JMVH

Volume 19 Number 3 July 2011
Journal of Military and Veterans' Health

- Occupational Health and Safety
- Cultural Religious Coping and Mental Health
- Asylum Seeker Health

The Journal of the Australian Military Medicine Association

AMMA MEMBERSHIP

Become an AMMA Member and receive a welcome gift and certificate plus receive the *Journal of Military and Veterans' Health* quarterly.

To become an AMMA Member contact the AMMA Secretariat:

P: 03 6234 7844

E: secretariat@amma.asn.au

www.amma.asn.au

Table of Contents

Cover photo: HMAS Tarakan – courtesy of Department of Defence.

Journal of Military and Veterans' Health

Australian Military Medicine Association

STATEMENT OF OBJECTIVES

The Australian Military Association is an independent, professional scientific organisation of health professions with the objectives of:

- Promoting the study of military medicine
- Bringing together those with an interest in military medicine
- Disseminating knowledge of military medicine
- Publishing and distributing a journal in military medicine
- Promoting research in military medicine

Membership of the Association is open to doctors, dentists, nurses, pharmacists, paramedics and anyone with a professional interest in any of the disciplines of military medicine. The Association is totally independent of the Australian Defence Force.

ISSN No. 1835-1271

Inside this edition

Welcome to the second of our themed editions, the focus of this issue being on occupational health and safety in the military context. Themed articles look at physiotherapy on active service, load carrying in female soldiers, injury prevention, and ultraviolet radiation exposure and melanoma. They are supported by other excellent articles on veterans' health in Sri Lanka, military healthcare in Tarun Kowt, asylum seeker health and the medical aspects of the loss of HMAS *Sydney* II.

The next issue (October 2011) will look at tropical diseases of operational significance and I am also expecting some excellent articles in this Issue. In July 2011, the Editorial Board agreed to the themes for 2012, which will be 'Heat and Cold in the Military' (January 2012), 'History of developments in Military Medicine' (April 2012); 'Mental Health' (July 2012) and 'Veterans' Health' (October 2012). We would welcome papers in all these themed areas and would encourage authors to start thinking now of what manuscripts they could contribute. As always, other articles on military and veterans' health topics are most welcome.

Finally, we are anticipating that we will move shortly to our ScholarOne online manuscript submission system, which will streamline our submission and peer review process. More information on the new system will be sent out to all members shortly. We would encourage members to familiarise themselves with the system, as authors or peer reviewers, when it becomes available.

Captain Andy Robertson, CSC

Editor-in-Chief

President's message

Welcome to the latest edition of JMVH, this spring edition finds the AMMA Conference committee busily put the finishing touches to the next AMMA conference to be held at the Melbourne Conference Centre on the 21-23 October. The conference is special as it marks the 20th annual conference for the Association and already the bookings have been strong. It will also be the last opportunity for many of us to congratulate and express our appreciation to the Commander of Joint Health Command, MAJGEN Paul Alexander AO and the Surgeon General Health Reserves Geoff Rosenfeld AM before their retirement. On behalf of the committee and members of AMMA I would like to thank them for their continued support and leadership through the challenging years of reorganizing and establishing the Joint Health Command.

The conference seems to go from strength to strength and is now recognised throughout the region and the world as one of the premier military health conferences and this year will, I am sure, enhance that reputation. Already we have two keynote speakers who are likely to stimulate lively and thought provoking comments. MAJGEN Molan AO is a well know former military leader and author in Australia who has a wealth of deployment and military educational experience and Professor Ryan was Joint Professor of Military Surgery at the Royal Army Medical College, London and Royal College of Surgeons of England. His war and disaster medical experience covers military and humanitarian operations in Northern Ireland, Cyprus, the Falkland Islands, Nepal, the Balkans, the Caucasus and Central Asia.

Our Journal's reputation, too, seems to be gathering place with a reported increase in article submissions which I have no doubt will increase the quality of articles. The committee is strongly supportive of the Journal as it believes that it performs an important function for its membership, ADF members, veterans' community as well as the wider community.

Looking forward to catching up with as many members as possible during our 20th Anniversary Conference.

Greg Mahoney

President

Mental health and cultural religious coping of disabled veterans' in Sri Lanka

Piyanjali de Zoysa, PhD[1] and Thulitha Wickrama, PhD[2]

Abstract

This study examined the prevalence of post traumatic stress disorder (PTSD) and Center for Epidemiological Studies Depression (CES-D) depressive symptoms, their association with previously untested supportive resources such as Buddhist religious activities, Buddhist bodhipuja rituals and horoscope readings for 45 recently wounded veterans in Sri Lanka. The results revealed an 85.4% prevalence rate of clinical levels of CES-D depression and a 42.2% prevalence rate of clinical levels of PTSD. The results of this study provide unique evidence for the significant role of Buddhist religious activities, the cultural activity of horoscope reading, and the support of family and friends in reducing the depressive symptoms in disabled veterans. Moreover, with the present study we were able to conclude that the support of family and friends reduced both perceived depressive symptoms and the PTSD symptoms of wounded veterans.

Introduction

The recently concluded ethnic conflict in Sri Lanka took thousands of lives, displaced thousands of families and severely damaged the economy and infrastructure. The exposure to war-related trauma has led to mental disorders among both Sri Lankan civilians and combatants alike (Miller & Rasmussen, 2010). The impact of such trauma exposure increases the impact of secondary stressors such as family conflicts and negative events, leading to increased mental health problems (Wickrama & Wickrama, 2008; 2010). While the immediate impact of war exposure on mental health can be severe for a significant portion of victims, mental health problems can persist for several years. For instance, nearly a decade after experiencing war, a group of combatants and civilians showed a 10% prevalence of depression (Basoglu et al., 2005).

Trauma research has well documented the influence of psychological and social resources to help in reestablishing feelings of self esteem, a sense of control and giving social support for the mental health of combatants (Aldwin et al., 1994; Basoglu et al., 2005; Desmond & MacLachlan, 2006). Studies have also shown that while military service exposes individuals to war trauma, it also has a positive influence on personal resources such as mastery and coping skills, which have been shown to moderate the negative influence of trauma on mental health (Aldwin et al., 1994). Conversely, the loss of a sense of control has been shown to increase the vulnerability to mental disorders such as PTSD and depression (Basoglu et al., 2005). While there is considerable research on the ability to cope following trauma and stress, less is known about the role of specific cultural and religious strategies available for trauma victims in traditional societies. Moreover, there is a significant dearth in knowledge of indigenous healing techniques that may have the ability to reduce post traumatic mental health problems.

Using a sample of disabled veterans in Sri Lanka (N=45), the present study examines the prevalence of mental illness alongside the practice of cultural and religious methods allowing the veterans to overcome the emotional trauma. In particular, the unique influences of Buddhist religious practice, Buddhist religious rituals, Sri Lankan cultural practices and the support of family and friends on PTSD and the depressive symptoms of physically disabled (wounded) veterans are examined.

Religiosity as a Coping Strategy

Among war veterans, after controlling for social support and the personal interpretation of their experiences, religious practices have been shown to have a significant influence on their mental health, particularly for PTSD symptoms (Aflaksier & Coleman, 2009). Hence, religiosity may serve as an effective coping resource among those exposed to war-related trauma (Drescher et al., 2007). Religiosity, broadly defined, involves religious beliefs, faith, spiritual practices and religious participation. An increase in religious participation, such as prayer, has been associated with exposure to war trauma (Ai et al., 2005) and a belief in god has been shown to be negatively associated with depression (Naelys et al., 2009). Also veteran survivor guilt, which is known to contribute to the severity of PTSD and depressive symptoms, has been shown to be relieved to some extent by religious faith (Khouzam & Kissmeyer, 1997). In contrast, weakened religious faith has been associated with the increased use of mental health services (Fontana & Rosenheck, 2004).

Buddhist Beliefs. Religious beliefs can give meaningful interpretations to stressful events. Exline et al. (2005) showed that 80% of traumatized individuals used religion to give meaning to their negative experiences, with an eventual increase in positive mood. The Buddhist concepts of impermanence (Anitta in Pali) and the reaping

of the consequences of one's own previous actions (Karma in Pali), even those of previous lives, provides an avenue for contextualizing personal war-related experiences (De Zoysa & Weerasinghe, 2000). It has been shown that the greater the trauma, the greater it is associated with a belief in Karma (Davidson et al., 2004). Some studies have shown that a belief in Karma is significantly more prevalent among those with greater trauma exposure than for those with less exposure (Davidson et al., 1994). However, findings on Karma as a coping strategy are mixed; some studies have shown that a belief in Karma is associated with poorer health, such as that among Sri Lankan Buddhists exposed to the tsunami (Levi et al., 2009). These findings warrant further investigation as to the role of the belief in Karma as a coping mechanism. The present study indirectly captures these beliefs through reports of religiosity.

Buddhist Religious Participation. Buddhist religious participation can be either through mental exercises such as meditation or through other practices including Bodhipuja, prayers, sermons, and chanting.

Meditation. Meditation has shown to decrease PTSD among youth exposed to war trauma (Gordon et al., 2004). Among Vietnam war veterans, transcendental meditation has been shown to significantly reduce the severity of their PTSD and depressive symptoms (Hankey, 2007). Increasingly, mental health programs have started to recognize the importance of these spiritual practices and have adapted these to suit the mental health needs among various client populations (i.e., among substance abusers, among those with unexplained medical symptoms including depression; De Zoysa, in press; Simpson et al., 2007; Somasundaram, 2002).

Some Buddhist practices are similar to Western psychotherapeutic methods, such as the cognitive behavioural methods that have been shown to be effective in reducing the psychological ramifications of trauma (Fernando, 2004). For instance, the Buddhist practice of identifying maladaptive thoughts and consciously modifying them to reflect reality (Bodhi, 2000) share similarities with the second wave of cognitive behavioral therapy (CBT), which emphasizes the importance of maladaptive information processing in the production of a mental illness (Beck, 1976).

Moreover, the Buddhist practice of mindfulness meditation has had an influence on the third wave of CBT with the advent of Acceptance and Commitment Therapy (Hayes et al., 1999), Dialectical Behavior Therapy (Dimeff & Linehan, 2001) and Mindfulness-Based Cognitive Therapy (Segal et al., 2002) which draws heavily from the Buddhist practice of mindfulness meditation. In these therapies, the use of this type of meditation has at its ultimate aim the alleviation of psychological distress and/or promotion of psychological well-being (Kabat-Zinn, 1990; Segal et al., 2002). CBT's third wave of therapy aims to enhance attention towards the current experience, increase receptive awareness and attention, disengage individuals from automatic thoughts, and assist in acceptance of the current situation whilst taking mindful action towards the desired change as appropriate (Segal et al., 2002).

While these specific therapies are not examined in the present study, they attest to the similarity between Buddhist meditation and some psychotherapies. The present study examines the influence of these meditation techniques through individual reports of participation in Buddhist religious activities, most of which have meditating components.

Buddhist Rituals. Bodhipuja is a Buddhist ritual - a religious activity often conducted for the emotional and devotional needs of an individual in association with a stressful event. Bhodipuja has been shown to ease the transition of war veterans into civilian life and has helped to give them a sense of physical and emotional healing (De Silva, 2006). A study of a tsunami-exposed Buddhist sample in Sri Lanka found that 40% of the participants found it helpful to engage in Bodhipuja as a coping strategy for dealing with their trauma experience (Hollifield et al., 2008). Building on these previous studies, the present study will examine if this practice is also useful in decreasing mental illness resulting from war-related trauma.

Cultural Practices. A horoscope, widely used and believed in the study population, is an astrologically based document written specifically for an individual that forecasts his or her life experiences. A horoscope may be interpreted by an astrologer to indicate that the war exposure was pre-determined, unavoidable, and out of one's control. In this regard, the belief in one's horoscope allows an individual to attribute this negative experience and the associated symptoms to one's 'bad period' in life. As, according to astrology, these 'bad periods' come and go, the believer is given hope that this 'bad' traumatic period will pass and better times will come (Tribe, 2007). Moreover, horoscope readers also provide remedies for these 'bad periods' (e.g. wearing gem stone rings) that are believed to protect the individual during that specific time. Thus this belief in a horoscope may provide greater inner strength to persevere through a difficult life period. The present study will examine the unique effects of this coping strategy in reducing mental illness in a sample of war trauma exposed veterans.

Social Support and Religiosity. Gaining social support has been shown to decrease depression among veterans (Desmond & MacLachlan, 2006). Religiosity has been shown to both directly and indirectly (by improving social support) affect mental health (Koenig, 2001). For instance, while religiosity has shown an independent influence on depressive symptoms it has also been linked to gaining social support (Bosworth et al., 2003). Lack of social support, a younger age, and lower socio-economic

status (SES) have all been linked to greater risk of PTSD (Brewin et al., 2000). Greater social support from family is associated with the greater use of coping mechanisms via a greater perceived hope among veterans (Irving et al., 1997). Religiosity and cultural beliefs appear to have an influence on post trauma depressive symptoms independent of the social support from the family (Bosworth et al., 2003). Thus, while the beneficial effects of social support in reducing post traumatic mental illness are well known, the present study will examine the unique influence of Buddhist religiosity and cultural practices as strategies over and above the influence of social support.

Methods

Sample, Sampling and Data Collection Procedure. Sri Lanka (formerly known as Ceylon) is an island of 66,000 square kilometers lying off the south-eastern tip of India. No fewer than ten separate ethnic groups, of varying sizes, can be distinguished in present day Sri Lanka. This includes the Veddas, a small group of primitive tribesman who have preserved their own distinctive social organization and technology and various immigrant groups (e.g., Mongoloids, Europeans, Indo-Aryans) who have arrived at different times throughout its history. However, the two principal ethnic groups in the country are the Sinhalese, who tend to be Buddhist and constitute approximately 74% of the population, and the Tamil minority who are largely Hindu and reside in the North and East of the country, forming approximately 18% of the population. Sinhala is the official language in the country, but Tamil is also a national language. English is spoken by about 10% of the population and is commonly used for official purposes. Sri Lanka has a mixture of religions with Buddhist (68%), Hindu (15%), Christian (8%) and Muslim (8%).

Sample Demographics. The present study was conducted among 45 disabled male soldiers of the Sri Lankan Army infantry wounded within a few years of data collection. They were residing in a facility for disabled soldiers. All 45 participants indicated that they participate in Buddhist religious activities. The average age of the sample was 26.48 (range from 18 to 42), while the average education level was 10th grade (64%). 66% of participants were unmarried.

Veterans who were on treatment for active symptoms of a mental illness were not included in the study, nor were those veterans who could not write (due to a hand/wrist related disability). The survey questionnaire was administered to the group by the principal investigator. Multiple regression analysis using SPSS 18.0 was used to investigate the influence of coping strategies on the mental health of wounded veterans.

Measures

Control Variables. *Disability* was assessed by calculating the mean composite of the three item Sheehan Disability Inventory (Sheehan, 1983), measuring the severity of disability at home, at work, and socially. Each item was scored on a 10 point Likert type scale ranging from 0 (not at all impaired) to 10 (very severely impaired). Age was assessed by asking the age of the participant veteran. Education was assessed by asking the highest level of schooling they completed on a Likert type scale ranging from 1 (no school at all) to 6 (university education).

Coping Strategies

Family support, Buddhist religious activities, Buddhist bodhipuja rituals, and horoscope readings each served as single item indicators of psychosocial, religious, and cultural coping strategies for veterans. PPrevious use of the translated version of these items in mental health studies involving Sinhalese Buddhist samples exposed to trauma indicated that the translated items maintained adequate psychometric properties (Wickrama & Wickrama, 2008; 2010).

Family Support was assessed using the single item "how much did family member support help you recover from post war stressful feelings and symptoms." The respondents indicated the degree of helpfulness ranging from 0 (not at all) to 3 (very helpful). This measure was adapted from Portes & Rumbaut (2001) that assessed mutual support and cohesion among family members. *Buddhist Religious Activities* were assessed using the single item "how much did religious activities help you recover from post war stressful feelings and symptoms." The respondents indicated the helpfulness ranging from 0 (not at all) to 3 (very helpful). *Buddhist Bodhipuja Rituals* were assessed using the single item "how much did Bodhipuja activities help you recover from post war stressful feelings and symptoms." The respondents indicated the helpfulness ranging from 0 (not at all) to 3 (very helpful). *Horoscope Readings* was assessed using the single item "how much did horoscope readings help you recover from post war stressful feelings and symptoms." The respondents indicated the helpfulness ranging from 0 (not at all) to 3 (very helpful).

To compute the subsample of non-practising Buddhists, the question item was then asked "How often do you practice your religion" . The respondents indicated their frequency of practice on a range from 1 (never) to 5 (daily). Those that answered 1 and 2 were used to compute the non-practising Buddhists subsample, while to compute the practising Buddhists subsample, those that answered 3, 4, and 5 were used.

Mental Health

Depressive Symptoms was assessed using the 20 item Center for Epidemiological Studies Depression (CES-D)

scale (Radloff, 1977). The respondents indicated their frequency of experiencing depressive feelings (1 = rare to 4 = most of the time) to items such as: "could not shake off the blues even with help from my family and friends," "trouble keeping my mind on what I was doing," "everything I did was an effort," "my life had been a failure," and "fearful." Summed scores for the composite measure of a participant could range between 0 and 60. Previous use of the English version of the CES-D in various studies indicated that the measure possesses good psychometric properties (Wickrama & Bryant, 2003). The use of translated versions of the CES-D in cross-cultural mental health studies including Sinhalese Buddhist samples exposed to trauma also indicated that translated forms maintain adequate psychometric properties (Noh et al., 2007; Wickrama & Wickrama, 2010). The internal consistencies for the depressive symptoms measures displayed an acceptable level in the present sample (alpha =.73).

Post Traumatic Stress Disorder (PTSD). Posttraumatic stress disorder (PTSD) symptom levels were assessed using 20 DSM-IV diagnostic interview items (American Psychiatric Association, 1994). This PTSD measure, assessing symptom severity for a specific traumatic event, consists of items composed of three sub-scales: re-experiencing, avoidance and hyper-arousal. They have been used in different ethnic groups, including Sri Lankan, Southeast Asian, West Asian, African, Balkan, and Middle Eastern groups (Wickrama & Kaspar, 2006; Kaspar, 2002). The items include PTSD symptoms specified in the DSM-IV,and were developed based on English versions of measures used in a number of published studies and have been shown to have good psychometric properties for screening PTSD (e.g., Kessler et al., 1995; Turner & Gil, 2002). Clinical levels of PTSD were assessed using the frequency of veterans experiencing symptom categories as laid out in the DSM-IV. This measure displayed an acceptable level of internal consistency in the present study sample (alpha=.71).

The measures of depressive symptoms and PTSD used in the present study were translated from English to Sinhalese in collaboration with an experienced local mental health professional and after pilot testing on five village respondents, the translated versions underwent the appropriate item revisions to aid understanding and to improve clarity (Marin, 1992; Wickrama & Wickrama, 2008).

Results

Mental Illness Prevalence. The prevalence rate of clinical levels of CES-D depression is 85.4% whilest the prevalence rate of clinical levels of PTSD (DSM-IV, 1994) is 42.2% in this sample.

Use of Coping Strategies. A wide range of coping resources were used to deal with the veterans' post-war experiences: Thirty-three percent (33%) indicated they used self-confidence to deal with their problems post - war; with a similar percentage (31%) indicating they used Buddhist religiosity. Twenty-five percent (25%) reported religious participation. Furthermore, 33% said their self-confidence was quite a lot of help, 24% said their family were quite a lot of help, 18% said the Buddhist ritual of Bodhipuja was quite a lot of help, while 36% also said Western medical hospitals were quite a lot of help. Table 1 details the means, standard deviations, and ranges in these and other coping strategies, while Table 2 details the bivariate correlations between the study measures.

Measures	M	SD	Range (min,max)	A
Age	26.48	6.56	18, 42	
Education	3.93	.61	3, 6	
Marital Status	.28	.44	0, 1	
Family Social Support	2.19	.64	0, 3	
Buddhist Religious Activities	1.44	.38	0, 2	
Buddhist Bodhipuja Ritual	1.90	.72	0, 3	
Horoscope Readings	.50	.48	0, 2	
Sheehan Disability Scale	11.15	5.08	0, 28	
PTSD	28.55	6.05	19, 41	.71
CES-D	27.40	7.58	12, 44	.73

Table 1. Characteristics of Measures of Study Sample.

