



# Using Linear Regression to Identify Critical Demographic Variables Affecting Patient Safety Culture From Viewpoints of Physicians and Nurses

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## Abstract

**Background:** The issues of patient safety and healthcare quality have become increasingly important around the world since the 1990s. Many hospitals manage to reduce the number of adverse events (AEs) that can threaten patient safety in healthcare organizations. Assessing the existing patient safety culture gives hospital management a clear vision of an organization's strengths and weaknesses. The Safety Attitudes Questionnaire, with its good psychometric properties and great internal consistency, has been used extensively to assess the patient safety culture in healthcare organizations.

**Objective:** Physicians and nurses form the core staff of each organization. With different demographic variables, they might perceive patient safety culture differently. This study purposed to identify critical demographic variables from the viewpoints of physicians and nurses that significantly influence the patient safety culture in a regional teaching hospital in Taiwan.

**Methods:** Linear regression with forward selection was employed in this study to focus on all physicians and nurses using results of a 2015 internal survey in the case hospital. Ten demographic variables were the independent variables, and seven dimensions of the Chinese version of the Safety Attitudes Questionnaire were dependent variables.

**Results:** Four out of 10 demographic variables had significant impacts on 6 out of 7 dimensions (with the exception of emotional exhaustion) from the Safety Attitudes Questionnaire. "Supervisor/manager" and "experience in position" followed by "age" were viewed by physicians and nurses as the most critical variables affecting the patient safety culture in this regional teaching hospital in Taiwan.

**Conclusion:** Assessing an organization's current patient safety culture provides a significant value to improving patient safety. This study revealed that "supervisor/manager" and "experience in position" are the 2 most important demographic variables influencing the patient safety culture. Hospital management should take heed of the suggestions of staff members regarding these characteristics to continuously enhance their patient safety culture.

**Keywords:** Patient Safety, Linear Regression, Physicians, Nurses

## 1. Background

The issues of patient safety and healthcare quality have become increasingly important across the world since the 1990s. Many hospitals manage to reduce the occurrence of adverse events (AEs) which are common in healthcare organizations. AEs due to a defective system or human negligence are enormous threats to patient safety. Previous studies in several countries have shown that approximately half of all AEs are considered preventable.<sup>1</sup> Some healthcare initiatives or policies have been implemented to enhance the quality of healthcare. The National Patient

Safety Agency in England advocated that healthcare organizations establish a "patient safety culture" which focuses on lessening and preventing harm to patients during the delivery of healthcare.<sup>2,3</sup>

A high level of patient safety results in positive assessments of care by patients.<sup>4,5</sup> Patient safety culture is defined as "the values shared among organization members about what is important, their beliefs about how things operate in the organization, and the interaction of these with work unit and organizational structures and systems, which together produce behavioral norms in the organization

that promote safety.”<sup>6</sup> International institutions such as the Institute of Medicine (IOM) and the Joint Commission are encouraging healthcare organizations to assess patient safety and reinforce medical quality through safety culture surveys. Assessing the existing patient safety culture allows management to have a clear vision of an organization’s strengths and weaknesses.

Various measures have been created for gauging a patient safety culture. The Safety Attitudes Questionnaire (SAQ), developed by Sexton et al, possesses good psychometric properties and great internal consistency for healthcare workers in many settings.<sup>7-9</sup> The SAQ was derived from the Flight Management Attitudes Questionnaire and retained 25% of it.

The SAQ has been validated in different languages and is recommended as an effective tool for use in patient safety assessment.<sup>7,9-15</sup> The Joint Commission of Taiwan (JCT) developed the Chinese version of the SAQ (SAQ-C) using forward and backward translation. The intelligibility and item applicability of the questionnaire was confirmed by an expert panel.<sup>15</sup> JCT modified the original questionnaire from six dimensions and 30 items to nine dimensions and 41 items. The 3 added dimensions (hospital management support for patient safety, teamwork across hospital units, and hospital handoffs and transitions) were integrated into the questionnaire. The SAQ-C current in 2014 retained 6 dimensions of the original SAQ and combined 2 new aspects, “emotional exhaustion” and “work-life balance”.

