Investigating patient safety culture across a health system: multilevel modelling of differences associated with service types and staff demographics

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Abstract

Objective. To use multilevel modelling to compare the patient safety cultures of types of services across a health system and to determine whether differences found can be accounted for by staffs’ professions, organizational roles, ages and type of patient care provided.

Design. Application of a hierarchical two-level regression model.

Setting. All services in the South Australian public health system.

Participants. Approximately half of the health staff (n = 14 054) in the 46 organizations, classified into 18 types of service, which made up the South Australian public health system.

Interventions. Staff completed the Safety Attitudes Questionnaire.

Main Outcome Measures. Attitudes regarding Teamwork Climate, Safety Climate, Job Satisfaction, Stress Recognition, Perception of Management and Working Conditions in participants’ workplaces.

Results. All SAQ indices showed statistically significant although modest variations according to service type. However, most of these differences were not accounted for by the differences in the demographic composition of services’ staff. Most favourable safety attitudes were found in the breast screening, primary/community health services, community nursing and metropolitan non-teaching hospitals. Poorer cultures were reported in the psychiatric hospital, mental health, metropolitan ambulance services and top-level teaching hospitals. Demographic differences in safety attitudes were observed; particularly, clinical, senior managerial, aged care and older staff held more favourable attitudes.

Conclusions. Differences in staff attitudes have been demonstrated at a macro-level across the type of health services but for the most part, differences could not be explained by staffing composition.

Keywords: multilevel modelling, patient safety, health systems, health services, staff attitudes, safety climate and culture

Introduction

Research into patient safety by its nature is multifaceted. Many studies have focused on the identification of causes of adverse incidents which are associated with substantial morbidity and mortality world-wide [1, 2]. The identification of causes of unsafe care has implied, and led to considerable research into, methods for decreasing patient harm [3, 4]. Strategies have been promulgated through safety improvement programmes developed for staff in health organizations or systems. Taking steps to address patient safety in services necessitates ways of identifying those that are potentially less safe and assessing whether safety improvement interventions or programmes have been effective. A range of assessment tools have been developed to measure aspects of the culture of healthcare settings [5, 6] that are believed to be associated with better patient safety [7, 8]. Some such as the Patient Safety Attitudes Questionnaire (SAQ) [8] and Hospital Survey...
on Patient Safety Culture (HSOPS) [9] have received favourable recommendations [5, 6]. Such tools can be used to assess the safety culture of services, of units and staff groups within services and changes over time.

The application of such tools has led to considerable knowledge about variation in attitudes towards patient safety associated with particular groups of healthcare staff. Many significant professional differences have been found between doctors’ and nurses’ views [10, 11] and between these professions and allied health personnel [12, 13]. Comparisons of the safety perceptions of direct care or clinical staff with those of staff providing indirect care, e.g. administrators, have also revealed significant differences. Singer et al. [14] found more problematic attitudes among clinical staff, while Braithwaite et al. [15] reported the reverse. Organizational role has also been linked to safety attitudes. Staff with a senior managerial role perceived seven patient aspects of safety culture more positively than did other managers who in turn held more positive views than non-managerial staff [16]. Some researchers have reported interactions between such factors, e.g. between organizational role and being a clinician or non-clinician [14]. Thus, the staff mix associated with particular services may be an important contributing factor to differences between their safety cultures.

However, as many of the demographic characteristics of health practitioners are correlated and associated with the features of the organization to which they belong, ascertaining their relative contributions to variations in safety culture has proven to be difficult. Such clarification would enable the identification of which factors contribute most to, for example, managerial performance or clinical outcomes. This process has been assisted by the development of multilevel modelling which is employed in the present study. Such statistical techniques extend regression analysis to hierarchical data so that estimates of variance may be partitioned for each level of the model. For example, this has been applied to find the separate contribution of both demographic variables and geographic region to the incidence of heart disease [17]. Deilkas and Hofoss [18] modelled the SAQ responses of staff in wards, units and departments in a Norwegian hospital. Most variation was found at the ward level. Smits et al. [19] modelled the responses of the HSOPS of staff in hospital units in the Netherlands and reported similar results.

