54 adolescents with cancer, the Cronbach's alpha was .947 (Chen, 2013). In this study, we used the Taiwanese version with the participants, and the Cronbach's alpha was .928.

PSS was developed by Cohen, Kamarck, and Mermelstein (1983). Participants' subjective feelings toward stress in life in the past 1 month are measured on a 5-point scale (with 0 = "never," 1 = "occasionally," 2 = "sometimes," 3 = "usually," and 4 = "always"). There are 14 questions in total, with questions 4, 5, 6, 7, 9, 10, and 13 being negative questions. After the scores were summed in the negative direction for these negative questions, the scores for the remaining questions were added directly. A higher score indicates higher perceived stress in the participant. The internal consistency of the scale was measured using Cronbach's alpha value, which was .85. This scale has been used internationally in different situations, with a Taiwanese version translated and revised by Chu and Kao (2005). In this study, the value of Cronbach's alpha was used to analyze reliability in the participants and was found to be .789.

Content validity was established by a panel of five experts, all working within the field of burn care. The expert panel rated each item of the instruments on relevance, accuracy, and applicability on a scale of one to five. The content validity index (CVI) for each item was calculated by dividing the number of experts who rated an item 4 or 5 by the total number of experts. The average CVI across the items in this study was 0.95.

## Statistical Analysis

The data were coded and analyzed by IBM SPSS Statistics for Windows, Version 20.0 to conduct statistical analysis, with $p < .05$ being used to determine statistical significance. Descriptive statistics were described for the distribution of categorical variables using frequency and percentages, continuous variables using mean and standard deviation, and normality using the Kolmogorov–Smirnov (K-S) test. Parametric statistics, including the Pearson

product–moment correlation, was used to analyze the relationship between continuous variables and resilience. An independent sample *t* test was used to analyze the relationship between two categorical variables and resilience. One-way ANOVA was used to analyze the relationship between three categorical variables and resilience, and any statistically significant results were verified using Scheffe's post hoc test. Nonparametric statistics, including Kendall's tau coefficient, Mann–Whitney U test, and Kruskal–Wallis test, were also used in this study. Multivariate statistical analysis by stepwise and linear regression was used to test these predictors of resilience. In addition, variance inflation factor (VIF) was used to measure of the amount of multicollinearity in a set of multiple regression variables.

## Results

A total of 30 burn patients from the FFCE were recruited for this study. Their mean age was 22.8 years (range: 18.0-35.0 years, normality K-S test: $p = .137$), and there were 19 men (63.3%). Most patients were university or 2-year technical students (76.7%), who were single (96.7%); 53.3% had religious beliefs, 53.3% were students, and 60.0% were self-employed. The average BSA of the patients was 45.0% (range: 8.8%-80.0%, normality K-S test: $p = .489$), with 70% of the patients having third-degree burns and 26.7% of the patients having nerve, tendon, or inhalation damage. Table 1 summarizes these results in detail.

The mean resilience score of the participants was 132.7 points (range: 98-168 points, normality K-S test: $p = .964$) with 75.8% of total scores. When the participants were divided into high ($\geqslant$147 points), moderate (121-146 points), and low ($\leqslant$120 points) resilience, 46.6% of participants were found to have moderate resilience. The mean stress level of the patients was 25.4 points (range: 10-50 points, normality K-S test: $p = .985$) with 45.4% of total scores. Table 2 summarizes these results in detail.

The resilience and stress levels were negatively correlated the participants (Pearson correlation $= -.72$, $p < .001$; Kendall's tau coefficient $= -0.53$, $p < .001$). The resilience and education levels showed significant differences in independent sample *t* test ($p = .044$), but no statistical significance in nonparametric method of Mann–Whitney U test ($p = .059$). These details are shown in Table 3.

The predictors of resilience in burn patients are shown in Table 4. The level of stress was found to be an important predictor of resilience; every 1-point increase in stress level decreased resilience by 1.69 points in the stepwise regression analysis of Model 1 ($p < .001$, VIF $= 1.00$, $R^2 = .525$) and 1.58 points by adjusting variables including stress level, gender, and education level of Model 2 ($p < .001$, VIF $= 1.01 \sim 1.06$, $R^2 = .583$).