**Table 1.** Chinese Version of the 2014 Safety Attitudes Questionnaire

Teamwork Climate	1. Nurse input is well received in this clinical area. 2. In this clinical area, it is difficult to speak up if I perceive a problem with patient care. 3. Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient). 4. I have the support I need from other personnel to care for patients. 5. It is easy for personnel here to ask questions when there is something that they do not understand. 6. The physicians and nurses here work together as a well-coordinated team.
Safety Climate	7. I would feel safe being treated here as a patient. 8. Medical errors are handled appropriately in this clinical area. 9. I know the proper channels to direct questions regarding patient safety in this clinical area. 10. I receive appropriate feedback about my performance. 11. In this clinical area, it is difficult to discuss errors. 12. I am encouraged by my colleagues to report any patient safety concerns I may have. 13. The culture in this clinical area makes it easy to learn from the errors of others.
Job Satisfaction	14. I like my job. 15. Working here is like being part of a large family. 16. This is a good place to work. 17. I am proud to work in this clinical area. 18. Morale in this clinical area is high.
Stress Recognition	19. When my workload becomes excessive, my performance is impaired. 21. I am less effective at work when fatigued. 25. I am more likely to make errors in tense or hostile situations. 26. Fatigue impairs my performance during emergency situations (e.g., emergency resuscitation, seizure).
Perceptions of Management	27. Management supports my daily efforts. 28. Management doesn’t knowingly compromise patient safety. 29. I get adequate, timely information about events that might affect my work. 30. The levels of staffing in this clinical area are sufficient to handle the number of patients.
Working Conditions	31. Problem personnel are dealt with constructively by our unit. 32. This hospital does a good job of training new personnel. 33. All the necessary information for diagnostic and therapeutic decisions is routinely available to me. 34. Trainees in my discipline are adequately supervised.
Emotional Exhaustion	20. I feel like I’m at the end of my rope. 22. I feel burned out from my work. 23. I feel frustrated by my job. 24. I feel I’m working too hard on my job. 35. I feel emotionally drained from my work. 36. I feel used up at the end of the workday. 37. I feel fatigued when I get up in the morning and have to face another day on the job. 38. Working with people all day is really a strain for me. 39. Working with people directly puts too much stress on me.
Work-Life Balance	40. I miss meals. 41. I have a hasty meal. 42. I work all day without break. 43. I change the individual or family plan because of work. 44. I cannot sleep well. 45. I sleep less than five hours at night. 46. I work overtime.

with nine and seven questions, respectively. The latest Chinese version is provided in Table 1.<sup>16</sup>

Relevant research revealed that having different demographic information will lead to different perceptions of patient safety among healthcare providers.<sup>2,17,18</sup> A study by Kim et al verified that nurses on the front line have more problems with patient safety than those who are older or who work in management positions.<sup>19</sup> Physicians and nurses form the core staff of each healthcare organization.<sup>17</sup>

### 2. Objective

They are the front line healthcare providers and have contact with patients at a high frequency. It would be of interest to observe how physicians and nurses with different demographic information perceive the patient safety culture. Therefore, this study aimed to identify the crucial demographic variables viewed by physicians and nurses as significantly influencing the patient safety culture in a regional teaching hospital in Taiwan.

### 3. Methods

This research was conducted in 2015 in a regional teaching hospital located in Taichung City, Taiwan. The studied hospital has all the major medical specialties and services and can admit approximately 700 patients. All the physicians and nurses in this hospital were invited to take part in the current study. After removing the invalid parentheses, the valid number of participants in this study was 376, comprising 42 physicians and 334 nurses. Data was collected internally in this case hospital through the 2014 SAQ-C from JCT which included 46 items that examine medical staff members' attitudes toward eight dimensions, i.e. teamwork climate, safety climate, job satisfaction, stress recognition, perceptions of management, working conditions, emotional exhaustion, and work-life balance. A 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree was used for responses for all dimensions except "work-life balance," which used a 4-point scale to measure the frequency per week. Because of its different scale, the analysis of "work-life balance" was excluded from this study. Unlike the other professional groups, physicians and nurses were asked to answer all question items. The demographics of gender, age, supervisor/manager, job position, job status, experience in organization, experience in position, education, and direct patient contact were taken into account for analyses.

Negatively-worded items (Items 2, 11, 20, 22, 23, 24, 35, 36, 37, 38, and 39) in this questionnaire were reverse scored. Individual questionnaire responses were aggregated by computing the score of the items for each dimension. The demographic variables were independent variables, while the score of each dimension was considered a dependent variable. To predict the dependent variables from predictor variables, this study employed linear regression with forward selection, which started with an empty set and continually added one attribute at a time. At each step, only the attribute which gave the highest performance was added into the selection. The model selection criteria of this technique were tractable and disclosed which

independent variable(s) (demographic variable(s)) were critical to a particular dimension.<sup>20</sup> All statistical analyses were carried out using SPSS software version 18.