Health systems comprised many types of services, with diversity in their patient populations, organizational structure, offered services, clinical protocols and goals, e.g. breast screening and mental health services, community-based care and hospital inpatient care, and the demographic characteristics of staff vary markedly across services. To our knowledge, differences in the safety culture between service types across a health system have not been examined. The aim of this study was to investigate whether safety culture varies according to the type of service in a large healthcare system. If such differences occur, to what extent are they explained by the demographic characteristics of staff working in these facilities, or are they independent of these? The answer to this question has implications for policy, particularly as to the type of interventions applied to improve safety culture in health systems.

Methods

Sample and setting

In 2009, Braithwaite et al. conducted an online survey of the attitudes towards patient safety of the public health workforce in the state of South Australia (SA, population 1.6 million) at the request of SA Health, which is responsible to the state government for public health services. All staff in services within the state were invited to participate and 52% (n = 16 619) did so. Some staff’s answers were only partially recorded due to computer problems. The remaining 14 054 fully recorded questionnaires made up the sample used in the present study. SA Health identified the 46 services which comprised the public health system. These were then grouped into 18 service types (Table 1). Staff from every unit and facility in all service types participated in the survey.

It should be noted that some services are organized at the state level, e.g. dental services and breast screening, while others operate independently in a number of the four health areas of the state, e.g. mental health services. Dental services in the SA public health system are only provided to schools and some pensioner groups. Most of the population attend private dentists. There is only one dedicated psychiatric hospital in the state. The emphasis is on community-based treatment (via the mental health services), and while there is a psychiatric ward in some hospitals, staff who worked there reported the hospital as their place of work in the survey. It was not possible to calculate the relative return rate from different services which probably varied for a range of reasons, e.g. enthusiasm of managers in promoting the survey, ease of computer access and staff morale.

Questionnaire

The questionnaire included the SAQ [8], which was modified slightly, e.g. substituting ‘patients/clients’ for ‘patients’ to match Australian usage, adding six additional items of interest to SA Health (which did not contribute to SAQ scores). The validity and reliability of the SAQ has been demonstrated and its six-factor model of attitudes relevant to patient safety has been demonstrated by confirmatory factor analysis [8]. It is one of the three safety culture assessment tools recommended by the European Union Network for Patient Safety [6]. Of the 13 tools compared by Singla et al. [5], the SAQ covers more aspects of patient safety as well as being one of only two that provide benchmarking data. The SAQ factors are Teamwork Climate (perceived quality of collaboration between staff), Safety Climate (perception of strong organizational commitment to safety), Job Satisfaction (positive feelings about work experience), Stress Recognition (acknowledgement of the influence of stressors on work performance), Perceptions of Management (approval of managerial action) and Working Conditions (perceived quality of work environment). Respondents’ scores on these factor scales range from 1 (unfavourable) to 5 (favourable) attitudes.
The questionnaire collected demographic information including respondents’ work stream (providing direct or indirect patient care), professional or occupational group, age, service in which they spent most of their work hours and organizational role. The optional answers to these questions are listed in Table 1. Participants indicated that they provided direct care by agreeing that they had ‘direct responsibility for or interaction with patients’ or indirect care by agreeing that they did not ‘have direct contact or interaction with patients but have a responsibility for patient care’. Members of the direct work stream (e.g. nurses, doctors) made up 68.2% of the sample. The remaining 31.8% of staff belonged to the indirect care stream (e.g. administrative/clerical staff).

Table 2 shows the demographic composition of staff in the service types.