**Table 1.** Demographics and Burn Severity of Patients From the FFCE ($N = 30$).

| Variable | *N* | % | *M* ± *SD* | Median | K-S test *p* value |
|---|---|---|---|---|---|
| Age | 30 | | 22.8 ± 4.3 | 22.0 | .137 |
| Gender | | | | | |
| Male | 19 | 63.3 | | | |
| Female | 11 | 36.7 | | | |
| Education level | | | | | |
| College | 7 | 23.3 | | | |
| University or 2-year technical school | 23 | 76.7 | | | |
| Marital status | | | | | |
| Single | 29 | 96.7 | | | |
| Separated | 1 | 3.3 | | | |
| Religious belief | | | | | |
| Yes | 16 | 53.3 | | | |
| No | 14 | 46.7 | | | |
| Occupation | | | | | |
| Student | 16 | 53.3 | | | |
| Nonstudent | 14 | 46.7 | | | |
| Source of income | | | | | |
| Self | 18 | 60.0 | | | |
| Others | 12 | 40.0 | | | |
| BSA (%) | | | 45.0 ± 16.4 | 40.0 | .489 |
| Depth of burn | | | | | |
| Second-degree | 7 | 23.3 | | | |
| Third-degree | 21 | 70.0 | | | |
| Fourth-degree | 2 | 6.7 | | | |
| Accompanying damage | | | | | |
| No | 22 | 73.3 | | | |
| Yes | 8 | 26.7 | | | |

*Note.* K-S = Kolmogorov–Smirnov test, $p > .05$ represented normal distribution; BSA = body surface area; FFCE = Formosa Fun Coast Explosion.

## Discussion

The results of this study showed that the mean resilience level of the participants was 132.7 points, with 75.8% of total scores. In the study by Jang et al. (2017), who used a similar scale, the resilience percentile score of burn patients in South Korea was 70.0%. We found that most of the burn patients in the previous study were of an older age, had no family caregiver, and had physical dysfunction in performing daily activities. Otherwise,

**Table 2.** The Level of Resilience and Perceived Stress in Burn Patients From the FFCE ($N = 30$).

| Variable | *N* | % | $M \pm SD$ | Median | K-S test *p* value |
|---|---|---|---|---|---|
| Resilience (25-175 points) | 30 | | 132.7 ± 20.3 | 129.5 | .964 |
| High resilience (⩾147 points) | 8 | 26.7 | | | |
| Moderate resilience (121-146 points) | 14 | 46.6 | | | |
| Low resilience (⩽120 points) | 8 | 26.7 | | | |
| Stress level (0-56 points) | 30 | | 25.4 ± 8.7 | 25.5 | .985 |

*Note.* K-S = Kolmogorov-Smirnov test, $p > .05$ represented normal distribution.
FFCE = Formosa Fun Coast Explosion.

the participants in this study were younger and had a family caregiver. Furthermore, following this major explosion accident in Taiwan, the government provided financial assistance for victims' medical expenses, whether in acute or rehabilitation stage (Ministry of Health and Welfare, 2015). This reason may cause higher resilience levels in participants than those in the study by Jang et al. (2017). In several previous studies in Taiwan, the resilience percentile score of healthy adolescents was 76.4% (Chen, Chen, & Wong, 2014), adolescents with congenital heart disease (CHD) was 79.4% (Huang et al., 2018), and adolescents with cancer was 70.1% (Wu et al., 2018). These results are difficult to compare with one another because the study participants faced different situations. In this study, the score of burn patients was found to be lower than adolescents with CHD, but higher than adolescents with cancer. In some situations, burn patients may experience repeated debridement or grafting, or face deformities in their appearance, psychological changes, and uncertainty for the future (Sainsbury, 2009). Adolescents with CHD may have undergone medical treatment or surgical correction early in childhood; thus, they may have positive perceptions of themselves (Apers et al., 2013). However, adolescents with cancer may suffer from a series of treatments, worsening physical function, an impacted appearance, negative emotional response, and even dealing with death (Chen et al., 2014; Wu et al., 2018). These different health outcomes may account for the different resilience levels.