**Table 2.** Demographic Information of the Studied Regional Teaching Hospital

Demographic Variable	No.	Percent
<b>Gender</b>		
1. Male	57	15.2
2. Female	319	84.8
<b>Age</b>		
1. Less than 20 years old	8	2.1
2. 21-30 years old	144	38.3
3. 31-40 years old	135	35.9
4. 41-50 years old	71	18.9
5. 51-60 years old	17	4.5
6. 61 years old and above	1	0.3
<b>Supervisor/Manager</b>		
1. Yes	39	10.4
2. No	337	89.6
<b>Respondents reporting events in the past 12 months</b>		
1. No	231	61.4
2. 1-5	127	33.8
3. 6-10	16	4.3
4. 11-15	2	0.5
5. More than 16	0	0.0
<b>Job Position</b>		
1. Physician	42	11.2
2. Nurse	334	88.8
<b>Job Status</b>		
1. Full Time	343	91.2
2. Contract	13	3.5
3. Part Time	6	1.6
4. Agency	14	3.7
<b>Experience in Organization</b>		
1. Less than 6 months	59	15.7
2. 6 to 11 months	10	2.7
3. 1 to 2 years	60	16.0
4. 3 to 4 years	50	13.3
5. 5 to 10 years	89	23.7
6. 11 to 20 years	96	25.5
7. 21 years or more	12	3.2
<b>Experience in Position</b>		
1. Less than 6 months	67	17.8
2. 6 to 11 months	9	2.4
3. 1 to 2 years	68	18.1
4. 3 to 4 years	58	15.4
5. 5 to 10 years	100	26.6
6. 11 to 20 years	68	18.1
7. 21 years or more	6	1.6
<b>Education</b>		
1. Junior High School or less	0	0.0
2. Senior High School	1	0.3
3. College/University	351	93.4
4. Graduate School or more	24	6.4
<b>Direct Patient Contact</b>		
1. None	10	2.7
2. Rarely	23	6.1
3. Very Often	343	91.2

#### 4. Results

Descriptive statistical analyses of respondents' demographic information presenting frequencies and percentages are depicted in Table 2. Women represented 84.8% of all the respondents. A total of 35.9% of respondents were within the age range of 31 to 40 years, while 38.3% of respondents were 21 to 30 years old. Most of them were not supervisors or managers (89.6%). During the 12 months preceding this study, more than half of them did not report any event (61.4%), and a third (33.8%) reported 1-5 events. A total of 91.2% of sample respondents had full-time jobs in this hospital. In addition, 25.5% of respondents had 11 to 20 years of experience in the organization, while 26.6% of them had 5 to 10 years of experience in their positions. The majority of respondents indicated that their work required them to have direct contact with patients (91.2%).

The results of the linear regression with forward selection are presented in Table 3 with  $\alpha = 0.05$ . The adjusted R-square values range from 0.048 to 0.138. Teamwork climate was negatively influenced by "supervisor/manager" and "experience in position," indicating that physicians and nurses who are not in charge are less satisfied, and physicians and nurses who have much more experience in their positions tend to be less satisfied as well. "Supervisor/manager" and "experience in position" had negatively impacts on the safety climate. That is, physicians and nurses who are not in charge and who have more experience in their positions are less satisfied.

"Supervisor/manager", "age", and "experience in position" are the 3 critical demographic variables affecting job satisfaction. Physicians and nurses who are in charge, elderly, or less experienced in their positions tend to have higher job satisfaction. Stress recognition is impacted by job position and supervisor/manager. Specifically, nurses tend to have less satisfaction in stress recognition.

"Supervisor/manager" and "experience in position" are the 2 essential demographic variables that negatively influence perceptions of management. Physicians and nurses who are not supervisors/managers and/or have much experience in their positions tend to have less

satisfaction in perceptions of management. The dimension of "working conditions" was impacted by "supervisor/manager", "experience in organization", and "age". Physicians and nurses who have much experience in the organization feel less satisfied. In contrast, employees who are elderly are more satisfied with their working conditions. Finally, the linear regression model could not be established between the dimension of "emotional exhaustion" and ten demographic variables. By further examining the correlation between "emotional exhaustion" and the demographic variables, the *P* values ranging from 0.067 to 0.976 indicate that there is no correlation between them if  $\alpha$  is set to 0.05.