Only limited information was available about non-respondents. The response rate for nurses was 46% and for doctors 35% of those employed by SA Health (not taking into account those on leave at the time of the survey). On average, 94% of direct and 87% of indirect care staff completed all items contributing to each SAQ scale, suggesting that indirect care staff found the questionnaire more difficult to answer and that indirect care staff may have been less likely to participate in the survey. As staff self-selected whether they were direct or indirect care providers, the participation rate of the two groups could not be determined.

Analysis

Multilevel models recognize the existence of data hierarchies and have become a preferred method to examine variations in outcomes across institutions, providers and other relevant groups [20]. In this study, we formulated a two-level model which allows for grouping of survey outcomes within services (Table 1). ‘Level 1’ comprised individual participants, characterized by their age group, profession, organizational role and whether they provided direct or indirect care of patients. ‘Level 2’ consisted of the 18 types of health services.

The parameters of this two-level regression model were estimated using SAS PROC MIXED [21]. They contain information about the mean of the score over all participants.
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<td>23.6</td>
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<td>33.7</td>
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<td>86.4</td>
<td>66.3</td>
<td>34.1</td>
<td>54.8</td>
<td>80.0</td>
<td>75.5</td>
<td>85.7</td>
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<td>76.4</td>
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<td>86.4</td>
<td>66.3</td>
<td>34.1</td>
<td>54.8</td>
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<td>2.4</td>
<td>1.3</td>
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<td>4.2</td>
<td>1.5</td>
<td>3.0</td>
<td>5.3</td>
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<td>7.1</td>
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<td>6.1</td>
<td>9.2</td>
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<td>70.6</td>
<td>77.2</td>
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<td>8.7</td>
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<td>12.1</td>
<td>22.4</td>
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<td>3.2</td>
<td>2.0</td>
<td>6.9</td>
<td>7.6</td>
<td>1.0</td>
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<td>71.2</td>
<td>3.0</td>
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<td>0.8</td>
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<td>0.0</td>
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<td>28.2</td>
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<tr>
<td>Allied: diagnostic/tech.</td>
<td>1.3</td>
<td>0.1</td>
<td>1.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
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<td>0.3</td>
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<td>0.6</td>
<td>0.1</td>
<td>1.4</td>
<td>0.0</td>
<td>0.5</td>
<td>17.6</td>
<td>4.5</td>
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<td>1.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>3.2</td>
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<td>1.2</td>
<td>7.9</td>
<td>0.0</td>
<td>4.5</td>
<td>2.7</td>
<td>0.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Aged care worker</td>
<td>0.0</td>
<td>0.3</td>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
<td>28.2</td>
<td>3.5</td>
<td>0.0</td>
</tr>
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<td>Dentist</td>
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</table>

Table 2 Distribution of participant characteristics across types of service (in %)
and services, the fixed effects of the level 1 explanatory variables and the level 1 and level 2 residuals which relate to the variance across participants and services, respectively. Since explanatory variables are categorical, a dummy variable was created for each category. We can then describe the outcomes by an individual participant as a combination of participant-level effects and service-level effects, each described by a distribution with its own variance component.

**Results**

**The empty model**

We sought to answer the question: is there any evidence for a service-based pattern of safety attitudes? In other words, do safety attitudes or cultures cluster by type of service? We started with the ‘empty’ model, i.e. without any explanatory variables. One way of quantifying this answer is to compute the unconditional intraclass correlation (ICC), which gives the percentage of the total variance that is associated with differences between services.

Table 3 displays mean scores, raw total variances, services variances and ICC estimates for all six SAQ indices. Average scores ranged between 3.47 and 3.92. Variability among participants was associated with variances of 0.44–0.73, with the lowest being for Safety Climate scores and greatest for Working Conditions. ICC was the highest for the measurement of Perception of Management (6.24%, \( P = 0.0034 \)). Stress Recognition, on the other hand, had a very small institutional variance, with an ICC of 1.02% and the least significant \( P \)-value of 0.0199.