The results of this study showed that the mean stress level was 25.4 points, with 45.4% of total scores. A population-based study indicated that people aged over 53 years in Taiwan received a stress percentile score of 25.9% (Glei et al., 2013). The study participants, all burn patients from the FFCE, were young individuals with an average age of 23 years. Most of them were

**Table 3.** Relevant Factors That Affect Resilience in Burn Patients From the FFCE ($N = 30$).

| Variable | *M* | *SD* | Pearson/ Kendall's $\tau$ coefficient | *p* value parametric/ nonparametric test |
|---|---|---|---|---|
| Stress level | | | −.72/−.53 | <.001/<.001 |
| Age | | | .08/.09 | .336/.493 |
| Gender | | | | .734/.061 |
| Male | 133.7 | 20.0 | | |
| Female | 131.0 | 21.8 | | |
| Education level | | | | .044/.059 |
| College | 119.3 | 14.6 | | |
| University or 2-year technical school | 136.8 | 20.3 | | |
| Marital status | | | | .343/.272 |
| Single | 132.0 | 20.4 | | |
| Separated | 152.0 | – | | |
| Religious belief | | | | .671/.755 |
| Yes | 131.2 | 23.6 | | |
| No | 134.4 | 16.5 | | |
| Occupation | | | | .320/.279 |
| Student | 129.2 | 21.0 | | |
| Nonstudent | 136.7 | 19.5 | | |
| Source of income | | | | .994/.932 |
| Self | 132.7 | 20.0 | | |
| Others | 132.7 | 21.7 | | |
| BSA (%) | | | −.16/−.10 | .200/.473 |
| Depth of burn | | | | .170/.169 |
| Second-degree | 136.3 | 25.0 | | |
| Third-degree | 129.2 | 18.4 | | |
| Fourth-degree | 156.5 | 6.4 | | |
| Accompanying damage | | | | .819/.870 |
| No | 133.2 | 20.8 | | |
| Yes | 131.3 | 20.4 | | |

*Note.* Parametric test such as Pearson product–moment correlation, *t* test or one-way ANOVA, nonparametric test such as Kendall's $\tau$ coefficient, Mann–Whitney U test, or Kruskal–Wallis test. BSA = burn surface area.

still school students who would have had a bright future. Physical deformities, and learning or job difficulties, can cause individual and concurrent psychiatric and emotional distress in burn patients (Chou, 2016). Therefore,

**Table 4.** Predictors of Resilience in Burn Patients From the FFCE ($N = 30$).

| Independent variable | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | β [95% CI] | VIF | β [95% CI] | VIF |
| Stress level | −1.69 [−2.31, −1.07]*** | 1.00 | −1.58 [−2.20, −0.96]*** | 1.06 |
| Gender | | | | |
| Male/female | — | | 5.00 [−5.86, 15.86] | 1.01 |
| Education level | | | | |
| University or 2-year technical school/college | — | | 10.61 [−2.10, 23.31] | 1.06 |
| $R^2$ | .525 | | .583 | |
| Adjusted $R^2$ | .508 | | .534 | |

*Note.* Model 1 used regression analysis by stepwise. Stress level was the only one significant variable. Model 2 used regression analysis by adjusting variables including stress level, gender, and education level. CI = confidence interval; VIF = variance inflation factor; FFCE = Formosa Fun Coast Explosion.
***$p < .001$.

psychosocial screening and follow-up for burn patients are important, mostly to avoid developing emotional distress or mental illness, especially, posttraumatic stress disorder (PTSD; McLean et al., 2017).