The correlation of seven dimensions and critical demographic variables is shown in Table 4. In summary, physicians and nurses who are not supervisors/managers feel less satisfied with the teamwork climate, safety climate, job satisfaction, stress recognition, perceptions of management, and working conditions. Employees who have much experience in their positions tend to be less satisfied with the teamwork climate, safety climate, job satisfaction, and perceptions of management. In addition, employees who have much experience in an organization are less satisfied with the working conditions. On the other hand, physicians have less stress than nurses. Finally, older employees tend to have a high satisfaction with their jobs and working conditions.

The coefficients of most explanatory variables were negative, clarifying that the respondents who were supervisors/managers and who had much experience in their positions had the greatest effect on the patient safety culture in this investigation. Healthcare workers who were supervisors/managers in this hospital indicated a higher level of satisfaction on the SAQ-C with the teamwork climate, safety climate, job satisfaction, stress recognition, perceptions of management, and working conditions. Healthcare workers with less experience in their positions in this hospital were inclined to have better perceptions of the teamwork climate, safety climate, job satisfaction, and perceptions of management. Nevertheless, "age" was the

**Table 3.** Linear Regression With Forward Selection of 7 Dimensions

	Demographic Variable	Unstandardized Coefficients	Standardized Coefficients	<i>t</i>	<i>P</i>
Teamwork climate	Supervisor/ Manager	-4.170	-0.289	-5.702	0.000
	Experience in position	-0.319	-0.126	-2.479	0.0014
Safety climate	Supervisor/ Manager	-5.292	-0.327	-6.507	0.000
	Experience in position	-0.312	-0.109	-2.179	0.030
Job satisfaction	Supervisor/ Manager	-3.861	-0.282	-7.025	0.000
	Age	1.042	0.236	5.119	0.000
	Experience in position	-0.508	-0.213	-4.646	0.000
Stress recognition	Job position	-1.672	-0.155	-3.033	0.003
	Supervisor/Manager	-1.614	-1.45	-2.834	0.005
Perceptions of management	Supervisor/Manager	-2.805	-0.296	-5.934	0.000
	Experience in position	-0.390	-0.234	-4.698	0.000
	Supervisor/Manager	-2.861	-0.292	-5.461	0.000
Working conditions	Experience in position	-0.533	-0.318	-5.472	0.000
	Age	0.447	0.137	2.242	0.0026

**Table 4.** Summary of 7 Dimensions and Critical Demographic Variables

	Teamwork Climate	Safety Climate	Job Satisfaction	Stress Recognition	Perceptions of Management	Working Conditions	Emotional Exhaustion
Age			+			+	
Supervisor/Manager	-	-	-	-	-	-	
Job position				-			
Experience in organization						-	
Experience in position	-	-	-		-		

only positive demographic variable. It is worth mentioning that job position had some bearing on patient safety culture.

**5. Discussion**

This study utilized the SAQ-C to assess the patient safety culture and identify the crucial demographic variables from the viewpoints of 376 physicians and nurses in 2015. Linear regression with forward selection was applied to analyze the data; results indicated that the predictor variable “supervisors/managers” was the most important variable for the respondents in this research.

Employees who serve as supervisors/managers had greater perceptions on all of the dimensions. In other words, the supervisors or managers who are the promoters of establishing a patient safety culture may have increased the outcome of this survey. According to some studies, leaders are the ones who understand current safety issues thoroughly and are able to create a patient safety culture.<sup>21,22</sup> They have a better comprehension of the patient safety culture than others. Their recognition of the patient safety culture will be changed whether or not the hospital policies are practiced well. The dimensions in SAQ-C are jointly related. The overall performance of the patient safety culture is affected by such recognition. Furthermore, some researchers do validate that leadership is associated with safety outcomes.<sup>23</sup> A leader can have an immense effect on individual employee behaviors in relation to safety.<sup>24</sup> Hospital management should make appropriate interventions to enhance a leader’s effectiveness in engaging their subordinates’ commitment.

The demographic variable “experience in position” demonstrated a negative influence on the teamwork climate, safety climate, job satisfaction, and perceptions of management. Therefore, employees with less experience in their positions had a higher satisfaction with these four dimensions than those with ample experience. These results contrast with those of Khater et al who explored nurses’ perceptions of the patient safety culture.<sup>25</sup> Their study indicated that the higher the number of total years of experience is, the better the nurse’s perception of the patient safety culture will be. Comparing the current study with the research conducted by Khater et al<sup>25</sup> highlighted some reasons that may have led to the diverse results. First, different measurement tools were used. Instead of the SAQ, Khater et al employed a hospital survey on patient safety culture developed by the Agency for Healthcare Research and Quality (AHRQ). Second, there is disparity in the sample size. Third, the current study surveyed physicians

and nurses, while nurses were the only respondents in Khater and colleagues’ study.