	1	2	3	4	5	6	7	8	9
1. Depression	1								
2. PTSD	.41**	1							
3. Age	-.13	-.19	1						
4. Education	-.09	-.07	13	1					
5. Sheehan Disability	14	.41**	-.25	-.09	1				
6. Family Support	.37**	-.48**	-.04	-.01	-.10	1			
7. Religious Acticities	.29*	-.12	.21	-.06	-.12	.03	1		
8. Bodhipuja Rituals	.20	-.14	.21	-.16	-.04	.29*	.09	1	
9. Horoscope Readngs	.14	.01	.16	.15	.03	.00	-.06	-.24	1

**** p<.001,**p<.01, * p<.05*

Table 2. Correlations Among Study Variables.

Table 3 indicates that the control variables age, education, and disability were not significantly associated with depressive symptoms (ß =-.08, p>.05; ß=-.05, p>.05; ß=.11, p>.05, respectively). Control variables only explained 2.8% of variance in depressive symptoms of the total sample. Entering the coping strategies in the regression analysis indicated that the coping strategies of family support, Buddhist religious activities, horoscope readings, and the Buddhist Bodhipuja ritual each were significantly associated with depressive symptoms (ß=-.48, p<.0001; ß=-.28, p<.05; ß=-.31, p<.05; ß=.44, p<.01, respectively), after controlling for demographic characteristics (age, education, disability). The model including coping strategies explained 43.3% of the total variance in depressive symptoms. Unlike these depressive symptoms, the control variable disability was significantly associated with PTSD among veterans (ß=.32, p<.01), while age and education were not significantly associated with PTSD (ß=-.10, p>.05; ß=-.02, p>.05). However, when testing the same coping strategies on PTSD, only support from family was significantly associated with PTSD symptoms (ß=-.47, p<.01), while Buddhist religious activities, the Buddhist Bodhipuja Ritual and the horoscope readings were not significantly associated with PTSD in the total sample (ß=-.05, p>.05; ß=.04, p>.05; and ß=.01, p>.05, respectively). While the control variables explained 17.5% of the variance in PTSD symptoms, the full model including coping strategies explained 38.9% of the variance in PTSD symptoms.

	Depressive Symptoms	PTSD		
	Model 1	Model 2	Model 1	Model 2
Controls				
Age	-.08	-.10	-.10	-.13
Education	-.05	-.08	-.02	-.05
Disability	.11	.07	.38**	.32*
Coping Strategies				
Family Social Support		-.48***		-.47**
Buddhist Religious Activities		-.28*		-.05
Buddhist Bodhipuja Ritual		.44**		.04
Horoscope Readings	2.8%	-.31*		.01
Variance Explained	11.15	43.3%	17.5%	38.9%

Note: Only significant coping strategies shown. +P<.10, *P<.05, **P<.01

Table 3. Regression for depression and PTSD (standardized betas) using the full sample (n=44).

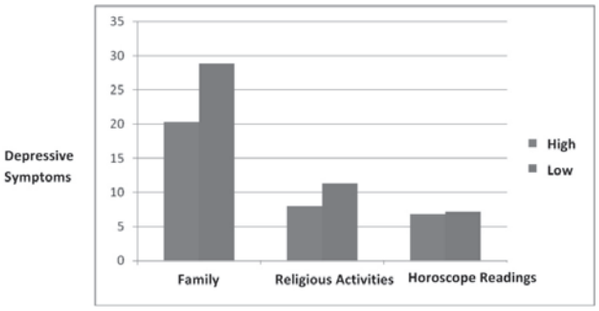
Table 4 examines the associations between coping strategies and the depressive symptoms separately on practising versus non-practising Buddhists of the all Buddhist study sample. In model 1, control variables age, education, and disability were not significantly associated with the depressive symptoms of practising Buddhists (symptoms (ß=-.13, p>.05; ß=.03, p>.05; and ß=-.04, p>.05, respectively) and only contributed to 1.8% of the depressive symptoms variance. In model 2, the coping strategies of family social support, Buddhist religious activities and Buddhist Bodhipuja ritual were significantly associated whilst the horoscope readings did not significantly associate with depressive symptoms amongst practising Buddhists (ß=-.41, p<.0001; ß=-.37, p<.05; ß=-.47, p<.05, and ß=-.13, p>.05, respectively). Model 2 explains 36.9% of the variance in depressive symptoms of the practising Buddhists subsample. Similar to the practising Buddhists subsample, control variables for age, education, and disability did not significantly associate with depressive symptoms of the non-practising Buddhists subsample (ß=.24, p>.05; ß=-.44, p>.05; and ß=.21, p>.05, respectively). Contrary to the results with the practising Buddhists, the coping strategies of Buddhist religious activities and the Buddhist Bodhipuja ritual did not significantly associate with depressive symptoms of non-practising Buddhists (ß=-.23, p>.05; ß=.13, p>.05, respectively). However, family social support and the unique horoscope readings were significantly associated with depressive symptoms for non-practising Buddhists (ß=-.59, p<.05 and ß=.90, p<.01, respectively). Moreover, these two coping strategies by non-practising Buddhists explains 95.9% of their variance in the expressed depressive symptoms.

	Practising (n=32)		Non-Practising (n=12)	
	Model 1	Model 2	Model 1	Model 2
Controls				
Age	-.13	-.16	.24	.22
Education	.03	.13	-.44	.15
Disability	-.04	-.08	.21	.13
Coping Strategies				
Family Social Support		-.41*		-.59*
Buddhist Religious Activities		-.37*		-.23
Buddhist Bodhipuja Ritual		.47*		.13
Horoscope Readings		-.13		-.90**
Variance Explained	1.8%	36.9%	22.2%	95.9%

Note: Only significant coping strategies shown. +P<.10, *P<.05, **P<.01

Table 4. Regression for depression (standardized betas); practising vs non-practising Buddhists.

As depicted in Figure 1, significant mean differences were found in depressive symptoms for low versus high family support and religiosity coping strategies. This figure indicates that those with greater family support and greater Buddhist religious activities are associated with significantly lower depressive symptoms than those with lesser family support and lesser Buddhist religious activities. These findings are consistent with the regression results showing lower depressive symptoms with greater family support and greater Buddhist religious activities in the full sample. There were lower depressive symptoms among those with greater family support than in either of the Buddhist religious activity subsamples. These results are also consistent with the stronger negative association between Buddhist religious activities and the depressive symptoms of practising Buddhists (those with a higher Buddhist religious activity).



Note: Significant difference in mean depression for family/friends support and religiosity coping (p<.05).

Figure 1. Difference in means between low and high coping strategy groups for CESD

Discussion

The present study investigates the association between previously untested coping strategies such as Buddhist religious activities and the cultural practice of horoscope readings with mental health problems of veterans. The results indicate that Buddhist religious activities and horoscope reading are negatively associated with depressive symptoms while the more traditional coping strategy of family support negatively associates with both depressive symptoms and PTSD symptoms of disabled veterans. Although the prevalent rates of depression and PTSD remain high, perceptions by the participants that Buddhist religious activities, horoscope readings, and family support helped cope with mental illness are negatively associated with their depressive and PTSD symptoms. This association is more pronounced among veterans who practice Buddhist religious activities compared with those who do not practice Buddhist religious activities. Among a sample with significant mental health problems, these findings provide evidence for the joint beneficial influence of beliefs and practice on mental health problems (statistical interaction). Moreover, the analysis between the practising Buddhists versus non-practising Buddhist subsamples provides evidence for joint beneficial influence between Buddhist religious practice and the belief in horoscope interpretation on mental health problems. According to the results, participants' perceptions that horoscope readings helped cope with mental illness was negatively associated with depressive symptoms among veterans who did not practice Buddhist religious activities. In fact, horoscope readings and family support contributed to 95.9% of the variance in depressive symptoms among non-practising Buddhists. The present study also re-affirms the previous finding that family support negatively associates with mental illness among veterans. However with the present evidence we are able to infer the role of an association of family support with both the depressive and the PTSD symptoms of wounded veterans.

Buddhist ritualistic practice of Bodhipuja was shown to be positively associated with depressive symptoms. Thus, Bodhipuja practice is not consistent with the negative association with depressive symptoms as shown in other coping strategies. While previous literature indicates that participating in Bodhipuja rituals is associated with feelings of easing back into life and the giving of a sense of healing after trauma, the present study indicates this activity may not serve as a coping strategy but may in fact increase depressive symptoms.

In a familistic and collectivistic society such as occurs in Sri Lanka, individual forms of trauma psychotherapy that disconnects an individual from a group might be less effective and may even exacerbate the symptoms (Fernando, 2007). Non-Western methods of therapy particular to a given culture may be used to heal the symptoms of an illness, including symptoms uniquely expressed in a given cultural context. Thus, to avoid the problem of disconcerting people and possibly exacerbating their symptoms, and to increase the chance of healing, culturally compatible methods, imbedded within an individual's social ecology should be used (Fernando, 2004). In fact, non-Western techniques such as Buddhist mindful meditation have been increasingly incorporated into Western therapy, particularly in the third wave of cognitive behavioral therapies of ACT, DBT and MBCT [define abbreviations] and these have been shown to be effective in reducing post traumatic illness symptoms (Follette et al., 2006).

Despite the high percentage of impairment in the sample, the perceived improvement in mental health suggest that programs incorporating Buddhist meditation techniques and other Buddhist religious activities may be an effective coping strategy for wounded veterans, especially in those who have positive beliefs about Buddhist religious activities. Moreover, wounded veterans who desire to undertake the cultural practice of horoscope readings may also experience mental health benefits because the positive perception of horoscope reading was negatively

associated with their actual depressive symptoms. Programs in Sri Lanka addressing the trauma of war-affected Tamil communities in Jaffna already use yoga methods, traditional forms of drama, and Tamil terminology to describe post traumatic emotions and these programs have yielded a favourable outcome (Somasundaram & Jamunanatha, 2002).

Migration and urbanization has somewhat affected the traditional extended family system that formerly was common in Sri Lanka. Nuclear families are far more frequent now, though more so in urban than in rural areas. The present research indicates that the existence of family support negatively associates with both depressive and PTSD symptoms of the participants. Hence, an effort to improve the family support received by disabled veterans may be beneficial in improving their mental health. The participants in the present study were living in a residential facility for the disabled, with adequate facilities for leisure, exercise and vocational rehabilitation. The nature of their injuries for some of these veterans made it difficult for them to be cared for in their homes (such as spinal cord injuries or above-the-knee amputations of both legs), especially as many of them were from lower socio-economic groups and could not afford special facilities. Hence they would need to remain at the facility. On the other hand, there were also veterans that had disabilities that could be cared for at home (such as an amputation of one leg). In light of the present research findings, it is important that such veterans be cared for by their family or have an opportunity for greater positive interactions with their family and hence obtain the mental health benefit of family support. However, it should also be cautioned that being resident at a rehabilitation facility may also have its benefits such as solidarity and companionship with fellow veterans (Armstrong, Best & Domenici, 2006). Removal of these important contributors to mental health, while increasing family contact, may have other negative repercussions. Hence, future research may need to study the impact of these diverse variables on the mental health of disabled veterans.

There are several limitations of this research. First and foremost, the small sample size and the fact that the participants were restricted to disabled soldiers. Hence the general applicability and the statistical power of the research were limited. Future research could investigate samples more representative of veterans and employ a larger sample size. In respect of the measures investigated in this study, only two measures of mental illness were explored – that of depression and PTSD. Future research may need to explore other types of psychological difficulties such as anger and chronic pain. Further, in our study, religiosity was assessed by the subjects' participation in Buddhist religious activities or the involvement in religious rituals such as Bodhipuja. However, religiosity is a complex multi-faceted concept so it would be important that other aspects of religiosity be assessed in future studies, along with its related term spirituality, which denotes a more inner seeking as opposed to the outward aspects indicated by religiosity (Neff, 2006). Despite the multi-faceted nature of religiosity, we may be able to conclude that the religious activities of participants who all identified themselves as Buddhists, would also practice Buddhist religious activities if they could claim to be practising-Buddhists. However, future studies should investigate specific religious activities of participants in greater detail, so there may not be ambiguity as to whether those identifying themselves as Buddhists and stating they are practising-Buddhists, actually did practice religious activities considered to be of the Buddhist religion (e.g. Buddhist meditation). Importantly, the measures that were used, although translated into Sinhalese and used in other cross-cultural research have not been validated in Sri Lanka. As psychology is still in its infancy in Sri Lanka (De Zoysa & Ismail, 2001) there is a dearth of culturally validated psychometric tools. Hence, at the time of this study, validated instruments to assess concepts studied in this research were not available in the country. Future research would need to use instruments that are validated in the Sri Lankan culture if it were to yield more representative results. Future studies would also benefit from expanded Likert-type scales that allow the capture of a greater variation in critical variables of interest. A follow-up study with this sample will allow us to examine predictors of change in mental illness among veterans. In the future, this study could also be repeated with a less impaired sample to test the model further.

Research studies on Sri Lankan combatants are scarce, despite Sri Lanka's recently ended decades long ethnic conflict. Studies on disabled veterans in Sri Lanka are unknown, and in other nations, rare. Despite the limitations of this albeit preliminary study, it does offer an important insight into psychological functions and the associations with the unique religious and cultural coping strategies used by a population of wounded veterans to improve their perceived mental health.

Authors' affiliations: [1]University of Colombo, Sri Lanka, [2]Auburn University, Auburn, AL
Corresponding Author: Assist Prof. Piyanjali de Zoysa, Dept Human Development and Family Studies, Auburn University, Auburn, AL
Email: tzw0003@auburn.edu

References

1. Aldwin, C.M., Levenson, M.R. & Spiro, A. (1994). Vulnerability and resilience to combat exposure: Can stress have lifelong effects? *Psychology and Aging*, 9 (1); 34-44. DOI:10.1037/0882-7974.7.3.331
2. Ai, A.L., Tice, T., Huang, B. & Ishisaka, A. (2005). Wartime faith-based reactions among traumatized Kosovar and Bosnian refugees in the United States. *Mental Health, Religion & Culture*, 8(4); 291-308. DOI: 10.1080/13674670902800133
3. Aflaksier, A. & Coleman, P.G. (2009). The influence of religious coping on the mental health of disabled Iranian war veterans. *Mental health, Religion & Culture*, 12(2); 175-190. DOI: 10.1080/13674670902800133
4. Armstrong K, Best S & Domenici P. (2006). Courage after fire. Coping strategies for troops returning from Iraq and Afghanistan and their families. CA: Ulysses Press.
5. Basoglu, M., Livanou, M., Crnobaric, C., Franciskovic, T., Suljic, E., Duric, D., Vranesic, M. (2005). Psychiatric and congnitive effects of war in former Yugoslavia. JAMA, 294 (5); 580-592. DOI:10.1001/*JAMA* .294.5.580
6. Brewin, C., Andrews, B. & Valentine, J.D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma exposed adults. Journal of *Consulting and Clinical Psychology*, 68(5); 748-766. DOI:10.1037/a0017045
7. Bosworth, H.B., Park, K., McQuoid, D.R., Hays, J. & Steffens, D.C. (2003). The impact of religious practice and religious coping on geriatric depression. *International Journal of Geriatr Psychiatry*, 18; 905-914. DOI: 10.1002/gps.1631
8. Catani, C., Kohiladevy, M., Ruf, M., Schauer, E., Elbert, T. & Neuner, F. (2009). Treating children traumatized by war and Tsunami: A comparison between exposure therapy and meditation-relaxation in North-East Sri Lanka. *BMC Psychiatry*, 9:22. DOI:10.1186/1471-244X-8-51
9. Davidson, J.R.T., Connor, K.M. & Lee, L. (1994). Beliefs in karma and reincarnation. *Soc Psychiatry Epidemiol*, 40: 120-125. doi:10.1093/acprof:oso/9780195101812.001.0001
10. Desmond, D.M. & MacLachlan, M. (2006). Coping strategies as predictors of psychosocial adaptation in a sample of elderly veterans with acquired lower limb amputations. *Social Science & Medicine*, 62; 208-216.
11. De Zoysa, P., & Weerasinghe , T. (2000). Psychological consequences and coping mechanisms of bomb blast survivors: an insight into the Sri Lankan experience. Sri Lanka Journal of Social Sciences, 22, 34-42. De Zoysa, P., & Ismail, C. (2001). Psychology in an Asian country: A report from *Sri Lanka. International Journal of Psychologists*, 2, 110-111.
12. De Zoysa, P. (in press) The use of Buddhist Mindfulness Meditation in Psychotherapy: A Report from *Sri Lanka. Journal of Transcultural Psychiatry*.
13. Drescher, K.D., Smith, M.W. & Foy, D.W. (2007). Spirituality and readjustment following war-zone experiences. Combat stress injury: Theory, research, and management. 295-310.
14. Exline, J.J., Smyth, J.M., Gregory, J., Hockemeyer, J. & Tullock, H. (2005). Religious framing by individuals with PTSD when writing about traumatic experiences. *The International Journal for the Psychology of Religion*, 15(1); 17-33.
15. Fernando, G. A. (2007). http://www.nytimes.com/2007/08/12/magazine/12wwln-idealab-t.html
16. Fernando, G.A. (2004). Working with survivors of war in non-western cultures: the role of the clinical psychologist. *Intervention*, 2(2); 108-117.
17. Fontana, A. & Rosenheck, R. (2004). Trauma, change in strength of religious faith, and mental health service use among veterans treated for PTSD. *J Nerv Ment Dis*, 192; 579-584.
18. Follette, V., Palm, K.M. & Pearson, A.N. (2006). Mindfulness and trauma: Implications for treatment. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, 24(1); 45-60.
19. Gordon, J.S., Staples, J.K., Blyta, A.,& Bytyqi, M. (2004). Treatment of posttraumatic stress disorder in postwar Kosovo high school students using mind-body skills groups: a pilot study. *J Trauma Stress*, 17(2): 143-7.
20. Hankey, A. (2007). CAM and post-traumatic stress disorder. *Evid Based Complement Alternat Med*, 4(1): 131-132.
21. Hollifield, M., Hewage, C., Gunawardena, C.N., Kodituwakku, P., Bopagoda, K. & Weerarathnega, K. (2008). Symptoms and coping in Sri Lanka 20-21 months after the 2004 tsunami. *The British Journal of Psychiatry*, 192, 39-44.
22. Irving, L.M., Telfer, L. & Blake, D.D. (1997). Hope, coping, and social support in combat-related posttraumatic stress disorder. *Journal of Traumatic Stress*, 10(3); 465-479.

23. Kaspar, V. (2002). Posttraumatic stress disorder: Diagnosis, prevalence, and research advances. *Sociological Focus*, 35(1); 97-108.

24. Kessler, R.C., Sonnega, A., Bromet, E. & Hughes, M. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*, 52(12); 1048-1060.

25. Koenig, H.G. (2001). Religion and medicine III: Developing a theoretical model. *International Journal of Psychiatry in Medicine*, 31(2); 199-216.

26. Khouzam, H.R. & Kissmeyer, P. (1997). Antidepressant treatment, posttraumatic stress disorder, survivor guilt, and spiritual awakening. *Journal of Traumatic Stress*, 10(4); 691-696.

27. Levy, B.R., Slade, M.D. & Ranasinghe, P. (2009). Causal thinking after a Tsunami wave: karma beliefs, pessimistic explanatory style and health among Sri Lankan survivors. *J Relig Health*, 48; 38-45.

28. Marin, G. (1992). Issues in the measurement of acculturation among Hispanics. In K.F. Geisinger (Ed.), *The psychological testing of Hispanics* (pp. 235-272). Washington, DC: American Psychological Association.

29. Miller, K.E. & Rasmussen, A. (2010). War exposure, daily stressors, and mental health in conflict and post-conflict settings: Bridging the divide between trauma-focused and psychosocial frameworks. *Social Science & Medicine*, 70; 7-16.

30. Naelys, D., Diane, G., Eloise, G.H. (2009). Predictors of depressive symptoms among impatient substance abusers. *International Journal of Mental Health and Addiction*, 7(2); 347-356.

31. Noh, S., Violet, K. & Wickrama, K.A.S. (2007). 'Overt and subtle racial discrimination and mental health: Preliminary findings for Asian immigrants'. *American Journal of Public Health*. Vol. 97. pp. 1269-1274.

32. Portes, A. & Rumbaur, R.G. (2001). Legacies. The story of the immigrant second generation. Berkeley, CA: University of California Press.

33. Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1(3), 385-401.