**Fixed effects model: level 1**

We then proceeded to add level 1 fixed regression parameters. Given that we had found a statistically significant clustering of outcomes by service type, we wanted to know if this clustering was attributable to the different demographic characteristics of staff in each service, or due to other unexplained factors. Additionally, which demographic variables had a significant impact in the differences observed between the services?

The level 1 explanatory variables were: healthcare stream, age group, profession and organizational role. The distribution of these variables across service types is shown in Table 2; all demographic variables were significantly related to service types (\( P < 0.0001 \)). There were large differences in the proportions of direct vs. indirect healthcare providers between facilities, with Regional Offices, Pathology Services and Breastscreen having much higher proportions of non-clinical workers compared with the ambulance and prison health services. Similarly, distributions of other staff characteristics varied considerably among service types. Since the number of dummy explanatory variables was very large, a method of LASSO selection [22] was used in order to choose (for each outcome) the model that best explained the observed values per SAQ dimension. Similar results (not shown here) were achieved using the related LAR method [23]. Collinearity diagnostics was performed by estimating the variance inflation of the level 1 explanatory variables included in each model. In all cases, values of the variance inflation factor remained smaller than 10. Also, large changes in the estimated regression coefficients, when a new regression coefficient was added, were not found. These procedures indicate that the degree of collinearity was not very high. The resulting regression coefficients for each model are shown in Table 4. In general, executives and to some extent senior managers, older staff particularly those aged over 60, aged care staff and ‘other health workers’ expressed more favourable attitudes. Staff providing indirect care displayed less favourable safety attitudes than those providing direct care. Among the professional groups, doctors expressed relatively higher Stress Recognition but unfavourable assessment of Management scores low. ‘Other staff’ had lower Stress Recognition and Teamwork Climate scores.

<table>
<thead>
<tr>
<th></th>
<th>Teamwork Climate</th>
<th>Safety Climate</th>
<th>Job Satisfaction</th>
<th>Stress Recognition</th>
<th>Perception of Management</th>
<th>Working Conditions</th>
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<td>Raw mean</td>
<td>3.85</td>
<td>3.91</td>
<td>3.92</td>
<td>3.65</td>
<td>3.47</td>
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<td>0.44</td>
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<td>0.65</td>
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<td>0.73</td>
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<tr>
<td>Institutional variance</td>
<td>0.012 (0.0057)</td>
<td>0.021 (0.0041)</td>
<td>0.031 (0.0037)</td>
<td>0.007 (0.0199)</td>
<td>0.043 (0.0034)</td>
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<tr>
<td>ICC (%)</td>
<td>2.31</td>
<td>4.72</td>
<td>4.75</td>
<td>1.02</td>
<td>6.24</td>
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<td>( R^2 )</td>
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<td>0.030</td>
<td>0.018</td>
<td>0.027</td>
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<td>Institutional variance</td>
<td>0.011 (0.0066)</td>
<td>0.020 (0.0046)</td>
<td>0.028 (0.0042)</td>
<td>0.004 (0.0598)</td>
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<td>(P-value)</td>
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<td>ICC (%)</td>
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<td>Demographic variables</td>
<td>Effect</td>
<td>Estimate</td>
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<td>( P &gt;</td>
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Only parameters with \( P < 0.01 \) are displayed.

\( \alpha \): two-tailed \( P \)-value corresponding to a \( t \)-statistic and associated degrees of freedom.
The ICCs for the fixed model (Table 3) were calculated. Comparison of the differences between unconditional values (ICC in the empty model) and conditional values (ICC in the model with fixed regression parameters) were small for five of the safety factors, indicating that the differences between attitudes across these services could not be explained by workforce characteristics. The exception was Stress Recognition; almost half of the variance (37%, see Table 3) was explained by workforce composition. Stress Recognition scores were the highest for staff from the professions of pharmacy, medicine and nursing/midwifery and were lower for participants over 60 years of age, ‘other health workers’, ‘other staff’ and administrative/clerical staff.