In the current study, “experience in organization” was shown to have a negative impact on working conditions. Respondents who had less experience in the organization had more satisfaction with the patient safety culture. A research regarding nurses from Korea also showed that nurses with fewer years of work experience at the present hospital held more positive views about the safety culture.<sup>19</sup>

Different age groups revealed diverse perceptions of the patient safety culture. The older healthcare workers in this hospital tended to have a greater patient safety culture. This result was also supported by a research in South Australia.<sup>26</sup> It can be inferred that older respondents may have a greater possibility of working in a better working environment, which will increase their perceptions of the patient safety culture. Another explanation might be an old ethic from Asian culture. In the Chinese traditional culture, maintaining harmony is always the top priority in the workplace; this tradition may cause staff members to conceal their true thoughts. Apparently, this might not be happening with the younger generation.

It should be noted that job position only influenced stress recognition. That is, physicians had a better recognition of stress than nurses in this teaching hospital. Considering some aspects from the dimension “stress recognition” on the SAQ, it is interesting to note that this dimension differs slightly from the others. The other dimensions inquire about behaviors that are related to other people in the workplace, while stress recognition focuses on respondents themselves, e.g., personal behaviors. When respondents are inclined to approve the items of stress recognition, that demonstrates how stress affects their work performance. Without a doubt, negative emotions will increase the possibility of workplace deviations. Some organizations or companies do not allow personal emotions to be brought to work, especially negative ones. The regulations or organizational culture mentioned above will affect the replies of respondents.

One possible solution to relieving negative emotions for physicians and nurses is to provide for them the mindfulness-based stress reduction program created by Dr. Jon Kabat-Zinn in 1979, building up the “positivity currency” of the staff, or establishing “appreciative inquiry” groups.<sup>18</sup> The general purpose of this program is to teach staff how to deal with stress, pain, and illness. In addition, when individuals focus on positive attitudes toward interactions, life events, and memories, and express their gratitude, “positivity currency” can be

printed and stored as assets. That is, maintaining a positive outlook and regularly expressing gratitude are the real values needed for employees to build resilience. Finally, “appreciative inquiry” is a model to cultivate employees in self-determined changes. Praising staff members for their past successful experiences is positive encouragement for employees to enthusiastically enhance resilience and a positive psychology toward negative emotions.

## 6. Conclusion

Many countries are making major efforts to enhance patient safety, and healthcare organizations have been encouraged to assess the existing culture in recent years. Such an assessment would provide significant values for enhancing the perceptions of the patient safety culture. It would give hospital management the clues they need to identify flaws in their hospitals and redesign systems if necessary. The current study revealed that “supervisor/manager” and “experience in position” followed by “age” are the most important demographic variables influencing the patient safety culture from the viewpoints of physicians and nurses.

Hospital management should heed the advice of staff members regarding these characteristics. Programs can be established for pioneering patient safety and keeping track of the outcomes from a survey based on the SAQ-C once a year to continuously improve the patient safety culture for healthcare organizations. Specific activities such as a mindfulness-based stress reduction program, positivity currency, or appreciative inquiry groups can be applied to teach physicians and nurses how to strengthen resilience and positive psychology toward negative emotions. Finally, the patient safety culture as viewed by the staff should be tracked on a yearly basis to monitor performance trends in order for healthcare organizations to provide a better healthcare environment for their patients.

## Authors' Contributions

All authors contributed equally to this research.

## Conflicts of Interest Disclosures

Hsin-Hung Wu received financial support from the Ministry of Science and Technology in Taiwan with the grant number of MOST 105-2221-E-018-015. For the remaining authors, none were declared.

## Ethical Approval

The clinical trial approval certificate (ethic statement) was approved by Cheng Ching General Hospital in Taichung, Taiwan with protocol number HP150029.

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## Research Highlights

### What Is Already Known?

Based on a literature review, few studies (maybe none) have used each dimension of the Safety Attitudes Questionnaire as the outcome of linear regression and ten demographic variables as input variables from the viewpoints of physicians and nurses.

### What This Study Adds?

The major contribution of this pilot study is the use of a regional teaching hospital as a case study to show that the relationship between each dimension and ten demographic variables can be established using linear regression with forward selection. In doing so, critical demographic variables that have significant impacts on each dimension were identified. Hospital management in this case hospital can use the results to take actions to improve the patient safety culture. Moreover, the authors believe that this philosophy can be further applied to other healthcare organizations worldwide when the patient safety culture is the focus.

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