34. Simpson, T.L., Kaysen, D., Bowen, S., et al. (2007). PTSD symptoms, substance use, and Vipassana meditation among incarcerated individuals. *Journal of Traumatic Stress*, 20(3); 239-249.

35. Somasundaram, D. (2002). Using traditional relaxation techniques in healthcare. *International Medical Journal*, 9(3); 191-198.

36. Somasundaram, D. (2003). Collective trauma in Sri Lanka. Intervention: *International Journal of Mental Health, Psychosocial Work & Counselling in Areas of Armed Conflict*, 1(1); 4-13.

37. Somasundaram, D. & Jamunanatha, C.S. (2002). Psychosocial consequences of war. Trauma, war, and violence: Public mental health in socio-cultural context. De Jong, J. (Ed.) 205-258. New York, NY. Kluwer Plenum Publishers.

38. Silva D.P. (2006). The tsunami and its aftermath in Sri Lanka: Explorations of a buddhist perspective. *International Review of Psychiatry,* 18(3); 281-287.

39. Tribe, R. (2007). Health pluralism: A more appropriate alternative to Western model of therapy in the context of the civil conflict and natural disaster in Sri Lanka? *Journal of Refugee Studies*, 20 (1); 21-36.

40. Turner, R.J. & Gil, A. (2002). Psychiatric and substance disorders in South Florida: Racial/ethnic and gender contrasts in a young cohort. *Archives of General Psychiatry*, 59; 43-50.

41. Wickrama, T. (2010; Under Review). Mothers' physical and mental health three years after the Tsunami in Sri Lanka. *Journal of Social Science and Medicine*.

42. Wickrama. K. A. S. & Bryant, C.M. (2003). Community context and adolescent mental Health. *Journal of Marriage & Family*. Vol. 65. pp. 850-866.

43. Wickrama, K.A.S. & Wickrama, T. (2010). Perceived community participation in Tsunami recovery efforts and the mental health of Tsunami-affected mothers: Findings from a study in rural Sri Lanka. *Int J Soc Psychiatry*, Epub ahead of print.

44. Wickrama, K.A.S. & Kaspar, V. (2007). Family context of mental health risk in Tsunami-exposed adolescents: Findings from a pilot study in Sri Lanka. *Soc Sci Med*, 64(3): 713-23.

45. Wickrama, K.A.S. & Wickrama, T. (2008). Family context of mental health risk in Tsunami affected mothers: Findings from a pilot study in Sri Lanka. *Soc Sci & Med*, 66: 994-1007.

Special operations task group regimental aid post presentations, Tarin Kowt, Afghanistan: February - June 2010

Nevin Colgrave MBBS (Hons), MPH, FRACGP

Abstract

Background: The Australian Defence Force (ADF) Special Operations Task Group (SOTG) in Tarin Kowt, Afghanistan, is supported by a Primary Health Care Team (PHCT) which provided health care through its Regimental Aid Post (RAP).

Purpose: To identify and analyse the types of injuries and illnesses for which SOTG personnel are seeking primary health care assistance in Tarin Kowt.

Material and Methods: An electronic record was kept of all presentations by ADF personnel to the SOTG RAP from 28 Feb to 26 Jun 2010.

Results: There were 1074 presentations during the study period, with the most common reasons for presentation being *Medical Examinations* (214 presentations), *Gastrointestinal Disorders* (191), *Upper Respiratory Tract Infections* (URTI) & *Ear, Nose and Throat* (ENT) *Disorders* (164), *Injuries* (117), *Dermatological Disorders* (105) and *Musculoskeletal Disorders* (103). Trends in the incidence of presentations during the study period were identified, with *URTI & ENT Disorders* noted to be more prevalent during the earlier stages of the study period, and *Medical Examinations, Gastrointestinal Disorders, Injuries* and *Musculoskeletal Disorders* all occurring more frequently during the second half of the study period.

Conclusion: These findings suggest that greater emphasis needs to be given to injury prevention and hygiene maintenance during deployments, particularly during the later stages of the deployment cycle, and highlight the importance of medical personnel utilising an electronic database to record patient contacts when deployed.

Introduction

Australia's contribution to the international campaigns against terrorism is termed Operation SLIPPER. A major component of this operation is the contribution of Australian Defence Force (ADF) personnel to the International Security Assistance Force (ISAF) in Afghanistan. At the time of writing, approximately 1550 ADF personnel are based in Afghanistan, principally in Uruzgan Province. The Special Operations Task Group (SOTG) is one element of the ADF presence in Uruzgan, focused on conducting population-centric operations and providing enhanced force protection to other ADF activities in the region. SOTG consists of approximately 300 ADF personnel, primarily drawn from the Special Air Service Regiment (SASR) and the 2nd Commando Regiment (2Cdo), and enabling and supporting units.[1]

The supporting elements of SOTG include a Primary Health Care Team (PHCT), which operates a Regimental Aid Post (RAP) in the SOTG compound. The PHCT consists of a medical officer, a nursing officer and 2-3 medics, and provides primary health care to the members of SOTG and medical support for training and operations. The RAP also has basic resuscitation equipment for use in emergencies that may occur on base and is generally manned by medical personnel 24 hours a day. It is supported by a multinational-run 'Role 2' medical facility located in an adjacent compound, which provides basic radiology and pathology services as well as general surgical, orthopaedic and inpatient care.

Methods

A record of every patient encounter involving ADF personnel presenting to the SOTG RAP was kept between 28 February to 26 June 2010 (precisely 17 weeks). Details regarding all such encounters were recorded on the Medical Information Management Index (MIMI), a non-proprietary suite of link databases developed in MS Access and widely implemented across the ADF. At a minimum, details recorded on MIMI included the member seen, the date of the consult, whether the consult was an initial encounter or a review, and the principal reason for attendance as per the ADF EpiTrack Health Surveillance System (a health surveillance tool based on the 10th revision of the International Classification of Diseases [ICD-10-AM]). Details on those members that were admitted to the RAP for monitoring or transferred to a higher level of care were also recorded.

Results

During the study period, there were 1074 patient encounters at the RAP involving 387 different ADF members. This equated to an average of 63.2 consults per week, however weekly consult numbers ranged from 26 to 137, with the busiest weeks being towards the end of the study period. Weekly consults are shown in Table 1 and Figure 1. The highest number of encounters attributable to an individual member was 20. Of the 1074 encounters, 857 were initial consults and 217 were reviews.

Week Beginning	No. of Consults
28/02/2010	37
07/03/2010	80
14/03/2010	43
21/03/2010	62
28/03/2010	35
04/04/2010	48
11/04/2010	59
18/04/2010	43
25/04/2010	58
02/05/2010	39
09/05/2010	26
16/05/2010	88
23/05/2010	67
30/05/2010	104
06/06/2010	79
13/06/2010	69
20/06/2010	137

Table 1 - RAP Consults by Week

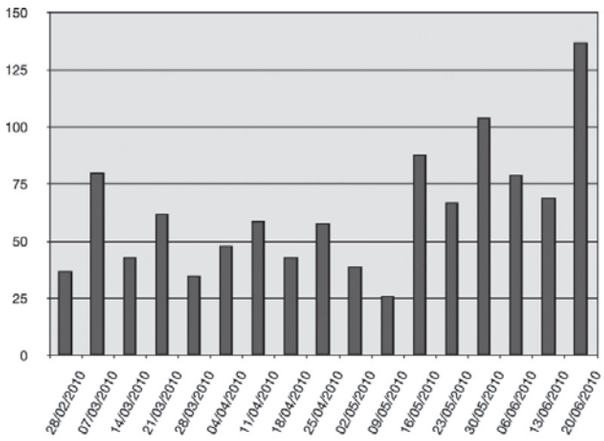


Figure 1 - RAP Consults by Week

Table 2 shows the principal reason for each of the presentations during the study period, as classified by the most appropriate EpiTrack descriptor. These presentations are then further classified according to initial and review consults. The most common single reason for presenting to the RAP was *Medical Examinations* (214 presentations). The vast majority of these were routine medicals performed on each member shortly before returning to Australia. *Intestinal Infectious Diseases* (i.e. Gastroenteritis) was another major reason for presenting (152), followed by *Upper Respiratory Tract Infections* (URTI) (94), *Other Dermatological Conditions* (92), *Disorders of the Ear, Nose and Throat* (ENT) (70) and *Other Musculoskeletal Diseases* (64). In all, there were 31 different EpiTrack descriptors used during the study period.

There were a total of 50 admissions to the RAP during the study period, involving 42 different members. 8 members were admitted twice during the study period. In terms of length of admission, 18 members did not require an overnight stay, 31 members were admitted for 1 night and 1 member stayed 2 nights. The reasons for admission are shown in Table 3, with 38 of the 50 admissions being for *Intestinal Infectious Diseases.* The RAP would only admit members who were haemodynamically stable and could be managed with simple measures including intravenous fluid resuscitation, analgesia, antiemetics and oral antibiotics, if clinically indicated. Any potentially unstable members or members requiring specialist medical input were referred to the Role 2 facility for management.

To better streamline the analysis of the data, several EpiTrack descriptors of a similar nature were combined. Through this process, 6 groups with over 100 presentations each were identified. These were:

Medical Examinations: 214

Gastrointestinal Disorders: 191

- Disorders of the Digestive System: 39
- Intestinal Infectious Diseases: 152

URTI & ENT Disorders: 164

- ENT Disorders: 70
- URTI: 94

Injuries: 117

- Injuries due to Hostile Action: 19
- Injuries due to Military Training: 4
- Injuries due to Sport: 17
- Injuries due to Transport Accidents: 24
- Injuries not due to TAs, Training, Sport or Hostile Action: 53

EpiTrack Descriptor	Total Consults	Initial Consults	Reviews
Climatic Injury (Heat and Cold)	1	1	0
Counselling, Specimen Collection and Special Screening	14	10	4
Deprivation and Motion Sickness	1	1	0
Diseases of Teeth and Oral Cavity	9	8	1
Diseases of the Circulatory System	4	1	3
Diseases of the Digestive System	39	33	6
Diseases of the Genito-urinary System	5	5	0
Diseases of the Nervous System	6	1	5
Disorders of Ear, Nose and Throat	70	52	18
Disorders of the Back	27	20	7
Disorders of the Knee	11	9	2
Eczematous Skin Conditions	13	11	2
Eye Disorders	13	11	2
Injuries Due to Hostile Action	19	9	10
Injuries Due to Military Training	4	3	1
Injuries Due to Sport	17	12	5
Injuries Due to Transport Accidents	24	5	19
Injuries Not Due to TAs, Training, Sport or Hostile Action	53	36	17
Intestinal Infectious Diseases	152	125	27
Lower Respiratory Tract Conditions (including Asthma)	7	5	2
Malaria	26	6	20
Medical Examinations: Routine, Periodic etc	214	214	0
Other Administrative Events Not Already Covered	8	7	1
Other Dermatological Conditions	92	76	16
Other Infectious and Parasitic Diseases	6	5	1
Other Musculoskeletal Diseases (excluding knees and backs)	64	40	24
Repeat Prescriptions: Pharmaceuticals, Spectacles etc	18	14	4
Sexually Transmitted Diseases	4	3	1
Symptoms, Signs and Ill-defined Conditions Not Elsewhere Classified	47	44	3
Upper Respiratory Tract Conditions (including URTI)	94	89	5
Vaccinations, Inoculations and Prophylactic Injections	12	1	11
Total	**1074**	**857**	**217**

Table 2 - Consults by EpiTrack Descriptor

EpiTrack Descriptor	Admissions
Diseases of the Digestive System	1
Disorders of Ear, Nose and Throat	2
Injuries Due to Sport	1
Injuries Not Due to TAs, Training, Sport or Hostile Action	2
Intestinal Infectious Diseases	38
Malaria	3
Other Dermatological Conditions	1
Symptoms, Signs and Ill-defined Conditions Not Elsewhere Classified	2
Total	**50**

Table 3 - Admissions by EpiTrack Descriptor

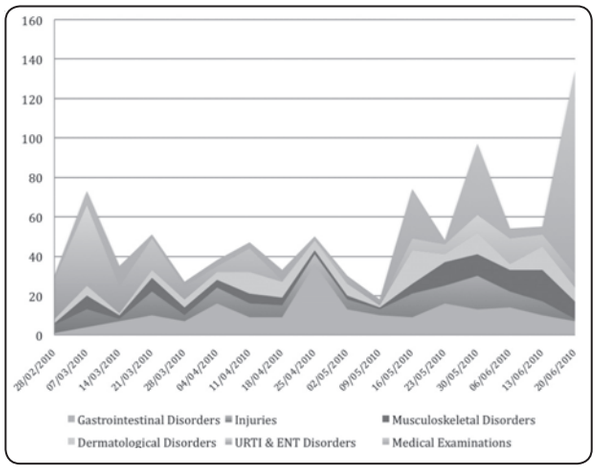


Figure 2 - Major EpiTrack Descriptors – Number of Presentations by Week

Dermatological Disorders: 105

Eczematous Skin Conditions: 13

Other Dermatological Conditions: 92

Musculoskeletal Disorders: 103

Disorders of the Back: 27

Disorders of the Knee: 11

Other Musculoskeletal Disorders: 64

Presentations for the above groups during each week of the study period are shown in Table 4 and graphically in Figure 2.

Discussion

An analysis of the weekly breakdown of the major presentations reveals a number of trends. Few presentations relating to *Medical Examinations* occurred during the first 11 weeks of the study period, with the vast majority of such presentations occurring after this point, particularly in the last week, which saw 103 presentations. This is explained by the requirement for members to undergo Return To Australia Medicals prior to completion of their deployment.

A further trend was that the majority of presentations for *URTI/ENT Disorders* occurred in the first 4 weeks of

Week beginning	Medical Examinations	Gastrointestinal Disorders	URTI & ENT Disorders	Injuries	Dermatological Disorders	Musculoskeletal Disorders
28/02/10	2	1	20	4	2	1
07/03/10	7	4	41	9	5	7
14/03/10	10	7	14	1	1	2
21/03/10	2	10	16	12	4	7
28/03/10	2	7	7	3	4	4
04/04/10	3	16	3	8	4	4
11/04/10	3	9	12	7	11	5
18/04/10	5	9	1	6	8	4
25/04/10	2	36	0	5	5	2
02/05/10	1	13	3	5	6	2
09/05/10	2	10	1	3	1	1
16/05/10	25	9	6	12	17	5
23/05/10	2	16	5	9	4	12
30/05/10	36	13	9	17	11	11
06/06/10	5	14	13	8	3	11
13/06/10	4	10	6	7	12	16
20/06/10	103	7	7	1	7	9
Total	**214**	**191**	**164**	**117**	**105**	**103**

Table 4 - Major EpiTrack Descriptors by Week

the study period (91 out of 164). A possible explanation for this was the colder temperatures during the late winter and early spring months of February and March, increasing the likelihood of contracting an URTI.[2] The exposure of members to local respiratory pathogens and environmental contaminants to which they were unaccustomed at the start of the deployment may also be a factor in the higher incidence of *URTI/ ENT Disorders* in the early part of the study period.

Another point of interest is the higher frequency of presentations of *Gastrointestinal Disorders* during the warmer months of May and June, with 128 of the 191 presentations (67%) occurring from Week 9 onwards (25/4/10 to 26/6/10). Warmer temperatures increase the rate of pathogen growth on contaminated food and other surfaces,[3] which would have put members at greater risk of developing gastroenteritis. Further, the higher operational tempo typically seen in warmer months meant that SOTG members were more active in the field and therefore more likely to be exposed to gastroenteritis-causing pathogens through contaminated food and water and the difficulties in maintaining ideal levels of hygiene.

A large proportion of injury presentations (54 out of 117) occurred during the last 6 weeks of the study period. This may have involved a number of factors. The higher operational tempo during the warmer months later in the study period would have meant members were more active in the field and therefore more prone to injury (both hostile and otherwise). Additionally, members may have suffered minor injuries earlier in the study period, which deteriorated in the subsequent weeks and months, ultimately resulting in them seeking medical attention at the RAP. There may possibly have been greater complacency and reduced vigilance of members with regards to injury prevention as their deployment wore on. Finally, there may have been a reluctance by members to report injuries earlier in the deployment for fear of being placed on restrictions or even medically evacuated back to Australia, as well as a propensity for members to report all injuries, no matter how minor, just prior to returning home to ensure they were adequately documented for possible future rehabilitation and compensation purposes. A closer look at the breakdown of injuries in Table 2 shows that 53 of the 117 injury consults were due to *Injuries not due to TAs, Training, Sport or Hostile Action*, which mainly included musculoskeletal injuries (sprains and strains) and minor lacerations, grazes and burns, as well as associated follow-up visits. The relative paucity of Injuries due to *Military Training* (4 consults) and *Injuries due to Sport* (17 consults) was likely due to the absence of organised sporting or training activities on base during the study period. Members generally maintained their fitness by undertaking individual, gym-based training, with injuries sustained from this type of activity generally classified under Musculoskeletal Disorders or *Injuries not due to TAs, Training, Sport or Hostile Action*. Finally, the high proportion of reviews from *Injuries due to Transport Accidents* (19 of 24 consults) was due to a single case of an injured member requiring regular follow-up over a period of several weeks.

As with injuries, presentations for *Musculoskeletal Disorders* were much more prevalent during the latter stages of the study period, with 64 of the 103 presentations occurring during the last 6 weeks. *Musculoskeletal Disorders* included minor strains as well as overuse and other non-acute injuries, and this higher prevalence towards the end of the study period could therefore be due to many of the aforementioned reasons proposed for the trend in injury presentations.

Malaria

Special note should be made of presentations for malaria during the study period. There were a total of 26 presentations (6 initial consults and 20 reviews) for malaria, with all occurring during the last 3 weeks of the study period (see Table 5). All 6 members involved presented initially over a period of 48 hours and had all worked closely together on high intensity operations in the field during the 1-2 weeks prior to presentation. Diagnosis was made on clinical symptoms and via blood films interpreted by a Dutch pathology technician, who felt that *Plasmodium vivax* was the most likely causative agent.

Week beginning	Malaria Presentations
28/02/2010	0
07/03/2010	0
14/03/2010	0
21/03/2010	0
28/03/2010	0
04/04/2010	0
11/04/2010	0
18/04/2010	0
25/04/2010	0
02/05/2010	0
09/05/2010	0
16/05/2010	0
23/05/2010	0
30/05/2010	0
06/06/2010	16
13/06/2010	9
20/06/2010	1
Total	**26**

Table 5 - Malaria Presentations

All SOTG members had access to malaria chemoprophylaxis during the duration of the study period, in accordance with ADF policy.[4] This consisted principally of doxycycline (100mg daily), with the alternative regimens of Malarone™ (atovaquone 250mg + proguanil 100mg, one tablet daily) and mefloquine hydrochloride (250mg weekly) also being available, however ultimately, no SOTG member accessed Malarone™ nor mefloquine from the RAP for malaria chemoprophylaxis during the study period. DEET-containing topical mosquito repellents were also made readily available from the RAP.

For the 6 individual members that contracted malaria, treatment was provided as per the relevant ADF directive and on the assumption that *P. vivax* was the causative agent.[4] This involved high-dose Malarone™ (4 tablets daily for 3 consecutive days) followed by a primaquine eradication course (primaquine phosphate 15mg twice daily for 14 days). Within 2-3 days, four of the affected members had recovered to the extent that they could resume light duties. The remaining 2 members showed initial improvement in their symptoms but suffered a relapse after 3-4 days and were given high-dose chloroquine (1g initially, followed by 500mg six hours later and 500mg on day 2 and day 3), which proved effective in both cases. Post-treatment blood for all 6 cases were taken and sent to the Role 2 facility, but the results of the slides prepared were interpreted as being inconclusive however. Pre-treatment slides for each of the 6 cases and a post-treatment slide for 1 case were then sent to the Australian Army Malaria Institute (AMI) in Enoggera, Queensland. While microscopy analysis conducted by AMI failed to identify parasites in any of the slides, subsequent PCR testing confirmed that 2 of the members had contracted *Plasmodium falciparum*, with 1 other member positive for mixed *P. falciparum* and *P. vivax*.[5]

Conclusion

This review demonstrates the importance of using an electronic database, such as MIMI, to record medical presentations in a deployed environment. The ease with which data can be collated and analysed by using such a database facilitates further comparative studies of RAP presentations during future SOTG deployments. Trends in presentation numbers and EpiTrack descriptors can therefore be more readily detected and proactive changes made to the delivery of healthcare to Special Operations members. Further, MIMI allows for presentations to be matched to individual members, enabling better tracking of conditions and identifying high risk groups within SOTG (e.g. as with the malaria cases). It is recommended that with these advantages, MIMI use should be mandatory for all future SOTG deployments.