Figure 1 shows the level 2 scores for the six indicators of patient safety attitudes. It provides a ranking of services according to their SAQ scores after accounting for demographics. The services with the most favourable safety attitudes were Breastscreen, other metropolitan hospitals, primary/community health care and the Royal District Nursing Service. The service types with the lowest scores on the safety factors were the psychiatric hospital, the metropolitan ambulance and mental health services, and top-level teaching hospitals.

Discussion

Initial examination of the results of the multilevel modelling showed that there were statistically significant, albeit relatively modest, differences between the safety cultures associated with the various types of services that made up a defined healthcare system. To our knowledge, this has not previously been demonstrated. The variance in safety cultures explained by the model was the highest for the Perception of Management and least for the Teamwork Climate and Stress Recognition scales of the SAQ. Examination of the types of services with more or less favourable safety cultures showed that those delivering care at a community level tended to have more positive safety score profiles, e.g. district nursing services, primary/community care and Breastscreen. The psychiatric hospital and mental health services were among those with more negative safety cultures. There was also a

![Figure 1](https://academic.oup.com/intqhc/article-abstract/24/4/311/1795494/317)

*Figure 1* Safety culture differences across Services: a ranking of services types according to their SAQ scores after accounting for demographics. Level 2 scores for each of the six SAQ indicators are displayed in order of increasing average score (bottom to top).
clustering of larger hospitals at the less favourable end of the scale, e.g. both groups of teaching hospitals and the Women’s and Children’s Hospital. The smaller hospitals (other metropolitan and country hospitals), which offer a less specialized range of services, had more positive cultures. A metropolitan–country divide was also apparent with the metropolitan ambulance services having much less positive safety cultures than rural services. The latter have strong community links in that large proportions of their personnel are rostered volunteers.

Larger more complex health services, such as hospitals that clustered at the negative end of the safety culture dimension, have been found in other studies to reveal considerable variation across units within the organization [18, 19]. Smits et al. [19] suggested therefore that safety interventions should focus on small units within a hospital. However, researchers comparing safety cultures across hospitals have identified organizational characteristics such as a hierarchical culture as having a negative effect on safety culture [24, 25]. They stress the importance of reducing this through strategies such as team development, particularly at a multidisciplinary level; this is of importance for policy and management. A question of interest is the extent to which our model can be generalised. Do facilities found to have more or less favourable safety attitudes in the SAQ system reflect the safety cultures of similar facilities in other health systems?

The results revealed that most of the differences found between services’ SAQ scores could not be explained in terms of the demographic characteristics of the staff working in the various service types. Thus, there was little support for the research hypothesis that the differences in safety attitudes that many studies have found to be associated with health professionals’ demographic characteristics would account for differences in the safety cultures of various types of health service. Nonetheless, when aggregated, small but significant differences in safety attitudes were found to be associated with all four staff demographic characteristics investigated. Close to half (37%) of the low amount (1.02%) of Stress Recognition scores that could be explained by the model was attributable to staff demographics, as were 11% of Perception of Management and 10% of Job Satisfaction scores. Very little of the variance of Working Conditions and Safety Climate scores could be predicted from staff characteristics. Many of the differences found were consistent with findings of previous research into the safety attitudes of various groups of healthcare workers, as outlined in the Introduction section, e.g. executives and senior managers expressed most favourable attitudes. As Table 4 shows the profession, organizational role, age and type of healthcare provided by staff were significantly associated with scores of all SAQ scales with the exception of Perception of Management (which was not associated with health stream) and Stress Recognition (which was associated only with profession and age).