This current study also found that stress level is an important predictor of resilience: the higher the level of stress, the lower the resilience in patients. The research revealed that there was a negative correlation in resilience and psychological distress of patients with burns in Pakistan (Masood et al., 2016), and a positive correlation in resilience and subjective well-being with burn patients (He et al., 2013). Huang, Chen, Cheng, and Sung (2014) conducted a study on patients with chronic mental illness, and their results showed that resilience was negatively correlated to stress. An integrative review identified three key themes, including encompassing relational strengths, positive coping, and resistance to trauma symptoms, that were fundamental constructs associated with developing and sustaining resilience (Kornhaber, Bridgman, McLean, & Vandervord, 2016). Patients with a higher resilience level usually have a more positive attitude and actively adopt response strategies to solve immediate frustrations. These individuals confront life with an optimistic attitude, are independent, have self-control, and low severity of PTSD symptoms (Masood et al., 2016; Quezada, Gonzalez, & Mecott, 2016). Besides being an important element in predicting the recovery of patients from illness or disability, resilience can also assist patients when facing the impacts of disease; it is a

result of being well adjusted, which can enable patients to pass smoothly through their lives' low points (He et al., 2013).

The participants in this study were burn victims from the FFCE, a major disaster in Taiwan, who were treated in a medical center in northern Taiwan. The study was limited to the inclusion of FFCE burn victims who were still hospitalized in the general ward for treatment, 3 months after being burned. By this stage, patients remaining in hospital for treatment were mostly moderate to severe burn patients. This might have led to an underestimation of the stress levels of these burn patients prior to the study. We surveyed the participants during the period of 3 to 5 months after the explosion due to research ethics issues (Research Ethics Committee of Institutional Review Board approval). Some patients had discharged already, which resulted in enrollment difficulties, and the number of cases in this study was therefore small. The small sample size limited the inference and representation of this study's results. We suggest that future studies could recruit other burn patients to understand the relationship between stress and resilience. In addition, this study used a cross-sectional and descriptive study design. However, resilience is a dynamic and multifaceted concept; thus, it is impossible to make inferences for long-term results. We suggest that long-term follow-up of resilience in burn patients can be conducted in the future to better understand the trends in changes in resilience and to increase the depth and breadth of this research.

## Conclusion

This study found that the stress levels in burn patients from the FFCE could effectively predict their resilience. As they undergo changes in their disease condition, these patients are required to undergo long-term rehabilitation and face changes in their body and mental image; therefore, they experience stresses that are uncommon. We thus need to know the stress levels of the burn patients first, and then provide methods for reducing stress, improving resilience, and assisting patients in adapting to adversity, so that they can return to society and work earlier.

### Acknowledgments

The authors are grateful to the participants in the study. We also thank the staff of the Department of Nursing for their dedicated help and assistance with participant recruitment.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by grants from the Taiwan Nurses Association (TWNA-1052025).

## ORCID iD


Hsueh-Hsing Pan https://orcid.org/0000-0002-9020-3279

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## Author Biographies

**Ya-Lin Chen**, MSN, RN, is a supervisor of Department of Nursing, Tri-Service General Hospital, National Defense Medical Center in Taiwan. She is major in emergency and burn care.

**Ming-Hsiu Lu**, MSN, RN, is a head nurse of Burn Ward, Department of Nursing, Tri-Service General Hospital, National Defense Medical Center in Taiwan. She is major in burn care.

**Ling-Tzu Weng**, MSN, RN, is a supervisor of Department of Nursing, Tri-Service General Hospital, National Defense Medical Center in Taiwan. She is major in critical care.

**Chin Lin**, PhD, is an assistant professor of School of Public Health and Graduate Institute of Life Sciences, National Defense Medical Center in Taiwan. He is a statistical expert.

**Ping-Wei Huang**, MS, has finished his master degree in School of Public Health, National Defense Medical Center in Taiwan. He is a statistical expert.

**Chih-Hsin Wang**, MD, is an attending physician, Division of Plastic and Reconstructive Surgery, Department of Surgery, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan.

**Hsueh-Hsing Pan**, PhD, RN, is an associate professor and major in cancer care, palliative care, critical care and education in nursing staff. She works at the School of Nursing, National Defense Medical Center in Taiwan.