The higher incidence of both injuries and musculoskeletal disorders during the warmer summer months and/or during the latter stages of the deployment cycle suggest that greater efforts need to be made in injury prevention during these periods. Organised occupational health and safety (OH&S) meetings involving the medical and command elements of SOTG could be held, especially during high risk periods, to discuss injuries and musculoskeletal presentations and devise strategies for minimising their occurrence.

Similarly, the higher incidence of gastroenteritis during the warmer months warrants greater emphasis on preventative actions. The importance of maintaining high standards of hygiene through regular hand-washing, drinking only bottled water and preparing and storing food appropriately needs to be emphasised to all members throughout their deployment.

Finally, the analysis confirms that malaria (including *P. falciparum*) is present in the areas of Afghanistan where SOTG members are operating. The occurrence of potentially fatal cases of malaria during the study period highlights the need for adequate malaria prophylaxis during the warmer months. All SOTG members are educated in appropriate prophylactic measures and are provided with chemoprophylaxis, and ongoing efforts need to be made in encouraging the uptake of these measures.

To test the validity of the trends in presentations raised above, a repeat study using MIMI statistics collected over a similar period of time but looking at a different SOTG rotation is planned.

Authors' affiliations: Department of Defence, Australia
Contact author: Nevin Colgrave, Tobruk Lines Health Centre, Tobruk Line, Holsworthy Barracks NSW 2173
Email: nevinco@hotmail.com

References

1. Department of Defence. Fact sheet 3: Australia's commitment in Afghanistan [Internet]. 2011 [cited 2011 Jan 19]. Available from: http://www.defence.gov.au/defencenews/articles/1017/files/3_Australia's%20 commitment%20in%20Afghanistan%20Fact%20Sheet%203.pdf

2. Leder K, Sundararajan V, Weld L, Pandey P, Brown G, Torresi J, GeoSentinal Surveillance Group. Respiratory tract infections in travelers: a review of the GeoSentinel Surveillance Network. Clin Infect Dis. 2003; 36 (4): 399-406

3. Hall GV, Kirk MD, Ashbolt R, Stafford R, Lalor K, OzFoodNet Working Group. Frequency of infectious gastrointestinal illness in Australia, 2002: regional, seasonal and demographic variation. Epidemiology and Infection 2006; 134: 111-118

4. Defence Health Services. Health directive 215: malaria. Canberra: Australian Defence Force, 2006 Nov 29

5. Australian Army Malaria Institute, Minute AMI 46/10, 2010 Sep 14

The changing role and treatment techniques of the Australian military physiotherapist on active service

Rolf Sellentin B. App. Sc. Physiotherapy, M. App. Sc. Manipulative Physiotherapy

Abstract

The contribution physiotherapy has made to military efforts has transformed over recent decades. With the change in warfare techniques and strategy over the last one hundred years came the development of new treatment techniques by Australian physiotherapists to deal with the multifarious and often complex injuries to Service personnel.

Advanced physiotherapy practice and modern methodologies of today have spawned treatment options for musculoskeletal injuries which enable a more rapid return to active duty than ever before in Australian military history. Additionally, physiotherapy now plays an integral role in social responsibility endeavours in the provision of civilian treatment in the local area of operations and in so doing advances the broader political aims linked with current military strategy.

This paper asserts that physiotherapy has evolved from a peripheral remedial activity to take a more central role in maintaining a vigorous and resilient operational force.

This paper offers the reader a contemporary exemplar in the military medical effort that is currently in Afghanistan.

Introduction

The role of physiotherapy in war has been to assist Service personnel to recover from an injury and to maintain the fighting capability of the Defence Force. Clinically there have been fundamental changes in treatment protocols over the last ninety five years as the profession has developed, and with this, the role of an Australian military physiotherapist has evolved from working in the rear echelons in General Hospitals to the present concept of treating injuries in Forward Operating Bases (FOB). This current shift in utilising Australian Physiotherapy Officers in this role enables commanders to maintain an effective force to carry the fight to the enemy.

Discussion

The changing role of physiotherapy in warfare and the evolution of physiotherapy treatment protocols.

Masseurs and masseuses (predecessors of physiotherapists) serving in the Australian Army since 1915, usually worked in overseas General Hospitals in the rear echelons or on Australian Hospital Ships, and provided a range of treatments to injured soldiers so that they could either be returned to duty or classed as an invalid and sent back to Australia (Wilson,1995).

Horrific injuries to Service personnel from gunshot and artillery shells during World War One (WW1) required comprehensive treatment and rehabilitation to restore function to the affected area. The treatment provided by the Army Massage Service was far greater than rudimentary massage and was soon recognised as not only being essential to the recovery and welfare of injured soldiers but also as an important adjunct to their overall medical care. As early as 1915, the Director General of Medical Services recognised the valuable service that the Army Massage Service provided; he advised that "joint injuries can be set at once, provided they are transported on ships with facilities for massage, simple electrical treatments… As regarding nerve injuries following necessary surgery, as soon as the wound is healed facilities must be provided for their continued treatment on the ship by splinting, massage, electricity" (Wilson,1995). Other treatments of the day consisted of massage and hot air baths to open wounds, which had been treated with zinc or copper ionization. An illustration of the amount of work that the Army Massage Service performed is summarised by Butler (1943) who stated that on any given voyage, three thousand treatments were provided to convalescing troops on their return to Australia. Of the different types of injuries seen, Staff Sergeant Beck, a masseuse, wrote in 1916 from Mena House Hospital in Egypt, that "there were plentiful supplies of injuries to knees, ankles, and lumbago" (Wilson, 1995).

Much like the advancement of medicine through war, a wider concept of physical therapy emerged towards the end of WW1; that being the recognition and incorporation of remedial exercise aimed at the attainment of a functional result. From this concept, the term 'physiotherapy' and its philosophy in the restoration of movement and function, through manual treatment and exercise therapy, emerged.

At the commencement of World War Two (WW2), physiotherapists were again called upon and were eventually incorporated into the Australian Army Medical Corps. During this period, several different and new treatment approaches were developed to assist in a soldier's recovery and to restore function. Innovative treatments were developed in line with injuries, such as graduated limb movements in heated saline baths for severe burns, massaging skin grafts with lanoline, treatment of hand injuries and the extended use of remedial exercise therapy. The concept of assisting and instructing in human movement came into being from the physiotherapist's use of passive and active movements to mobilise stiff joints following closed procedures for wounds in plaster casts. When procedures changed to open wound management, the physiotherapist vitalised the skin graft by friction massage movements using lanoline. Much like their WW1 predecessors, physiotherapists continued to remain in the rear echelons, providing secondary care with the view to restoring a serviceman's physical capabilities, enabling them to return to full duty or repatriation back to Australia.

It was not until the Vietnam War that the need for a physiotherapist well forward in the battle space was recognised. Three physiotherapists were deployed in succession with the 1st Australian Field Hospital in Vang Tau from 1969 to 1970 and undertook chest care in the Intensive Care Unit to soldiers following injuries caused by mine explosions as well as in short term rehabilitation to those who were injured by minor gunshot or fragment wounds (Liebich, 2008).

Unlike their predecessors, these physiotherapists worked close to the fighting, and now this role has evolved further in the modern military physiotherapist's expanded role in conflicts such as East Timor and Afghanistan.

In today's theatre of operations, such as Afghanistan, unconventional warfare has taken on a more dominant role compared to previous conflicts. The need for Forward Operating Bases to combat this type of warfare has necessitated the requirement of fully supported units, and with this, the deployment of Australian Physiotherapy Officers within the Area of Operation (AO). Their role is similar to that of previous conflicts but with one important difference – a greater emphasis on restoring the physical impairment of an injured soldier and returning them back to their unit in the shortest possible time, thereby maintaining the fighting capability of the force.

This major difference between the historical role of physiotherapy in previous conflicts and the present role of maintaining a unit as an effective fighting force at the coalface is fundamental. Not only is it costly to repatriate a soldier back to Australia for physiotherapy but there is also the issue of a unit's fighting capability being eroded from the loss of key personnel - two important factors that require remediation. A deployed Physiotherapy Officer with the unit's medical asset has several very important advantages; it compliments the delivery of primary health care by resolving musculoskeletal pain and dysfunction; it is a valuable resource to the Commander by providing an injury recovery timeline for injured personnel and injury prevention strategies; and it is a force multiplier, achieved by maintaining the fighting force by facilitating the recovery of acutely injured soldiers using manual therapy and specific exercise programmes, thus providing the ability to return them to their unit in the shortest possible time.

As a Physiotherapy Officer who was deployed to Tarin Kowt, Afghanistan, in 2009-10, the author had first hand experience in this paradigm shift in the role of an Australian physiotherapist on active service. Deployed with the Regimental Aid Post (RAP) for six months, the author assessed and treated many musculoskeletal injuries that would have either resulted in a serious impediment to the soldier's performance whilst on a mission or to necessitate evacuation back to Australia for rehabilitation. Not only were the unit's 'operators' (front line fighters) treated but also personnel from Combat Service Support (cooks, drivers, mechanics, electricians, stores and medical personnel) who must sustain their capability. Having a Physiotherapy Officer on base ensured that all personnel of the task force could access immediate treatment, thereby maintaining the Force's combat capability.

Although the types of injuries assessed were much like those that Staff Sergeant Beck experienced back in 1916, the important difference in 2010 is that recovery time is quicker as treatment was commenced immediately, and continuity of active service was maintained for the soldier while being treated on location. This last point is of great importance as the 'operator' is able to keep up-to-date with regard to training and missions whilst being treated, thereby maintaining the operational tempo. Furthermore, it was also found that the demand upon the medics and the Medical Officer was reduced with musculoskeletal injuries being treated by the Physiotherapy Officer and thereby freeing their time for other types of ailments and tasks.

Common injuries and key treatments in Afghanistan.

The majority of musculoskeletal injuries assessed in Afghanistan were usually caused by load carriage whilst patrolling beyond the FOB or from gym exercises on base. The types of injuries were many and varied, including facet joint dysfunctions of the spine and ribs, lumbar disc strain, radicular and somatic pain, rotator cuff strains, knee & ankle sprains and tendonitis. These can be quite debilitating to the individual - affecting the ability to run, twist, turn and carry loads, and so reducing the response time to drop to the ground if under fire. This reduction in the soldier's optimum performance under combat conditions poses not only a risk to that individual, but also a significant loss to the effectiveness of that section and to the fighting capability of the unit as whole. Other types of injuries, such as burns, blast and gunshot wounds were rarely seen by the author as the patients were usually sent back to the Role 3 Hospital in Kandahar or Germany and then later transported back to Australia for further treatment depending upon severity.

The skill sets of today's physiotherapists have built upon those of WW1 and WW2, having similarities in the basic therapeutic approach but with some major differences which lend themselves well to the current employment of physiotherapists in a FOB. Apart from the use of manual therapy, which is "a broad group of skilled hand movements used by the physical therapist to mobilise soft tissue and joints for the purpose of modulating pain, increasing the range of motion, reducing or eliminating soft tissue inflammation, inducing relaxation, improving contractile and non-contractile tissue extensibility and improving pulmonary function" (Bottomley, 2000)[4]. The development of manipulative therapy (the application of accurately determined and specifically directed manual forces to the body to improve mobility in areas that are restricted within joints, in connective tissues or skeletal muscles, Korr, 1978)[5] over the last four decades has continued this trend in providing the delivery of effective treatment outcomes to patients that have been observed clinically. These skill sets provide the Physiotherapy Officer with a much broader range of treatment options than his or her predecessors, enabling delivery of a more effective and responsive treatment regime.

The author found that management of a musculoskeletal injury at Tarin Kowt often involved a multidirectional treatment approach to obtain the desired outcome. This could consist of a combination of manipulation (a high velocity but short thrust of the affected joint of the spine) or mobilisation (graded oscillations to a peripheral or spinal joint), correction of muscle length and strength imbalances, dry needling, neural mobilisation, and individually graded exercises that took into account the type and degree of injury and the operational time constraints of the individual. It is this type of treatment approach that enabled soldiers to be rapidly rehabilitated on site and represents a significant shift in the role of an Australian military physiotherapist.

Physiotherapy statistics from the previous three years at Tarin Kowt demonstrated that musculoskeletal injury to the spine had the highest incidence above all other types of injuries. Two examples the author encountered in Afghanistan were lumbar disc strain and facet joint dysfunction of the spine. Lumbar disc strain and disc derangement, usually caused by load carriage (carrying a weighted back pack, body armour and helmet, weapons and ammunition), or long periods of sitting while being driven over rough terrain, resulted in a reduction of the individual's trunk range of movement and difficulty in transferring between standing, sitting or lying due to pain. This injury can severely debilitate the soldier for many weeks and even risk a return to Australia for treatment. Physiotherapy treatment was very successful in resolving this type of injury by using strapping tape to off-load the disc (figure 1), mobilisation to the lumbar spine to restore segmental movement to the area, McKenzie lumbar extension exercises to facilitate this movement and core strengthening exercises to maintain the correction.

Figure 1. Taping the lumbar spine to off-load the disc.

Facet joint dysfunction, which was mainly caused by load carriage, or possibly due to constriction on spinal joints whilst wearing body armour or a combination of both, was also a common injury and often involved the lumbar, thoracic or costovertebral facet joints. This injury can severely restrict movement due to localised pain and associated muscle spasm and greatly hinder the soldier in the field. Movement and function were usually restored very quickly by a localised manipulation (figure 2) to the facet joint with the soldier promptly returning to combat duties, often within 24 hours.

Figure 2. Performing a localised lumbar manipulation.

Another key treatment tool used to facilitate segmental mobility and restore function to a facet joint is mobilisations (figure 3). This treatment can also reduce radicular pain by altering the patency of the spinal foramina and affecting the corresponding exiting nerves. The soldier in picture 3 was experiencing radicular pain extending from the lower cervical spine and down both arms. His condition was successfully managed with mobilisations and he could remain in the AO as an effective member of his combat unit.

Figure 3. Mobilisation to the lower cervical spine.

The role in Counter Insurgency (COIN) and Stability Operations.

Another major difference in the role of physiotherapy in Afghanistan compared to previous conflicts was assisting with the medical care of local Afghans. Counter Insurgency (COIN) and Stability Operations are now a large part of military strategy designed to capture the "hearts and minds" of the local populace as a means of securing a long term and stable resolution. In keeping pace with this philosophy, physiotherapy can play a major part, which contrasts to the physiotherapy role of yesteryear. The author was fortunate to have the opportunity to assist the American Forward Surgical Team (FST) at Tarin Kowt to treat local Afghan civilians, who had suffered from various injuries, often orthopaedic, through accident or conflict (figures 4 & 5). The use of manual therapy and exercise prescription was administered to facilitate their recovery and the provision of this health service to local Afghan people ennobled the Coalition Forces in their minds, thereby contributing to this important COIN concept.

Figure 4. Joint mobilisation of the elbow to improve movement.

Figure 5. Instructing exercises for the knee.

Future developments in treatment protocols

Future treatment protocols for physiotherapists in the Australian Defence Force (ADF) could parallel that of developments currently being undertaken in the Australian public hospital sector. Physiotherapists are now employed in Emergency Departments of many major hospitals, providing assessment, treatment, and advice to patients with acute orthopaedic trauma. Australian military physiotherapists could likewise be a valuable asset in the acute trauma setting whilst on deployment, giving many benefits such as non-surgical interventions, faster flow-through of patients and improved patient clinical outcomes. Furthermore, many public hospital physiotherapists in the UK are training as extended scope practitioners, treating such conditions as subacromial bursitis with a cortisone injection and follow up shoulder exercises. Although Australia has been slow to take up this progression, these extended skills would give the Australian Physiotherapy Officer a broader range of treatment options in the acute care setting whilst on deployment, or in Australia treating Garrison Troops. As new skills and treatments continue to develop in physiotherapy, the need to keep pace is very important and should be reflected in the professional development for military physiotherapists. This is paramount for Physiotherapy Officers in order to continue to provide a valued and essential physiotherapy service to the ADF.

Conclusion

Physiotherapy as a profession has evolved since 1915 through the development of new treatment techniques and methods in response to war injuries. Correspondingly, the role of physiotherapy has also changed from a small contingent of the Army Massage Service providing secondary care in rear echelon hospitals during WW1, to the present day treatment of soldiers in the primary care role well forward in the AO. Today, the ability for Australian Physiotherapy Officers to treat a wide range of conditions on site in the AO enables Commanders to maintain continuity and cohesiveness to their force to maximise operational readiness. Physiotherapy has had a long association with the Australian military service and continues to meet the challenges brought by war, making a significant contribution to the ADF.

Authors' affiliations: Department of Defence, Australia
Contact author: Capt Rolf Sellentin, 3HSB,
Keswick Barracks, Adelaide, South Australia
Email: rolf.sellentin2@defence.gov.au

References

1. Wilson HC. Physiotherapy in war. Gillingham Printers Pty Ltd 1995; 1, 6, 9.
2. Butler AG. Official History of the AAMC: Problems and Services. Australian War Memorial 1943 Vol III; 694.
3. Liebich G.Physiotherapy: the development of a "new practice" and the challenges of the early years. ADF Health 2008; 9: 43-46
4. Bottomley JM. Quick reference dictionary for physical therapy. SLACK Incorporated, Thorofare NJ. 2000; 93.
5. Korr IM. The Neurobiologic Mechanisms in Manipulative Therapy. Plenum Press, New York. 1978; XV.

Load carriage and the female soldier

Robin M Orr[1], Venerina Johnston[1], Julia Coyle[2], Rodney Pope[1,2]

Introduction

There are obvious differences between men and women, differences which are taken into consideration when training athletes. Numerous texts discuss the gender-specific requirements of the female athlete, from coaching styles[1] and training methods1, to dealing with social pressures[2] and the impact of factors that selectively affect the female athlete[3,4]. On this basis, when it comes to athletic endeavours, the specific requirements of the female athlete are well considered. Unfortunately, when it comes to the female soldier and load carriage, there is a notable lack of such dedicated research literature. While several load carriage studies have included female soldiers as participants or even had female participants as their only subjects[5-12], load carriage research traditionally fails to consider the lessons learned from female athletes and apply them to the female soldier undertaking heavy load carriage tasks.

Acute Coagulopathy of Trauma

Acute traumatic blood loss activates the normal coagulation pathway, but massive injury can defeat the normal haemostatic effect of the coagulation cascade. Continued massive exsanguination and ongoing attempts at clotting deplete the body's stores of coagulation factors. Activation of haemostatic mechanisms in turn trigger anticoagulation mechanisms, particularly the Protein C pathway, further reducing the efficacy of the clotting cascade through inhibition of factors V and VII, reduced fibrinogen use and induced fibrinolysis [7]. Coagulopathy of trauma chiefly results from consumption of blood coagulation products, coagulation factor dilution, and abnormal anticoagulation pathway activation, culminating in a pathological fibrinolysis[3-7].

While there may be many more females in the general population engaging in sport and other athletic activities than are serving in defence forces, the number of women serving in the defence forces is growing[13]. Furthermore, while some forces still restrict the employment of women in direct combat roles,[13] the changing nature of warfare and combat environments[14] have seen female soldiers engaging with the enemy[15], receiving awards for combat actions[14], and becoming combat fatalities[14]. These warfare changes require the female soldier, like their male counterpart, to wear body armour and carry increasingly heavy loads[16,17], loads ranging between 40 to 60 kg in Iraq and Afghanistan, as an example[17].

With these loads increasing and the number of female soldiers exposed to these heavy loads increasing, an understanding of the impact of load carriage on the female soldier is of importance, as is consideration of factors already identified as impacting on the female athlete and the female soldier. This paper will review the physiological, biomechanical and health impacts of load carriage on the female soldier, as well as extending to include issues acknowledged as impacting on the female athlete.

Load carriage and its physiological impact

The greater the load carried, the greater the energy cost of standing and moving[6,18,19]. With load carriage a part of a female soldier's vocational tasks, and the absolute loads carried by soldiers increasing[16,17], these findings suggest that whether they be standing while controlling a vehicle check point, or walking on a patrol, the weight of a female soldier's load is going to extract a physiological cost.

The amount of load carried, together with its position, impacts on energy cost[20]. In addition, the speed of march[18,19], march duration[11], gradient of incline[21], and nature of the terrain[22] all impact on the energy cost of carrying a given load.