The more favourable attitudes found among ‘other health workers’, and to a lesser extent unfavourable attitudes of ‘other staff’, led to the investigation of the likely membership of these groups. These optional answers to the question about professional membership were included particularly for allied health participants whose specific occupation was not listed (but who might not consider that they belonged to allied health; usually defined as the direct healthcare professions distinct from medicine, dentistry and nursing) and for staff who did not believe that they provided even indirect patient care. Dental services had a high proportion of ‘other health workers’ (29.4% of staff, see Table 4). It seems likely that these were dental assistants who did not class themselves as belonging to allied health; perhaps because in Australia, unlike some other countries, they are not eligible for membership of the allied health professions’ peak association. There were high concentrations of ‘other health workers’ in primary/community healthcare services (13.1% of staff) and mental health services (9.3%). Many of these staff were probably social workers or psychologists. Their lack of identification as allied health may be due to the fact that large proportions of their fellow professionals do not work in healthcare. ‘Other staff’ were concentrated in regional offices, country and rehabilitation hospitals (12.8–10.8% of staff).

Given that the SAQ is a frequently used measure of health safety cultures, it is of interest to consider some aspects of the Stress Recognition scale which may illuminate why it performs differently from other SAQ scales. When a respondent agrees with items assessing Stress Recognition, e.g. ‘I am less effective at work when fatigued’, it is an acknowledgement of how stressors affect personal performance. Respondents recognize their limitations and potential for making errors. However, none of the items on the scale yield information about the degree to which stressors impinge on respondents in their present workplace. Stress Recognition items differ from those in other SAQ scales in that they assess self-behaviour while other SAQ scales focus mainly on behaviours of others in the respondent’s workplace and how these affect the respondent, e.g. staff teamwork, management’s performance and working conditions. Thus, the Stress Recognition scale assesses personal reactions which seem likely to remain relatively constant as a practitioner moves across workplaces. Support for the notion that the Stress Recognition scale measures a qualitatively different characteristic comes from an examination of the correlations between all respondents’ SAQ scores. There were moderate-to-high positive correlations between scores on all factors except Stress Recognition which had correlations of between −0.13 and −0.10 with the other five factors.

To obtain information as to the degree to which stressors are being encountered by staff in a facility, other SAQ scores also need to be examined. For example, a facility characterized by staff with low scores on Safety Climate, Teamwork Climate, Job Satisfaction and Perception of Management and Working Conditions suggests a very stressful environment. It would be of value to compare the work performance in such a workplace of staff with higher and lower Stress Recognition scores. Some health workers seem to deny that the stress of excessive workloads, fatigue or tension at work increases their likelihood of making errors because such sentiments are at variance with the older ethic that ‘good’ health
practitioners do not allow their feelings to affect performance. Thus, the finding that staff aged 60 years or more had lower Stress Recognition scores than their younger colleagues may be a generational effect due to this notion becoming out-dated, with increasing recognition of the role stress plays in performance errors. Additionally, the potential for making serious errors is clearly higher in the work practices of some professions. Members of such professions might be expected to have higher Stress Recognition scores. Their professional education and exposure to the consequences of colleagues’ errors probably contribute to their Stress Recognition. As Table 4 shows, some professions, notably pharmacy, medicine and nursing/midwifery, contributed to the regression equation for Stress Recognition. Policymakers’ attention might usefully be focused on how stress among health professionals manifests and is managed.

The generalizability of the findings to other health systems may prove to be limited. Other health systems may classify their services differently from does SA Health. The number of staff in different services and the organizational multiplicity and complexity of the different services varied markedly. Future research might attempt to include such variables at a third level of the model though the idiosyncrasies underlying the categorization of health services present difficulties. A limitation of the study was that the representativeness of the samples from the various services which were compared could not be established and probably varied between services.

Conclusion

Types of health service within this large health system can be differentiated to a significant but limited extent by their safety cultures with more community-based and less complex services having the most positive cultures. Most of the variance found between SA Health services was not attributable to the demographic mix of their staff members. The organizational composition and characteristics of services such as hierarchical structure may contribute to safer cultures.

Ethics approval

Ethics approval was granted for the patient safety climate survey study from the South Australian Department of Health’s Human Research Ethics Committee on 24 July 2008.

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References