It has been suggested that load carriage ability has a relationship to a subject's absolute strength[21]. Absolute strength is related to body mass, with heavier men and women tending to have greater absolute strength[23]. A study by Patterson, et al.[11] found that the female soldiers who successfully completed a 15 km march (5.5 km/h, 35 kg load) were taller, heavier, stronger, and had a slightly greater aerobic capacity than the females who failed to finish. Similar findings were made by Pandorf et al.[24] who observed that larger female participants, with more muscle mass, were able to carry heavy loads (40.6 kg load) more rapidly over a 3.2 km distance than their smaller female colleagues. Similarly, other load carriage studies have observed that heavier personnel were less affected by the carried loads[25] than their lighter fellow soldiers. Furthermore, heavier participants wearing 18 kg battle dress were able to work for longer durations[26] and achieve faster casualty rescue times (i.e. dragging an 80 kg manikin 50m)[27]. Thus, for the female soldier, it appears that being heavier and stronger with a slightly greater aerobic capacity may be beneficial during load carriage tasks.

Lyons et al.[28] claim that body composition is more important than total body mass in meeting the aerobic demands of heavy load carriage. This claim is supported by research findings where female participants with increased body fat mass were associated with a reduced aerobic capacity and load carriage task performance[28, 29]. Even when wearing a relatively light load (10 kg body armour), the amount of body fat of female (and male) participants was negatively correlated with physical task performance[29]. Conversely, several studies suggest that body fat (21-32%) does not impact on load carriage task performance for events like an obstacle course and a 3.2 km loaded run[24,30]. It is interesting to note that the studies finding a negative effect of body fat on ability were all load carriage walking activities[28,29,28,29], while the studies failing to find any significant differences were assessed on obstacle course performance and the completion time of a loaded run activity[24,30]. A possible reason for the differences in results may be the differences in task requirements with the low intensity -high volume of prolonged walking being different to the higher intensity-shorter volume of running and obstacle course negotiation in several ways, most notably energy system requirements.

Load carriage and its biomechanical impact

As the carried load increases, the biomechanical posture and movements of the load carrier are altered. Soldiers have been found to increase forward lean from the trunk with increasing backpack loads[31-33]. This postural adaptation alters biomechanics further up the spine, with the head adopting a more forward posture and moments of force around the trunk increasing to counterbalance the load[32]. Increasing load also brings with it changes in spinal curvatures[12,33,34]. While the majority of studies finding changes in spinal shape from heavy load carriage were conducted with male participants[33,34], a study by Meakin et al.[12] employing postural Magnetic Resonance Imaging and Active Shape Modelling (a statistical model of object shape) on both male and female participants identified changes in spinal curvature with loads of 8 kg and 16 kg[12] respectively. Increasing loads unilaterally accentuates lateral lumbar spine curve, increasing the concavity on the opposing side[35]. Therefore, it is understandable that increases in backpack loads have the potential to increase spinal injuries by increasing strain on the musculoskeletal system[32]. As will be discussed, intrinsic factors, like pelvic floor muscle dysfunction, have the potential to further increase the potential for lower back injuries.

Increasing loads also impact on the kinematics of gait for female soldiers. With gait speed the product of stride length and stride frequency3[6], shorter stride lengths, typical of shorter female soldiers, require higher stride frequencies to maintain a given pace[16]. With the exception of a study by Ling et al.[7], whose female participants did not alter stride frequency as loads increased, female participants have been found to further increase stride frequency rather than stride length when required to carry greater loads or increase walking speed[16]. Harman et al.[37] suggest that there may be a point where stride frequency can no longer be increased, which means that stride length must increase to maintain a given speed. This stride frequency limitation, which may explain the results of Ling et al.[7] whose female participants failed to increase stride frequency significantly as loads increased, raises potential concerns if load carriers normally utilise this mechanism to accommodate increases in load and speed. With the load carrier no longer able to increase stride frequency as loads or march speeds increase, they have to increase stride length. In addition soldiers are often forced to maintain a given pace or 'keep in step'. This practice likewise limits stride frequency and forces stride lengths to increase if a given speed is to be maintained. For some soldiers, and particularly shorter soldiers, this may require a stride length that is greater than their maximum comfortable and safe stride length, meaning they overstride. This adaptive overstriding can place additional shearing stress on the pelvis, leading to stress reactions or stress fractures in the pelvic bones[38]. Pope[38] found that the incidence of pelvic stress fractures in female army recruits was reduced by 95% when a multifaceted preventive intervention was implemented by Physical Training Instructors. This intervention included, among other elements: reducing marching speed; reducing the requirement to 'keep in step'; and encouraging recruits to march at comfortable stride lengths.

Changes in gait mechanics are coupled with changes in forces acting on the body. Ground reaction forces (GRF), which are the result of all the reaction forces between the foot and the ground as the foot makes contact with the ground[39], have been found to increase in both female and male participants as loads increase[31]. These increases in GRF create shearing forces which can induce blisters[40] and, by increasing the total volume of impact forces, can increase the risk of overuse injuries[41].

Load carriage and its health impact

Load carriage places strain on the musculoskeletal system of the carrier[31,37]. On this basis, load carriage tasks have the potential to cause acute and chronic overuse injuries. During military load carriage activities, military personnel have presented with blisters[40], stress fractures[38], knee pain[41], foot pain[16,41], brachial plexus palsy[16], and lower back injuries[41]. Increased fitness may provide one means of mitigating the negative impact of load carriage[16,42].

Low levels of fitness are associated with an increased risk of injury during both general military training[43] and load carriage activities[44]. Therefore, physical conditioning to increase fitness levels may constitute one means of limiting load carriage injuries[16,42].

Traced back as far as the Roman Legionnaires and Macedonian foot soldiers[17], recognition of the need to condition soldiers to carry loads is not new. However, load carriage conditioning needs to be applied with care. Even though initial training has been found to increase the fitness levels of female soldiers[45], studies have found that injury rates at the commencement of initial training can be relatively high. A review of a six week Marine Corps Officer Basic Training Course found a cumulative injury incidence of 80% for female candidates[46]. In addition, over the longer 11 week Marine Basic Training Course, female recruits showed increases in levels of bone resorption markers, indicating bone stress, in Weeks 2, 8, 9, 10 and 11 of training. These examples highlight the need for the general conditioning process, including the load carriage conditioning, to be slow, progressive, and include adequate and appropriately-timed periods of recovery[42]. In addition, consideration needs to be given to gender-specific concerns identified as impacting on female athletes; concerns like the female athlete triad, poor nutrition and hydration practices, urinary incontinence (UI) and pelvic floor muscle function, and poor equipment fit. These additional considerations are further discussed below.

The female athlete triad

The term "female athlete triad" was first coined in a special American College of Sports Medicine (ASCM) conference in 1992[47]. The concept was developed following concern over three risk factors associated with female athletes, these being amenorrhoea, osteoporosis and eating disorders[48]. Alone, or in combination, these three factors pose a significant threat to physically active women and hence female soldiers involved in load carriage[49].

By definition, amenorrhoea is a dysfunction of the menstrual cycle which leads to an absence of a regular menstrual cycle[50]. With the cessation of menstruation, hormone balances are disrupted and the uptake of calcium is affected, thus leading to bone loss and porosity 2 and in turn increasing the risk of stress fractures[51]. In a study by Rauh et al.[51], female soldiers who reported being amenorrheic, missing six or more menses during a 12 month period, were found to have an almost threefold increase in lower-extremity stress fracture risk. This is important in the knowledge that an amenorrhoea prevalence rate of around 45% has been found for female military recruits[52].

Amenorrhoea can be caused by several factors prevalent in female military soldiers. High intensity physical exercise, for example, has been found to cause amenorrhoea in female athletes[53]. The stress of war has also been shown to induce menstrual abnormalities including amenorrhoea[50]. In addition, recent studies have reported that female soldiers have been found to favour menstrual suppression during deployment[54]. With the long term health implications of menstrual suppression requiring further study[55], some research has found participants on certain programs, like medroxyprogesterone injections, to have lower bone mineral density[56]. This bone mineral loss is reversible on cessation of the treatment[56]. Other programs, like monophasic oral contraceptives, may have a neutral or positive effect[55] on bone density while programs using vaginal rings have, at this stage, an unknown impact[55]. Considering all this, there is the potential for amenorrhoea to increase the female soldier's risk of adverse health sequelae, like osteoporosis.

Osteoporosis is an increase in the porosity of bone caused by a decrease in bone mineral density[48]. Although osteoporosis is more common in post menopausal women, athletes suffering from eating disorders and amenorrhoea are highly susceptible to osteopenia and osteoporosis, with disordered eating reducing important nutrient intake and menstrual disturbances decreasing bone protection[3,49]. As the number of missed menstrual cycles accumulate, the loss of bone mineral density also accumulates[57]. This loss may not be completely reversible[49]. For the younger female soldier, these conditions may lead to them never attaining a normal peak bone density and, with natural age related bone loss, may make them susceptible to osteoporotic fractures at an early age[3] and increase their risk of postmenopausal fractures[58].

Osteoporosis and amenorrhoea may also be caused by an eating disorder[49]. A study by Lauder, et al.[59], 60 found an incidence of 8% for diagnosed eating disorders in female soldiers. This result was higher than that for the general population but lower than that for a female athlete population. They also found that 33% of these female soldiers were 'at risk' of an eating disorder and fell into the category of disordered eating, a term used to describe eating behaviour rather than being a definitive clinical diagnosis[3]. Having a third of the cohort with dietary concerns that can be linked to the female athlete triad is of concern. Stressful environments like combat zones have the potential to further increase the number of women suffering from eating disorders in the military[61]. Disordered eating in female soldiers may increase the incidence of amenorrhoea and osteoporosis and the subsequent prevalence of fractures[49,51], through activities like load carriage[38].

In their 2007 position stand on the female athlete triad, the ACSM suggested that it is low energy availability rather than disordered eating which is of concern[49]. This conclusion has ramifications for female soldiers on exercise or deployment, where sustenance comes from combat ration packs. Female soldiers may simply not consume sufficient energy[62]. Even though ration pack meals are designed to provide sufficient energy, many soldiers discard portions of their ration packs due to personal taste and thus fail to meet required energy intakes63. This is of notable concern as research has shown that load carriage during field tasks increases energy requirements[64] thus making the divide between energy intake and energy expenditure even greater and placing the female soldier at greater risk in relation to the features of the female athlete triad.

Additional Nutrition Concerns

Even when consuming enough food to meet their daily energy requirements, female soldiers may not be meeting their recommended daily iron intake requirements[64]. As iron is essential for haemoglobin production, low iron intake will impact on haemoglobin synthesis[65]. Low haemoglobin production reduces the ability of the body to transport oxygen in the blood to the working muscles, thereby impairing performance of physical tasks[65,66], like load carriage.

In addition, while dietary iron intake may be insufficient, iron requirements may increase during physical activity, as physical training is known to create an iron cost for the body[65,66]. Therefore, it is not surprising that the commencement of military training, with its increase in physical demands, has led to findings of an increase in iron deficiency in female soldiers and of iron deficiency anaemia occurring during, and immediately following, basic training[65,67]. While no studies that examine the impact of military pre-deployment training on iron status could be found, the sudden increase in physical training and field exercise training could be expected to increase the prevalence of iron deficiency and iron deficiency anaemia. A notable concern becomes evident if this deficiency occurs just prior to deployment, a protracted period where combat stress and ration pack meals may have a further negative impact on dietary iron uptake and iron status. Even mild iron deficiency has been found to impair cognitive function, and clear thinking specifically[65]. Load carriage has also been found to impact on alertness and vigilance[5]. On this basis, the combination of these two factors may profoundly impact on a soldier's ability to notice visual cues when scanning for enemy and other threats (like Improvised Explosive Devices), and steps should be taken to prevent this situation.

Urinary Incontinence and Pelvic Floor Muscle Function

Female soldiers have reported experiencing urinary incontinence (UI) during heavy load carriage activities, with one study reporting an incidence rate as high as 26%[68]. A study of American active duty female soldiers by Davis et al.[68] found that 31% of female soldiers reported suffering UI whilst on duty to such an extent that it interfered with their job, was socially embarrassing, and was considered particularly debilitating during field exercises. UI is a symptom of pelvic floor muscle (PFM) dysfunction or fatigue[68]. Of importance to load carriage is the established link between PFM function and spinal stabilisation[69,70]. The transverse abdominal muscles have been found to improve spinal stabilisation through increasing intra-abdominal pressure[69]. Research has also found that it is essential for effective spinal stabilisation that pelvic floor and diaphragm muscles contract as the transverse abdominals contract[70]. With dysfunctional pelvic floor muscles, the ability of the transverse abdominals to contribute to spinal stabilisation is lost and the lower back becomes more susceptible to injury[70].

In the load carriage context, heavy loads have been found to increase trunk forward lean, increase lumbar compression and shear forces, change thoraco-pelvic rhythm and increase spinal torques[12,31]. Thus, the PFM dysfunction often associated with UI has the potential to reduce spinal stability and increase the risk of lower back injury in female soldiers.

Some self-administered preventative strategies for UI also have the potential to cause illness during load carriage events. Davis et al.[68] and Sherman et al.[71] both found that approximately 13% of female soldiers who reported experiencing UI significantly restricted their fluid intake during field activities. Therefore, in order to reduce experiencing an incontinence episode, female soldiers put themselves at risk of heat related illnesses through becoming dehydrated during periods of high physical exertion, like field exercises and when conducting load carriage tasks.

Poor Equipment Fit

It is widely acknowledged in the sporting field that poor equipment fit can lead to injury and reduced performance[72]. When it comes to carrying loads, female soldiers have raised concerns over load carrying equipment[44,73]. Problems with pack fit, shoulder strap fit and position of the waist belt have been identified as the more common concerns[7,44,73]. These load carriage equipment concerns are thought to be exacerbated when female soldiers are required to wear body armour[73]. A study by Fullenkamp et al.[74], capturing the anthropometric data of defence force soldiers from four NATO countries, highlighted the fact that

designing protective equipment to accommodate female soldier structure was not as simple as scaling down male-proportioned figures. Likewise, data collected by Harman et al.[73] led the authors to recommend that female soldiers required more specific sizing options than male soldiers due to greater variability in chest-waist-hip ratios. An immediate example is the failure of body armour designs to accommodate female breast tissue. As such, it is of no surprise that female soldiers raise concerns that body armour is not comfortable and restricts breathing[73].

Failure to accommodate soldier anthropometrics in one piece of equipment can impede the function of other pieces of equipment even if these factors were addressed in these other pieces of equipment. For example, the looseness of the Interceptor Body Armour around the waist was found to impede the cinching of the waist belt of the pack being carried[73]. The inability to cinch the waist belt impedes a design intent of the US Modular Lightweight Load-Carrying Equipment (MOLLE) pack – that being to remove load from the shoulders and shift it to the pelvis[75]. The inability to cinch the waist belt will mean the load carrier becomes less efficient[44] and more prone to injuries16. A lack of accommodation of female soldier requirements in equipment design may contribute to a reduction in female load carriage performance[25] and compromise soldier safety[74]. However, before load carriage and body armour equipment designers consider how best to meet female soldier requirements, Browne[76] offers a poignant caution that military equipment should focus first and foremost on combat effectiveness before considering anthropometric concerns or personnel.

Summary

Physiological factors, like body fat mass, strength, and aerobic endurance, as well as biomechanical factors, like stride length and forward lean, have the propensity to increase both the energy cost of completing a load carriage task, and the potential for injury. The female athlete triad, which can be induced or worsened by intense physical activity (like load carriage), poor nutritional intake, and stressors within the combat environments, likewise raises injury potential concerns. Furthermore, iron deficiency, PFM dysfunction or fatigue, and military equipment issues can reduce performance, increase fatigue and increase the risk of injury in female soldiers.

Strategies to improve female load carriage performance and minimise injuries

This paper has reviewed and discussed the physiological, biomechanical and health impacts of load carriage on the female soldier. The discussion of factors affecting load carriage by female soldiers and its impacts on the female soldier has been broadened and diversified to include issues known to affect female athletes and hence also many female soldiers engaged in load carriage. In order to address issues affecting load carriage performance and minimise load carriage injuries in female soldiers, several strategies should be considered, including: structured physical conditioning, improving nutrition and hydration practices, and modification of load carriage equipment to meet female soldier requirements.

Structured Physical Conditioning

Load carriage conditioning needs to be structured and carefully implemented. With consideration of the susceptibility of female soldiers to nutritional deficiencies, the female athlete triad and subsequent general overuse conditions, the load carriage program needs to include 'deloading' periods to facilitate musculoskeletal and metabolic recovery. While load carriage conditioning sessions should be conducted at least once every two weeks[42], supplemental aerobic conditioning and strength training should be included[42]. The introduction of pelvic floor muscle education and training may also be of benefit[69]. The impacts of this multi-layered approach will assist in addressing several concerns identified within this report, most notably being the need to increase lean muscle mass, control body fat mass at a low healthy level, increase muscle strength, increase aerobic capacity, and improve pelvic floor muscle function.

Complementing these conditioning programs would be the implementation of an effective injury surveillance program. This program should be both proactive, through ongoing monitoring and forward adaptation of training, and reactive, responding to findings and initiating improvement strategies within training programs. The benefits of these types of programs are highlighted by the findings of a study into recruit injuries at the Australian Army Recruit Training Centre. The study noted that the injury surveillance system played a strong, positive role in identifying, controlling, and influencing the causation of injuries, thereby reducing injury rates[77].

Improving Nutrition Practices

To improve iron status, nutritional education programs, which highlight the importance of iron intake and daily requirements and provide information on good iron sources from daily lifestyle diet, should be provided and these choices made easily available[65-67]. Oral iron supplementation may be considered a viable option to improve iron intake. Although a study by Carins et al.[65] found that a daily iron supplement of ~18mg did not affect the iron status of female soldiers, other literature supports the use and effectiveness of iron

supplementation[66,67]. However, Johnson[78], recommends that the conservative education approach be tried before single-nutrient supplementation is warranted. On this basis, caution is advised regarding iron supplementation until further research validates the efficacy of its use.

Improving Hydration Practices

Awareness of the impact of fluid avoidance and the subsequent consequences must be raised and assured among female soldiers. However, future research in this field is needed as no literature could be found that examines the use of awareness-building strategies to reduce the impact on performance and health of fluid avoidance as a means of preventing urinary incontinence. Furthermore, alternatives to hydration avoidance (like pelvic floor muscle conditioning and promotion of acceptable means of managing urinary incontinence in the field and during load carriage tasks) must be made readily available and promoted in order to address the underlying causes of hydration avoidance among female soldiers engaging in load carriage[68,71].

Modification of Load Carriage Equipment to meet Female Soldier Requirements

Soldier modernisation programs are currently being undertaken by numerous defence forces around the globe, including Australian (Land 125/project WUDURRA), Canadian (IPCE), German (IdZ), Dutch (Dutch Soldier Modernisation Program), French (FELIN), Italian (Combattente 2000), Spanish (Combatiente Futuro), South African (African Warrior), British (FIST) and US (LAND WARRIOR / OBJECTIVE FORCE WARRIOR) defence forces, as well as the Greek, Israeli and Norwegian defence forces[79]. These modernisation programs include focus on several areas that either directly or indirectly impact on soldier load carriage systems[79]. With claims by Ling et al.[7] that the MOLLE military backpack was created based on male anthropometric characteristics and with the female-specific fitting concerns and need for a greater range of sizes available to female soldiers identified, it would seem logical that these future warrior programs specifically tailor equipment to include female anthropometric features. Failing to do so could impact on future force generation and sustainment.

Limitations of this paper and recommendations for future work

While this paper has started to merge scientific evidence from the fields of female soldier load carriage and the female sporting athlete, many topics have yet to be discussed. The impacts of pregnancy, menstrual and ovarian cycles, and potential psycho-sociological issues provide examples of topics that, although explored in regards to the female athlete, have yet to be explored in the context of military load carriage. Furthermore, while several key strategies have been discussed, other potential strategies, like soldier selection, have yet to be reviewed. It is hoped that this paper provides the impetus for future discussion papers and research in which the field of female soldier load carriage and the field of the female sporting athlete are further considered and expanded

Conclusions

It is clear from the research evidence presented in this paper that sufficient evidence exists to inform the development and implementation of strategies to enhance load carriage performance and reduce associated risks in female soldiers – an area which has historically received little attention. Some of this evidence is drawn from research in the military context, and some from research in the context of female athletes. While much further research is warranted, it is timely in light of recent developments in the nature of military operations for military forces worldwide to consider the available evidence and implement appropriate strategies to enhance load carriage performance and reduce associated risks among female soldiers.

Authors' affiliations: [1] The University of Queensland, [2] Charles Sturt University
Corresponding author: LT Robin Orr, c/- Level 7, Physiotherapy Division, School of Health and Rehabilitation Sciences, The University of Queensland,St Lucia, QLD 4072
Email: Robin.Orr@defence.gov.au

References

1. O'Connor B, Fasting K, Dahm D, et al. Complete conditioning for the female athlete: Wish Pub; 2001.
2. Costa DM, Guthrie SR. Women and sport: Interdisciplinary perspectives: Human Kinetics Publishers; 1994.
3. Brunet M. Unique Considerations of the Female Athlete: Cengage Learning; 2009.
4. Ireland ML, Ott SM. Special concerns of the female athlete. Clinics in sports medicine. 2004;23(2):281.
5. May B, Tomporowski PD, Ferrara M. Effects of Backpack Load on Balance and Decisional Processes. Military Medicine. 2009;174(12):1308-1312.
6. Pederson AV, Stokke R, Mamen A. Effects of extra load position on energy expenditure in treadmill running. Eur J Appl Physiol. 2007;102(1):27-31.
7. Ling W, Houston V, Tsai YS, et al. Women's load carriage performance using modular lightweight load-carrying equipment. Military Med. 2004;169(11):914-919.
8. Leyk D, Rohde U, Erley O, et al. Maximal manual stretcher carriage: performance and recovery of male and female ambulance workers. Ergonomics. 2007;50(5):752-762.
9. Hansen AH, Childress DS. Effects of adding weight to the torso on roll-over characteristics of walking. Journal of Rehabilitation Research and Development. 2005;42(3):381-390.
10. Ricciardi R, Deuster P, Talbot LA. Metabolic demands of Body Armor on physical performance in simulated conditions. Military Med. 2008;173(9):817-824.
11. Patterson MJ, Roberts WS, Lau WM, et al. Gender and Physical Training Effects on Soldier Physical Competencies and Physiological Strain. Defence Science and Technology Organisation. 2005:65.
12. Meakin JR, Smith FW, Gilbert FJ, et al. The effect of axial load on the sagittal plane curvature of the upright human spine in vivo. J Biomech. 2008;41(13):2850-2854.
13. Davison S. The Combat Exclusion of Women in the Military: Paternalistic Protection or Military Need? Australian Army Journal. 2007;IV(3):59-79.
14. Sheppard C, Waggener A. Women in Combat: ARMY WAR COLL CARLISLE BARRACKS PA; 2007.
15. Burnes T, Army War Coll Carlisle Barracks PA. Contributions of Women to US Combat Operations: ARMY WAR COLL CARLISLE BARRACKS PA; 2008.
16. Knapik JJ, Reynolds KL, Harman E. Soldier load carriage: Historical, physiological, biomechanical, and medical aspects. Military Med. 2004;169(1):45-56.
17. Orr RM. The History of the Soldier's Load. The Australian Army Journal. 2010;vii(2):67-88.
18. Robertson RJ, Caspersen CJ, Allison TG, et al. Differentiated perceptions of exertion and energy cost of young women while carrying loads. Eur J Appl Physiol Occup Physiol. 1982;49(1):69-78.
19. Charteris J, Scott PA, Nottrodt JW. Metabolic and kinematic responses of African women head loaded carriers under controlled conditions of load and speed. Ergonomics. 1989;32(12):1539-1550.
20. Abe D, Yanagawa K, Niihata S. Effects of load carriage, load position, and walking speed on energy cost of walking. Appl Ergon. 2004;35(4):329-335.
21. Scott PA, Ramabhai L. Load Carrying: in situ Physiological responses of an infantry platoon. Ergonomics. 2000;2000(1):18 - 24.
22. Soule RG, Goldman RF. Terrain coefficients for energy cost prediction. J Appl Physiol. 1972;32(5):706-708.
23. Zatsiorsky VM, Kraemer W. Science and practice of strength training. 2nd ed: Human Kinetics; 2006.
24. Pandorf CE, Harman E, Frykman PN, et al. Correlates of load carriage and obstacle performance among women. Work. 2002;18(2):179-189.
25. Harper WH, Knapik JJ, de Pontbriand R. Equipment compatibility and performance of men and women during heavy load carriage. Paper presented at: Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting1997.

26. Bilzon J, Allsopp A, Tipton MJ. Assessment of physical fitness for occupations encompassing load-carriage tasks. Occup Med (Lond). 2001;51(5):357-361.

27. Harman E, Gutekunst DJ, Frykman PN, et al. Prediction of Simulated Battlefield physical performance from Field-Expedient Tests. Military Med. 2008;173(1):36-41.

28. Lyons J, Allsopp A, Bilzon J. Influences of body composition upon the relative metabolic and cardiovascular demands of load-carriage. Occup Med (Lond). 2005;55(5):380-384.

29. Ricciardi R, Deuster P, Talbot LA. Effects of Gender and Body Adiposity on physiological responses to physical work while wearing body armor. Military Med. 2007;172(7):743-748.

30. Frykman PN, Harman E, Pandorf CE. Correlates of obstacle course performance among female soldiers carrying two different loads. RTO Meeting Proceedings 56: Soldier Mobility: Innovations in Load Carriage System Design and Evaluation. Kingston, Canada: Research and Technology Organisation/North Atlantic Treaty Organization; 2000.

31. Polcyn AF, Bensel CK, Harman E, et al. The effects of load weight: a summary analysis of maximal performance, physiological and biomechanical results from four studies of load carriage systems. RTO Meeting Proceedings 56: Soldier Mobility: Innovations in Load Carriage System Design and Evaluation. Kingston, Canada: Research and Technology Organisation/North Atlantic Treaty Organization; 2000.

32. Attwells R, Birrell SA, Hooper RH, et al. Influence of carrying heavy loads on soldier's posture, movements and gait. Ergonomics. 2006;49(14):1527-1537.

33. Fowler NE, Rodacki AL, Rodacki CD. Changes in stature and spine kinematics during a loaded walking task. Gait Posture. 2006;23(2):133-141.

34. Orloff HA, Rapp CM. The effects of load carriage on spinal curvature and posture. Spine. 2004;29(12):1325-1329.

35. Filaire M, Vacheron JJ, Vanneuville G, et al. Influence of the mode of load carriage on the static posture of the pelvic girdle and the thoracic and lumbar spine in vivo. Surg Radiol Anat. 2001;23(1):27-31.

36. Hoffman J. Physiological aspects of sport training and performance: Human Kinetics; 2002.

37. Harman E, Han K-H, Frykman PN. Load-speed interaction effects on the biomechanics of backpack load carriage. RTO Meeting Proceedings 56: Soldier Mobility: Innovations in Load Carriage System Design and Evaluation. Kingston, Canada: Research and Technology Organisation/North Atlantic Treaty Organization; 2000.

38. Pope R. Prevention of pelvic stress fractures in female army recruits. Military Med. 1999;164(5):370-373.

39. Grimshaw P. Sport and exercise biomechanics: BIOS Scientific Publ; 2006.

40. Knapik JJ, Reynolds KL, Barson J. Risk factors for foot blisters during road marching: Tobacco use, ethnicity, foot type, previous illness, and other factors. Military Med. 1999;164(2):92-97.

41. Reynolds KL, White J, Knapik JJ, et al. Injuries and risk factors in a 100-mile (161-km) infantry road march. Preventative Medicine. 1999;28(2):167-173.

42. Orr RM, Pope R, Johnston V, et al. Load Carriage: Minimising soldier injuries through physical conditioning - A narrative review. Journal of Military and Veterans' Health. 2010;18(3):31-38.

43. Pope R. Prediction and prevention of lower limb injuries and attrition in army recruits, Charles Sturt University; 2002.

44. Knapik JJ. Physiological, Biomechanical and Medical Aspects of Soldier Load Carriage. Soldier Mobility: Innovations in Load Carriage System Design and Evaluation. Canada2000:KN1-1 - 18.

45. Moran DS, Evans R, Hadid A, et al. Gender Differences in Physical Fitness of Military Recruits during Army Basic Training. RTO Human Factors and Medicine Panel (HFM) Symposium. Antalya, Turkey2008:13-11 - 13-12.

46. O'Connor F. Injuries during Marine Corps officer basic training. Military Med. 2000;165(7):515-520.

47. American College of Sports Medicine. The Female Athlete Triad. Position Stand. 1997;25(5).

48. McArdle WD, Katch FL, Katch VL. Exercise Physiology: Nutrition, Energy, and Human Performance: Lippincott Williams & Wilkins; 2009.

49. Nattiv A, Loucks AB, Manore MM, et al. American College of Sports Medicine position stand. The female athlete triad. Medicine and science in sports and exercise. 2007;39(10):1867.

50. Kaufman A. Amenorrhea. Family Medicine. 2009;118:10-12.

51. Rauh MJ, Macera CA, Trone DW, et al. Epidemiology of stress fracture and lower-extremity overuse injury in female recruits. Medicine & Science in Sports & Exercise. 2006;38(9):1571.

52. Cline AD, Jansen GR, Melby CL. Stress fractures in female army recruits: implications of bone density, calcium intake, and exercise. Journal of the American College of Nutrition. 1998;17(2):128.

53. Castelo-Branco C, Reina F, Montivero AD, et al. Influence of high-intensity training and of dietetic and anthropometric factors on menstrual cycle disorders in ballet dancers. Gynecological Endocrinology. 2006;22(1):31-35.

54. Trego LL, Jordan PJ. Military Women's Attitudes Toward Menstruation and Menstrual Suppression in Relation to the Deployed Environment: Development and Testing of the MWATMS-9 (Short Form). Women's Health Issues. 2010.

55. Christopher LA, Miller L. Women in War-Operational Issues of Menstruation and Unintended Pregnancy. Military medicine. 2007;172(1):9-16.

56. Curtis KM, Martins SL. Progestogen-only contraception and bone mineral density: a systematic review. Contraception. 2006;73(5):470-487.

57. Drinkwater BL, Bruemner B, Chesnut III CH. Menstrual history as a determinant of current bone density in young athletes. JAMA 1990;263(4):545.

58. Hosmer WD, Genant HK, Browner WS. Fractures before menopause: a red flag for physicians. Osteoporosis International. 2002;13(4):337-341.

59. Lauder TD, Williams MV, Campbell CS, et al. Abnormal eating behaviors in military women. Medicine & Science in Sports & Exercise. 1999;31(9):1265.

60. Lauder TD, Madigan Army Medical Center Tacoma WA. The female athlete triad: prevalence in military women1997.

61. Antczak AJ, Brininger TL. Diagnosed eating disorders in the US military: a nine year review. Eating Disorders. 2008;16(5):363-377.

62. Keep L. Health Care For Women In Mobilization and Deployment. Military Preventative Medicine: Mobilization and Deployment, Volume 1. 2003:341-362.

63. Booth CK. Combat rations and military performance-do soldiers on active service eat enough? Asia Pacific journal of clinical nutrition. 2003;12:S2.

64. Booth CK. Not eating enough-the trouble with combat rations. Paper presented at: International Congress of Military Medicine2002.

65. Carins J, Booth C, Coad R. Low Dose Ferrous Gluconate Supplement Fails to Alter the Iron Status of Female Officers-in-Training. 2005.

66. Brothers M, Wilson C. Iron Deficiency in Women and Its Potential Impact on Military Effectiveness. Nurs Clin N Am. 2010;45:95-108.

67. McClung JP, Karl JP, Cable SJ, et al. Randomized, double-blind, placebo-controlled trial of iron supplementation in female soldiers during military training: effects on iron status, physical performance, and mood. American Journal of Clinical Nutrition. 2009;90(1):124.

68. Davis G, Sherman R, Wong MF, et al. Urinary incontinence among female soldiers. Military mede. 1999;164(3):182-187.

69. Bo K, Morkved S, Frawley H, et al. Evidence for Benefit of Transversus Abdominis Training Alone or in Combination With Pelvic Floor Muscle Training to Treat Female Urinary Incontinence: A Systematic Review. Neurourology and Urodynamics. 2009;28:368-373.

70. Richardson CA, Hodges P, Hides JA. Therapeutic exercise for lumbopelvic stabilization. A Motor Control Approach for the Treatment and Prevention of Low Back Pain. 2nd Edition ed: Churchill Livingstone; 2004.

71. Sherman RA, Davis GD, Wong MF. Behavioral treatment of exercise-induced urinary incontinence among female soldiers. Military med. 1997;162(10):690-694.

72. Gotlin RS. Sports Injuries Guidebook: Human Kinetics Publishers; 2007.

73. Harman E, Frykman PN, Pandorf CE, et al. Physiological, biomechanical, and maximal performance comparisons of female soldiers carrying loads using prototype U.S. Marine Corps Modular Lightweight Load-Carrying Equipment (MOLLE) with Interceptor body armor and U.S. Army All-Purpose Lightweight Individual Carrying Equipment (ALICE) with PASGT body armor. Technical Report T99-9. NATICK MA, U.S. Army Research Institute of Environmental Medicine. 1999.

74. Fullenkamp AM, Robinette KM, Daanen HA. Gender Differences in NATO Anthropometry and the Implication for Protective Equipment. Air Force Research Lab Wright-Patterson AFB OH Biomechanics, Branch, AFRL-RH-WP-JA-2008-0014. 2008.

75. Palmer C. From ALICE to "Molly". Soldiers. 1998;53(10):20.

76. Browne K. Co-ed combat: the new evidence that women shouldn't fight the nation's wars: Sentinel; 2007.

77. Pope RP. Injury surveillance and systematic investigation identify a rubber matting hazard for anterior cruciate ligament rupture on an obstacle course. Military Medicine. 2002;167(4):359-362.

78. Johnson AE. Iron Supplementation and the Female Soldier. Military mede. 2006;171(4):298-300.

79. Baddeley A. Combat Soldier C4I. Military Technology. 2007;31(9):34-40,42-44.

The loss of HMAS *Sydney* II: medical aspects

Neil Westphalen, RAN MBBS (Adel), MPH, Dip AvMed, FRACGP, FAFOEM

HMAS Sydney 11

HMAS *Sydney* April 1940[1]

On 19 November 1941, HMAS *Sydney* was 100nm off Shark Bay, on her way back to Fremantle after escorting the troopship *Zealandia* to Sunda Strait, between Java and Sumatra.

At 1600 she encountered the German auxiliary cruiser *Kormoran*. The ensuring battle began at 1730 and ended at 1825. *Sydney* was last seen on fire at 2300 while *Kormoran* was scuttled and sank just after midnight. There were 318 survivors from *Kormoran's* crew of 399, but no survivors from *Sydney's* crew of 645. Both wrecks were found in March 2008 and this led to a Commission of Inquiry to address the various controversies and conspiracy theories related to *Sydney's* loss[2].

This article describes the medical aspects of *Sydney's* final action, as an acknowledgement to her medical department. All sickbay staff at the time of her loss had joined *Sydney* between April and August 1941, following her return to Australia the previous February from a deployment to the Mediterranean that made her famous[3].

Sydney's Medical Facilities

It is necessary to describe *Sydney's* medical facilities, in order to provide context.

The dental surgery was located in the bridge superstructure, in a somewhat odd location next to the captain and navigator's sea cabin.

The sickbay was used as the Main Dressing Station in action. It was located two decks below the dental surgery. The Auxiliary Dressing Station was right aft another deck below, in the Warrant Officer's Mess.

In action, first aid personnel drawn from the cooks and stewards were also based in the Petty Officer's pantry and the half-deck space, on the wardroom deck level.

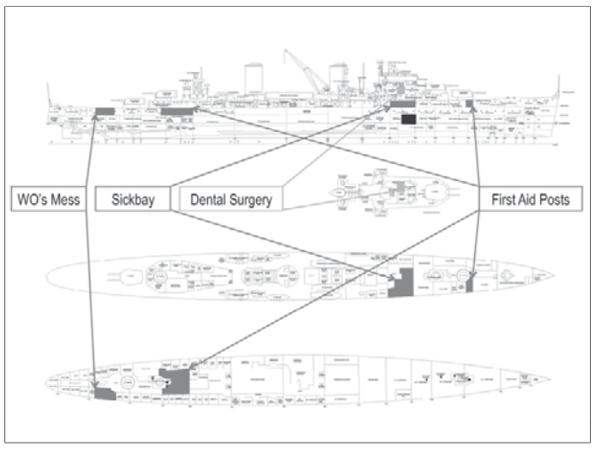


Figure 1: HMAS Sydney medical facilities

HMAS *Sydney* medical facilities[4]

There were also three damage control bases, with the aft one co-located with the after first aid post. What would be called Damage Control Central (DCC) today, was located in the lower steering position, two decks below the sickbay.

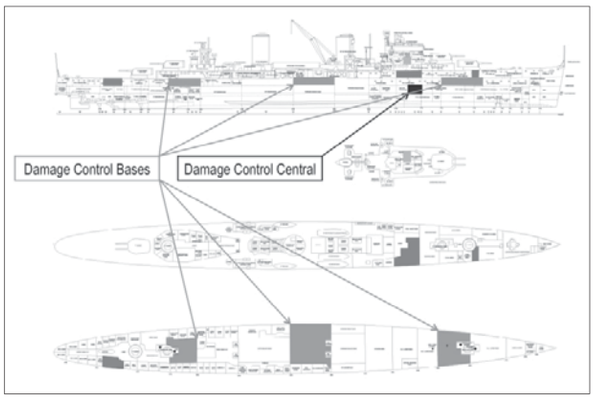


Figure 2: HMAS Sydney damage control bases

The Action

The Germans indicated that *Kormoran* opened fire when *Sydney* was abeam or just abaft her starboard side, on a parallel course, at a range of only 1500 metres. *Kormoran's* first target was *Sydney's* bridge, followed by her forward turrets. Soon after *Kormoran's* guns opened fire, she hit *Sydney's* bows with a torpedo, which made the forward part of the ship sit lower in the water[6].

The Germans then stated that *Sydney* turned to port in an apparent attempt to ram. This meant *Kormoran's* gunfire remained targeted on the forward half of the ship. Sydney passed astern of *Kormoran*, opening her starboard side to German gunfire. As night fell, *Sydney* slowly disappeared over the horizon at about five knots. The glow from her fires was last seen at about 2300[7].

Meanwhile *Sydney* hit *Kormoran* in the engine room, causing a fire which could not be controlled. *Kormoran* was abandoned at about 2100, although the last of her crew did not leave the ship until midnight, after setting scuttling charges. She blew up and sank half an hour later[8].

Kormoran was armed with six 150mm guns, of which four could bear on either side of the ship. She also had two 37mm anti-tank guns, five 20mm guns, four torpedo tubes, 400 mines, and a reconnaissance aircraft[9].

The key consideration for the damage inflicted on Sydney was the 150mm guns, which fired high explosive (HE) and armour-piercing (AP) rounds. Both shell types weighed about 45kg. The HE shells contained about 4.5kg of explosive, generated about 4000 fragments per shell, and caused damage within a 3 metre radius, and injuries within a 5 metre radius. The AP shells had about 1kg of explosive, generated much fewer but larger fragments per shell, with damage and injuries within smaller radii[10].

Based on the footage from MV *Geosounder* when she found *Sydney* in March 2008, DSTO found at least 87 150mm shell hits, resulting in about 200,000 red-hot frags travelling up to 1200 m/sec. This is equivalent to 300 frags per crew member, and does not include secondary fragments from the ship's structure[11].

To put *Kormoran's* gunpower into context, this is a photo of a blown out bulkhead during DSTO trials aboard ex HMAS *Derwent* in 1994. This damage was caused by a stationary 4.5 kg cased charge, while *Kormoran's* shells were moving at nearly *700m/sec*.

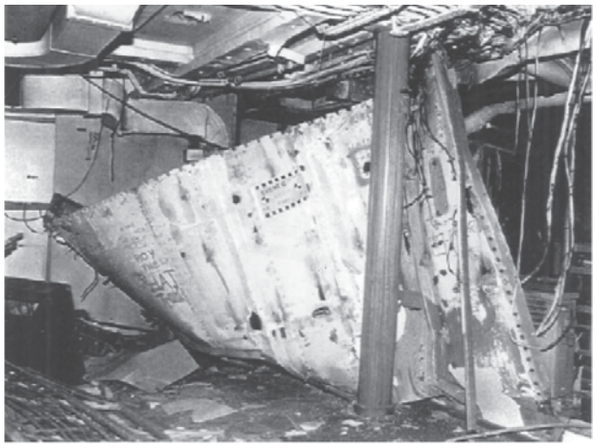


Figure 3: 1994 DSTO trial HMAS Derwent[12]

DSTO estimated that *Sydney* received 41 150mm shell hits on the port side, and 46 on the starboard. DSTO also assessed the orange areas as fire-damaged.

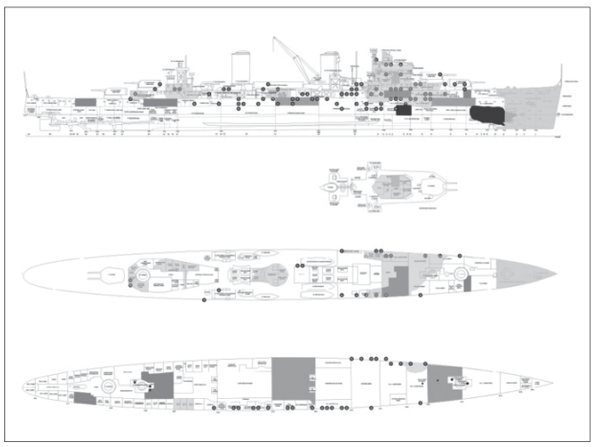


Figure 4: HMAS Sydney shell and torpedo hits and fire damage[13]

DSTO also assessed *Sydney* did not sink on losing her bows, but that the bows were lost as a result of her sinking.

It can be seen that if *Sydney's* crew was at action stations when the battle started, the medics in the sickbay and the forward and midship DC parties would have had little chance.

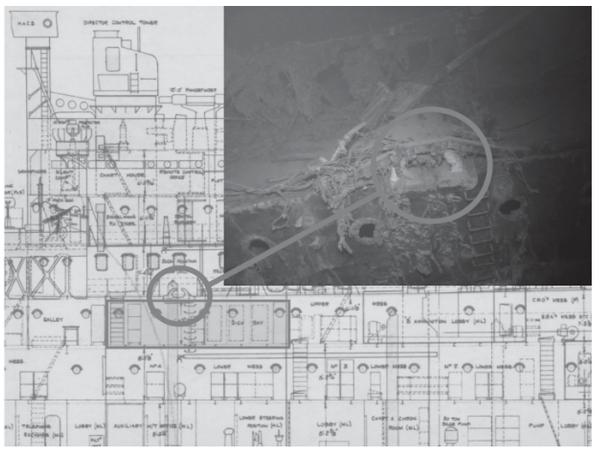


Figure 5: HMAS Sydney sickbay damage[14,15]

This wreck photo shows the sickbay area, indicated by the mooring fairlead and boarding ladder. The item humped over the top of the fairlead is a degaussing cable fitted after the outbreak of war. It can be seen that the superstructure above (including the dental surgery two decks above the sickbay) has been totally wrecked. This is probably where up to half of the sickbay staff met their fate.

Figure 5 shows the quarterdeck, with the wardroom underneath on the port side.

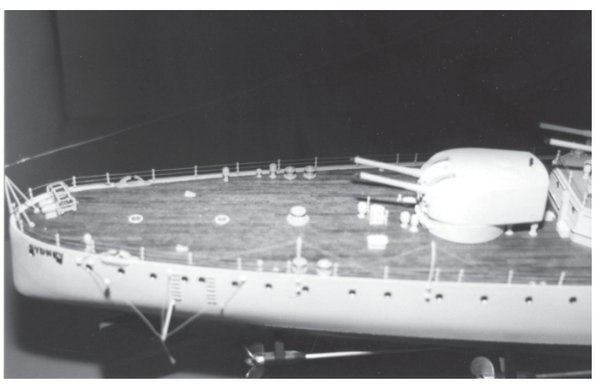


Figure 6: HMAS Sydney model – aft section (AWM)

This is what the area looks like today. Although shell damage is minimal, the quarterdeck was crushed downwards by water pressure as the ship sank. The wardroom deck below is most likely the area used to treat casualties following the loss of the sickbay forward.

Figure 7: HMAS Sydney – aft section[16]

This DSTO diagram shows the likely pattern of *Sydney's* damage. It can be seen that the sickbay and the forward and midships DC parties were hard hit from *Kormoran's* heavy guns. It can also be seen that even the aft DC party and first aid post probably would have sustained some casualties.

The grey areas show small-calibre damage, and it can be seen these targeted *Sydney's* bridge and four inch gun deck. The torpedo damage caused considerable flooding forward.

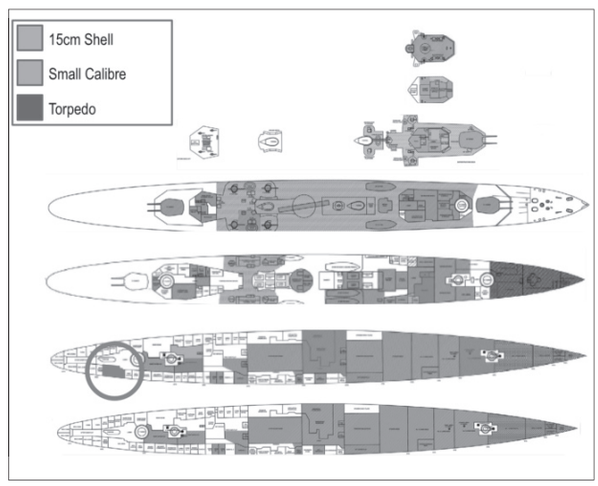


Figure 8: HMAS Sydney damage[17]

This DSTO diagram indicated where *Sydney* sustained her casualties, which would have stemmed both from direct weapons effects, and additional fire and smoke casualties from a lack of escape routes.

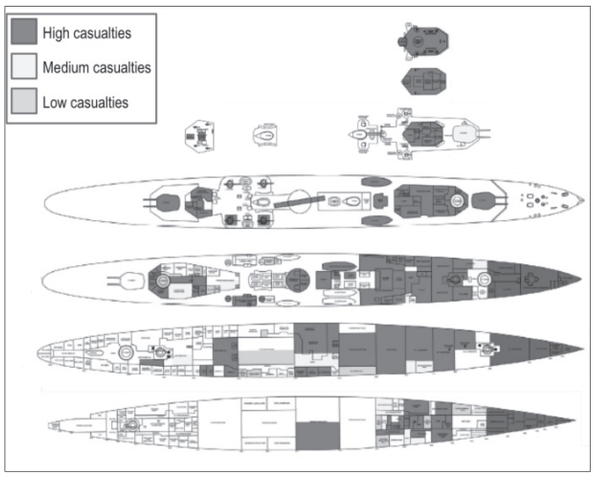


Figure 9: HMAS Sydney casualties[18]

DSTO estimate that *Sydney* sustained a *minimum* of 70% casualties, or about 450 men[19]. A maritime casualty prediction algorithm suggests that half (225) were KIA and about the same WIA. The latter would have included 207 P1 and P2 cases, half of whom would have had severe burns[20].

This DSTO diagram shows the DC problem confronted by *Sydney's* crew. Much of the forward end of the ship was flooded and on fire, with men trapped below. Although there were fewer fires and no flooding aft, the after engineering spaces would have been full of smoke and the rest of the ship would have been only somewhat better.

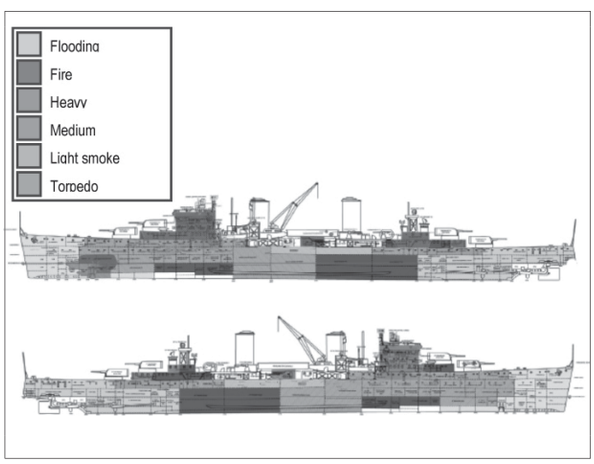


Figure 10: HMAS Sydney damage control problem[21]

By late evening the sea was starting to get up. This DSTO graphic shows how *Sydney* was on fire amidships, down by the bows and listing to port, She would also have been rolling between 15 and 40 degrees.

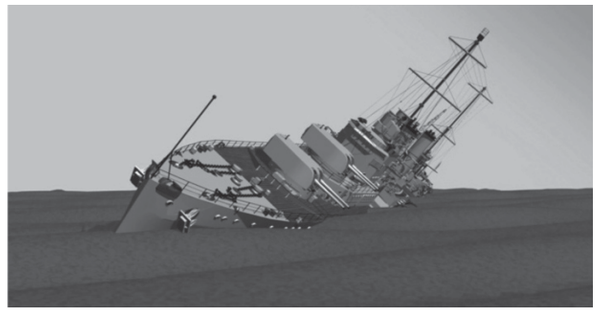


Figure 11: Sydney at a roll angle of about 40° to port in sea state 3[22]

This meant progressive flooding through shell holes forward that would otherwise have been above water. The fires would have limited the ability to stop the flooding, and it is also likely that damage to the fire main forward meant that only the aft hose points were available. Furthermore, any water used for fire fighting would have exacerbated the flooding.

It should be stressed that the real situation would have been far worse: no moon, pitch dark apart from emergency lighting and torches, wind about 20 knots and lots of white horses.

Unless any of the forward first aid party made it aft, there probably only would have been a maximum of five unwounded medics and perhaps up to five unwounded first aiders in the wardroom and aft DC station. If the SMO was in DCC and the junior MO was in the sickbay, this would have left only the dentist in charge aft[23]. Providing first aid for up to 200 casualties in a smoke-filled ship rolling up to 40° would have been horrendous; trying to treat them on the upper deck would probably have meant losing them over the side.

If the ship sank with little or no warning, it is therefore likely that the medics and their casualties were all caught below in the WOs mess and wardroom. It also seems likely that the engineering and DC parties would also have had little or no chance to escape. It therefore seems likely that very few able-bodied men would have made it off the ship[24].

Sydney's Boats

At the time of her loss *Sydney* had eight boats and nine Carley floats, giving a total lifesaving capacity of only 616 people (29 short). Only two boats were in davits while the rest required an electrically-driven crane to get them into the water. Their primary role was as workboats rather than lifeboats. None of *Sydney's* boats could stay afloat if they were holed[25].

Figure 12: HMAS Sydney boats loading beer, Alexandria July 1940[26]

Of the nine boats, five were found with the wreck.

Figure 13: HMAS Sydney boats[27]

Carley Floats

Carley floats were canvas-covered metal pontoons, with slatted wooden platforms that dropped down either way they ended up in the water. This meant the survivors were always in – not on – the water, at least up to their waists.

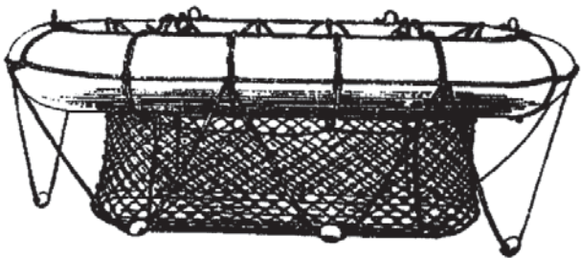


Figure 14: Carley Float[26]

Sydney had two large and seven small Carley floats, weighing 410 or 175 kg respectively. Getting them into the water in the first place therefore posed some challenges. Only two of the small floats were ever found, including one off Christmas Island two and a half months later, with a body in it. This compares with postwar evidence that only 10% of Carley floats got off their ship.

Figure 15: HMAS Sydney escorting the troopships Queen Mary and Queen Elizabeth off Wilson's Promontory, September 1941. Note the Carley floats[29]

Sydney's Carley floats were rated for either 67 or 20 survivors (half of whom would have been outside the float, hanging on to the lifelines)[30]. It should also be noted that the floats did not include food, water or any other survival equipment. RN data suggests that any *Sydney* survivors were therefore unlikely to survive on a Carley float for more than three to five days[31].

Sydney's Lifebelts

The Admiralty Pattern 14120 lifebelt had a single bladder and manual inflation. It had a flotation capacity of 4.3kg, compared to the modern Pattern 50N (16.4 kg) and the Special Duties lifejacket (22.4 kg)[32].

Figure 16: Admiralty Pattern 14120 Lifebelts[33]

Figure 16 from the Australian War Memorial shows that the rubber bladder had a stockingette cover.

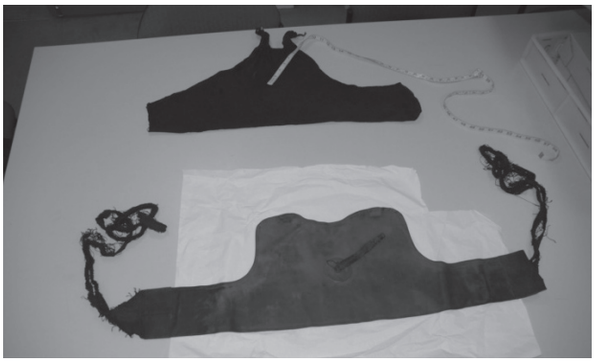


Figure 17: Admiralty Pattern 14120 life belt bladder and cover (Author)

Officers could also buy a waistcoat with a similar rubber bladder built-in, with similar flotation capacity.

Figure 18: Officer's lifesaving waistcoat (Author)

Figure 19: RAN Special Sea Dutymen lifejacket[34]

Despite its name, the Admiralty Pattern 14120 life belt was not meant to be worn around the waist – otherwise it could flip the wearer upside down and drown him. When worn properly, it was to be positioned as high as possible below the armpits, however it provided no head support and (unlike modern lifejackets), it was never designed to flip unconscious wearers face up. This meant higher sea states made drowning more likely. Although the water temperature off Shark Bay (23-24°C) made hypothermia unlikely, the estimated survival time for the Sydney survivors using these lifebelts was probably no more than a few hours[35].

After the Sinking

The first outside evidence of the battle came when some *Kormoran* survivors were picked up by the troopship *Aquitania* en route to Sydney on 23 November, however she was unable to inform anyone ashore until she reached Wilson's Promontory four days later[36].

The first report to reach the shore was on 24 November, when more *Kormoran* survivors were picked up by the tanker *Trocus*[37].

Air searches commenced later that day, five days after the battle. Although they covered the right area, the searches were initially flown at about 1500 feet, which would have been fine for a visual search for the ship, but not for her survivors, who would have needed them to be at about 500 feet. Although later sorties were flown at a lower heights looking for boats (finding only those from *Kormoran*), no searches were flown low enough to spot small debris items, survivors or bodies.

Dead bodies initially sink: it is the gases from decomposition that make them float three to ten days later. However this takes longer if the water is cold, and in deep water the water pressure prevents the gas from expanding sufficiently to make bodies float. The search was called off on 29 November, most likely before any bodies had a chance to surface[39].

Conclusion

In summary, any medical staff in *Sydney's* sickbay at the time the action began were unlikely to have survived *Kormoran's* fire directed at the bridge above them.

Any medics who made it aft to the wardroom would have been overwhelmed by about 200 P1 and P2 casualties, half of whom would have had severe burns. The list and increasing sea state that evening would have prevented caring for them on the quarterdeck, which meant most if not all were probably caught below with the surviving damage control parties and engineers when the ship sank.

Survival time in the water for any survivors was probably only a few hours wearing a lifebelt, and three to five days in a Carley float. Air searches did not begin until five days after the sinking, and were not flown low enough to find survivors or debris in the water before they were called off.

Authors' Affiliations: Department of Defence
Contact author: SO1 Medical Services,
Directorate of Military Medicine
Joint Health Command, CP2-6-040,
PO Box 7911, CANBERRA BC ACT 2610
Email: neil_westphalen@bigpond.com

Sickbay Staff, HMAS *Sydney* II, 19 November 1941

Surgeon Commander John Reid Hasker RAN
Surgeon Lieutenant Commander Francis Harrison Genge RANR
Surgeon Lieutenant (Dental) Mervyn Clive Townsend RAN
17877 Sick Berth Petty Officer Eric Ralph Barham
22556 Acting Leading Sick Berth Attendant David William Boyd
PA1908 Sick Berth Attendant Lindsay James Medlen
PM2984 Sick Berth Attendant Leslie Charles Minns
22213 Sick Berth Attendant John Robert Payne
PA1946 Sick Berth Attendant Roderick Richard Wilson
PM3095 Sick Berth Attendant 2nd Class (Dental) Stewart Thomas Laxton

Lest We Forget

References

1. Australian War Memorial (AWM) photograph collection [on line] available from URL http://cas.awm.gov.au/item/006400. [2010, 29 Jan].
2. Department of Defence. HMAS *SYDNEY* Commission of Inquiry (COI), [on line] 2009 [2010 29 Jan] available from URL: http://www.defence.gov.au/sydneyii
3. National Archives of Australia. Navy Records of Service Cards Series A6769 (officers) and A6770 (sailors) [on line], available on URL http://recordsearch.naa.gov.au/SearchNRetrieve/Interface/SearchScreens/AdvSearchSeries.aspx.
4. Buckland, M, Cannon, S.M, de Yong, L, Gamble, G.I, Jeremy, J.C, Lyon, T, et al. Defence Science and Technology Organisation (DSTO). HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS Sydney and HSK Kormoran (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 45-53.
5. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 45-53.
6. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 367.
7. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 391-2.
8. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 367.
9. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 121-126.
10. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 215-219.
11. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 153.
12. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 257.

13. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 154-171.

14. RAN Sea Power Centre. Ship's Legend HMAS *SYDNEY* II.

15. Australian War Memorial (AWM) photograph collection [on line] available from URL. http://cas.awm.gov.au/item/P09281.391. [2010, 29 Jan].

16. Australian War Memorial (AWM) photograph collection [on line] available from URL. http://cas.awm.gov.au/item/P09281.274. [2010, 29 Jan].

17. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 252-253.

18. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 254-255.

19. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 255.

20. Heugh, M., Law, G.A, Flannery P.J. Excel spreadsheet: Casualty Estimation Model. DSTO; July 2000.

21. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 257.

22. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 283.

23. This assumption is based on the fact that the junior medical officer was killed (among others) when his ship *Hobart* (sister ship to *Sydney*) was hit aft by a Japanese torpedo on 12 July 1943. The hit destroyed Hobart's wardroom and it is assumed the disposition of her medical parties was similar to Sydney's.

24. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 298-299.

25. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 54-58.

26. Australian War Memorial (AWM) photograph collection [on line] available from URL. http://cas.awm.gov.au/item/306686. [2010, 29 Jan].

27. Australian War Memorial (AWM) photograph collection [on line] available from URL. http://cas.awm.gov.au/item/P09281.793. [2010, 29 Jan].

28. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 89.

29. Australian War Memorial (AWM) photograph collection [on line] available from URL. http://cas.awm.gov.au/item/128094. [2010, 29 Jan].

30. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 88-96.

31. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 295.

32. Drohan, D. Discussion Paper for Sea Safety and Survival A017140 Part 1 and Part 2. Department of Defence, Canberra, 08 September 2009. pp 86-87.

33. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 59.

34. Drohan, D. Discussion Paper for Sea Safety and Survival A017140 Part 1 and Part 2. Department of Defence, Canberra, 08 September 2009. p 89.

35. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 295-297.

36. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 177.

37. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 177.

38. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. p 291.

39. Buckland, M et al. DSTO. HMAS *SYDNEY* II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS *Sydney* and HSK *Kormoran* (DSTO – GD – 0559) Jan 2009. Maritime Platforms Division, DSTO, Fisherman's Bend, Australia. pp 295-299.

Lessons learnt in aslyum seeker health, a personal reflection

Katrina Sanders

Operation Resolute is the ADF's contribution to domestic maritime security activities. At any one time up to 400 ADF personnel are assigned to Operation Resolute. The commitment includes RAN Armidale-class Patrol Boats (ACPB), AP-3C Orion Maritime Patrol Aircraft, Australian Army Regional Force Surveillance Units, a Transit Security Element and standby RAN fleet units. A Medical Officer is assigned to the commitment and is present on board an ACPB in the northern waters at all times.

Having researched asylum seeker health prior to deployment I was expecting to be confronted with:

- infectious diseases including TB, malaria and intestinal parasites
- nutritional deficiencies
- poor oral health
- unrecognised chronic disease
- chronic pain
- psychological disorders such as post traumatic stress and anxiety
- sequelae of torture and trauma

It was not until I first boarded an asylum seeker vessel that I was confronted with the reality of asylum seeker health – that is, desperation. The vessel was a wreck, falling apart and slowly sinking. It was overfilled with men, women and children, empty packets of two minute noodles and empty water bottles strewn over the deck. I tried to ignore the scorpions, ants, vomit and faecal debris as I began to review the pregnant women and children on board. I was prepared to treat the likely potential medical conditions, however was not prepared to treat their desperation.

Many feigned chest pain, seizures, varying degrees of unconsciousness and from some, even psychosis, to gain my attention. Whilst I was overwhelmed by the pervasive atmosphere of desperation, I was also acutely aware that rumours existed that if you were ill the Doctor would take you to the mythical land called Australia. It is this balance with which I struggled. Was the patient truly ill and in need of medical attention, or were they so desperate they would go to extreme lengths for help?

On reflection, I was excited to be a part of Operation Resolute, looking forward to testing and improving my clinical skills in asylum seeker health. In reality, I faced a desperation that I had never seen before. I didn't get the balance between acute illness and desperation right every time, but I certainly learnt that the balance is the key element to managing asylum seeker health and it influences all other aspects of their healthcare.

Author's affiliations: Department of Defence, Australia
Contact author: katrinasanders@defence.gov.au

Developing injury prevention strategies for the Australian Defence Force

PG Warfe, DD Jones, SK Prigg

Reprinted from Aust Mil Med 2000; Vol 9 No. 1; pp 3-8

Abstract

Casualties caused by injuries have a major impact on the readiness of the Australian Defence Force (ADF). The Department of Defence has developed a system for reporting occupationally related illnesses and injuries. Data from the DEFCARE database and a wide range of other data have been analysed to determine the leading causes of injury and illness as well as the associated costs. During financial year 97/98 over 32,000 working days were lost due to injuries. In addition, over $100 million was spent on workers compensation costs. The five activities associated with the highest number of working days lost were all related to physical training and sports. Modifications to the physical training program at 1 Recruit Training Battalion were associated with dramatic reductions in the injury presentation rate and the number of male medical discharges. Further development of this type of approach should help the ADF to minimise preventable injuries in the future.

Introduction

Casualties caused by injuries have a major impact on the readiness of the Australian Defence Force (ADF). Therefore, the ADF is seeking to capture data, which will assist in determining priorities for injury prevention, designing specific interventions, and measuring progress based on implemented interventions.

Methods

The Australian Defence Force (ADF) is conducting a major study to quantify the current health status of the Force as quantitatively as possible. This project, the ADF Health Status Report, began with the compilation and analysis of a wide-range of data. The desired outcomes from this process include setting health support priorities; developing illness and injury prevention strategies; and beginning the process of monitoring progress toward desired health outcomes.

The Department of Defence has developed a system for reporting occupationally related accidents and incidents. The following data from workplace injuries, illnesses and incident reports are recorded in the DEFCARE database: the nature, location, agency and mechanism of injury; the activity engaged in when the injury occurred; and other information on factors which may have contributed to injuries. One of the most useful features of the DEFCARE database is the capture of working days lost (WDL) associated with each reported casualty in terms of days in hospital, days off all duties, and days of light duty. This provides an important measure of the impact of various injuries and illnesses on personnel availability. Financial Year (FY) 97/98 was the first year for which data was compiled in the DEFCARE database.

Data on workers compensation claims in the ADF was obtained from the Military Compensation and Rehabilitation Service (MCRS), which administers workers compensation in the ADF. Although efforts are currently under way to integrate workers compensation into the DEFCARE system, this was not achieved as of FY97/98. However, some data was available on the condition for which compensation was claimed in terms of the part of the body affected.

Because ADF personnel must maintain a high standard of fitness, each Service has the right to retire members on the grounds of invalidity, that is, a physical or mental incapacity to due their duties. There are three classifications of invalidity retirements: Class A (60% or greater incapacity), Class B (30% to 59% incapacity), and Class C (less than 30% incapacity). Data on invalidity retirements was obtained from the Defence Force Retirement and Death Benefits (DFRDB) Scheme and the Military Superannuation and Benefits Scheme (MSBS). Both the DFRDB and MSBS maintain statistics on the cause of invalidity in terms of the body system affected.

Each of the Services in the ADF collects data on hospital admissions, including the reason for admission using International Classification of Diseases Edition 9 (ICD-9) coding. This allows for a determination of the number of admissions associated with injuries and musculoskeletal diseases and disorders. Each of the military Services also maintains records of deaths due to all causes. Based on this data it is possible to ascertain the number of deaths resulting from accidents and injuries.

In addition to the aforementioned sources of data, the ADF Health Status report included a review of previously collected data and studies on injuries in the ADF. Significant in this regard was a major report on injuries in the Australian Army from 1987-1991 by Rudzki.[1] All the sources of data mentioned above were analysed in an attempt to develop a comprehensive picture of patterns of injuries and illnesses in the ADF. Where possible, an attempt was also made to establish causal relationships in order to guide casualty prevention strategies.

Results

In FY97/98 there were 5038 casualties among full-time military personnel reported to the DEFCARE database, which represents a rate of 91 per 1000 per year (9.1% of the Force). The resulting WDL was 32,644 (148 work years), including 1216 days in hospital, 6287 sick days, and 25,141 light duty days. In FY97/98 1067 casualties among part-time military personnel were reported to DEFCARE resulting in an additional 2680 WDL. When calculated in terms of full-time equivalents the casualty rate among part-time forces was 28.5%.

The activity groups associated with workplace injuries and illnesses among full-time personnel are presented in Figure 1. Work-related activities accounted for almost one-third of all casualties reported. Sports activities were also associated with approximately one-third of casualties. Physical training was the third leading activity group in terms of the number of casualties produced. Military training and motor vehicle accidents played a smaller, but still important role.

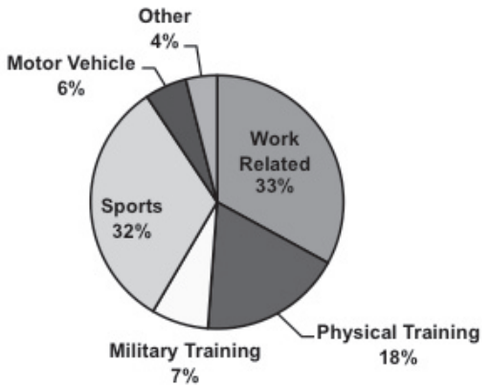


Figure 1. Workplace Related Casualties by Activity Grouping

The individual activities associated with the highest number of casualties included the following: physical training (18.2%), walking (non-sport and fitness) [6.7%], rugby union/league (5.0%), equipment maintenance (4.6%), touch football (4.1%), soccer (3.9%), stores handling (3.9%), driving (3.8%), fighting (3.4%), ship maintenance (2.8%), running/jogging (2.6%), cleaning (2.5%), Australian Rules football (2.4%), and basketball/netball (2.3%).

However, in terms of priority for prevention the individual activities associated with the highest WDL are of greatest concern. Figure 2 presents a summary of activities associated with the highest percentage of WDL. The five leading activities associated with WDL are physical training (PT) and four sports activities, including touch football, soccer, rugby union/league, and running/jogging. Several other sports activities were associated with the highest proportion of WDL. Military training activities, such as marching and parachuting, were also important contributors to WDL. Walking and stores handling were work-related activities associated with relatively high WDL.

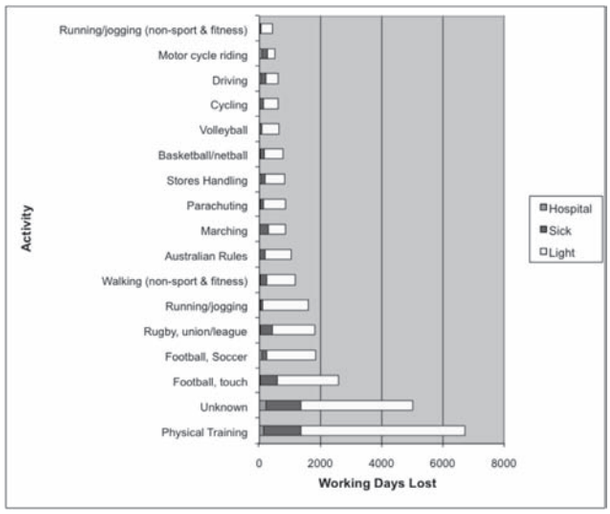


Figure 2. Individual Activities Associated with the Highest Number of Working Days Lost

Sprains and strains of joints and adjacent muscles was by far the leading injury nature associated with lost working days and accounted for almost 30% of all casualties and 31% of WDL. Disorders of muscle, tendons and other soft tissues and fractures were also major contributors to WDL with each accounting for approximately 18% of days lost. Dislocations and dorsopathies each accounted for approximately 5% of WDL. The types of injury associated with the highest WDL are not surprising given the activities associated with the highest WDL.

Figure 3 presents a summary of the location of injuries and illnesses in full-time military personnel reported to DEFCARE in FY97/98. Again it is not surprising that lower limbs were affected in one-third of casualties given the types of activities associated with the highest rates of casualties. Lower limb injuries are associated with over 50% of WDL. Upper limbs were affected in 22% of casualties reported and accounted for 20% of WDL. The third highest body location to be impacted was the trunk, which accounted for over 15% of casualties and WDL. All other body locations were much less likely to be affected.

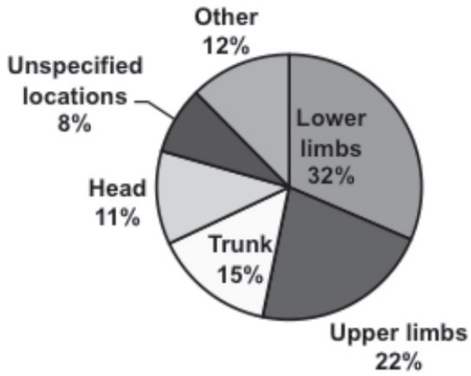


Figure 3. Injury Location Group Summary for ADF Workplace Injuries and Illnesses

Workers compensation costs in the ADF have seen significant escalation over time. The number of workers compensation claims received almost doubled between FY90/91 (3208) and FY97/98 (6285). The total cost of military worker's compensation benefits was $101.23 million in FY97/98. Although part of the increase in the number of claims is likely associated with greater client awareness of benefits and the long lag time between injury and submission of claims in the ADF, the high cost of work-related injuries and illnesses in the ADF is clear. Knee injuries accounted for 19.4% of compensation claims between FY92/93 and FY96/97. Other leg injuries accounted for an additional 18.7% of claims. Back and arm injuries accounted for an average of 15 and 13% of claims, respectively over the five-year period. Integration of workers compensation data into DEFCARE should provide for useful comparisons in the future.

In FY97/98 there were a total of 574 invalidity retirements in the ADF from all causes. This represents 1% of the full-time force. The annual liability for Class A and B retirements in FY97/98 was $67.6 million. While Class A retirements have held relatively steady over the past five years, Class B retirements have steadily increased over the past four years. Class C retirements, which are by far the most numerous, fluctuated considerably with a range of 158 to 264 per year. Diseases and disorders of the musculoskeletal system accounted for 62% of Class A and B retirements and 63% of Class C retirements in FY97/98 under MSBS. A total of 37% of all invalidity retirements were associated with diseases and disorders of joints and 16.5% were associated with spinal injuries.

Based on a review of hospital admission data over the last several years, the average number of admissions related to injuries and poisonings or musculoskeletal diseases and disorders was over 2000 per year. Australia's Health 1998[2] indicated that the average cost per admission for musculoskeletal diseases and disorders and injuries, poisonings, and toxic effect of drugs was $3369 and $2307, respectively. Thus, the cost of hospitalisation of ADF personnel for such injuries and illnesses is estimated to be millions of dollars. The Australian National Audit Office (ANAO) has estimated that the total cost of injuries in the ADF

Activity	Nature of Injury	Bodily Location	Injury Mechanism
Physical Training	Sprains & strains (49%) Disorders of muscles, tendons and soft tissues (12%) Fractures (10%)	Lower limbs (48%) Upper limbs (20%) Trunk (18%)	Body stressing (34%) Falls, trips, & slips (29%) Hit by moving objects (15%)
Touch Football	Sprains & strains (44%) Disorders of muscles, tendons and soft tissues (17%) Fractures (11%)	Lower limbs (56%) Upper limbs (26%) Trunk (10%)	Falls, slips & trips (34%) Body stressing (22%) Hit by moving objects (15%) Hitting objects (14%)
RugbyUnion/League	Sprains & strains (35%) Fractures (16%) Disorders of muscles, tendons and soft tissues (14%) Dislocation (8%)	Upper limbs (31%) Lower limbs (31%) Head (14%) Trunk (14%) Neck (7%)	Hit by moving objects (66%) Falls, slips & trips (11%) Hitting objects (10%) Body stressing (8%)
Soccer	Sprains & strains (48%) Fractures (20%) Disorders of muscles, tendons & soft tissues (11%)	Lower limbs (69%) Upper limbs (13%) Trunk (7%)	Hit by moving objects (47%) Falls, slips, & trips (19%) Hitting objects (15%) Body stressing (13%)
Running/jogging	Sprains & strains (52%) Disorders of muscle, tendons and soft tissues (17%) Fractures (8%)	Lower limbs (78%) Upper limbs (7%) Trunk (7%)	Falls, slips & trips (40%) Body stressing (32%)

Table 4. Profile of the Activities Associated with the Highest WDL

is between $210 and $840 million. 3 Furthermore, on average, 22 ADF personnel die as a result of accidents and injuries every year with motor vehicle accidents taking the greatest toll on life.

Given the major costs associated with workplace injuries and illnesses in the ADF, the need for focused injury prevention efforts are clear. Based on a thorough analysis of available information it became clear that a substantial numbers of injuries and illnesses (particularly musculoskeletal diseases and disorders) are preventable. PT and sports injuries should receive the highest priority for prevention efforts. Military training activities such as marching and parachuting should also receive attention along with work-related activities associated with high numbers of casualties (eg. walking, maintenance, and stores handling).

The rest of this paper will focus on the ADF's initial efforts in seeking to address the problems of PT and sports injuries.

Table 4 provides a profile of the nature, location, and mechanism of injury for each of the leading causes of WDL and indicates the proportion of casualties associated with each.

While this information is useful it is also important that the risk factors for injury be well understood. A summary of risk factors for military training injuries prepared by Gillespie et al[4] for the British Army is provided in Table 5 below. The levels of evidence were originated by the U.S. Agency for Health Care Policy. A grade of B requires availability of well-conducted clinical studies but no randomised trials on the topic of recommendation. A grade of C requires evidence from expert committee reports and/or clinical experience of respected authorities and indicates the absence of directly applicable studies of good quality. Level IIa corresponds to evidence obtained from at least one well-designed controlled study without randomisation. Level IIb corresponds to evidence obtained from at least one other type of well-designed quasi-experimental study. Level III corresponds to evidence obtained from well-designed correlation studies, non-experimental descriptive studies, and case-control studies. It is vitally important that the ADF use an evidence-based approach in seeking to minimise injuries in the ADF.

Citing a report on sports injuries in Australia by the Centre for Health Promotion and Research, Rudzki noted that based on questionnaires completed by coaches, administrators and medical staff, a mean estimate of 30-50% of sports injuries were regarded as realistically preventable.[1] Rudzki also cited an Australian Sports Medicine Federation study indicating the major causes of sports injury are human error (54%), terrain (31%), and equipment (15%).[1] Rudzki concluded that the main areas of manipulation are education and modifying the environment with coaches and trainers being the people deemed most important in preventing sports injuries. The ADF must learn from training and conditioning programs of professional and top amateur sports programs how to minimise preventable injuries. In essence the ADF must learn to train smarter to minimise risk. This will require greater education of commanders and all personnel regarding the benefits, risks and prevention strategies for minimising injury.

Risk Factor	Level of Evidence
Age over 24 years	Grade B level Iib
Low or average physical activity prior to training	Grade B level Iib
Female gender	Grade B level III
Smoking >10 /day	Grade B level Iib
Hyperpronation of foot	Grade C level IV
Total amount of marching/ running (military training)	Grade B level Iib
Running frequency > 3 days/week for 30 mins	Grade B level Iia
Running duration >30 mins for 3 days per week	Grade B level Iia

Table 5. Risk Factors for Training Injury

Where primary prevention efforts fail, the ADF must have the means to aggressively manage injuries to ensure they are completely healed and do not become chronic problems that can eventually lead to medical discharge. Physiotherapy is extremely important as a means of secondary prevention. However, when other means fail, the ADF must have strong rehabilitation programs in place.

A case study at 1 Recruit Training Battalion (1 RTB) by Rudzki and Cunningham provides an idea of the potential impacts that smarter training can have.[5] Medical staff at 1 RTB was able to convince commanders at the Army establishment for initial recruit training that changes in physical training could result in fewer injuries while still providing rigorous training and physically fit recruits. Changes in the PT program included the following: cessation of road runs, introduction of 400-800m interval training, reduction in test run distance from 5km to 2.4km, standardisation of road marches, and introduction of deep water training. These changes address several of the risk factors in Table 5. The results of the uncontrolled observational study included a 46.6% reduction in the total injury presentation rate for medical treatment. In addition the annual rate of medical discharges among males decreased by 40.8% resulting in an estimated savings of over $1.2 million.

Conclusions

Injuries and illnesses have a major impact on the ADF both in terms of decreased personnel availability and monetary costs. Physical training and sports injuries should receive the highest priority for prevention efforts. Based on a survey of relevant literature and the case study at 1 Recruit Training Battalion, it appears that substantial numbers of injuries and illnesses can be prevented through smarter training. Resources invested in prevention efforts are likely to be extremely cost effective as well as increasing Defence readiness.

References

1. Rudzki SJ. Injuries in the Australian Army 1987-1991: A Comparison to the US Army Experience. Canberra: Directorate of Publishing, 1994.
2. Australian Institute of Health and Welfare. Australia's Health 1998: the sixth biennial health report of the Australian Institute of Health and Welfare. Canberra: AIHW; 1998.
3. Australian National Audit Office. Australian Defence Force Health Services. Canberra: Commonwealth of Australia; 1996 Audit Report No. 34.
4. Gillespie WJ, Quinn KM, Handoll HHG. Research study on the effectiveness of interventions to prevent or treat musculoskeletal injuries in soldiers. London: Ministry of Defence; 1997 Feb.
5. Rudzki SJ, Cunningham MJ. The effect of a modified physical training programme in reducing injury and medical discharge rates in Australian Army recruits. Mil Med. In press.

Ultraviolet radiation exposure and melanoma in Australian naval personnel

Scott Kitchener

Reprinted from Aust Mil Med 2001; Vol 10 No. 2, pp 55-59

Abstract

In the tropics of Australia, the Royal Australian Navy operates two permanent bases and conducts a large number of operations. Despite an overall incidence of melanoma not significantly different to that of the general Australian population (Standardised Incident Ratio, SIR = 149, p>0.05), older members of the RAN (SIR = 236, aged >29 years) and those holding duties in engine spaces while at sea (SIR = 412 compared to the remainder of the Navy) have an increased incidence of melanoma after indirect age standardisation, suggesting a risk factor associated with Service.

Introduction

The Royal Australian Navy has two permanent operational bases in the tropics of Australia, at Cairns and Darwin, and conducts many exercises and operations in tropical waters.

Previously, Defence Force personnel serving in tropical latitudes have been found to be significantly over-represented in a skin cancer case group of men at draft age during 1941-451. The latitudinal distribution of skin cancers has been well known for some time[2], including both melanotic and non-melanotic skin cancer[3]. Queensland has the highest rate of skin cancer in the world[4,5], probably due to a combined effect of greater exposure and a large population of Caucasian people living in the region[6,7].

Outdoor occupations other than in the maritime environment have been associated with an increased risk of developing melanoma such as farmers[8,9]; however, this is not a consistent association[10], especially when controlled for other risks for cancer such as smoking and age[11]. Links between melanoma and outdoor occupations are not well established[12].

Considering the environmental exposure of Naval personnel, the incidence of melanomatous skin cancer for sailors has been evaluated, including closer scrutiny of higher risk groups.

Methods

Rates of melanoma in the Navy were initially ascertained from the ICD9 (172, Melanomatous skin cancers) coded database (MEDREX) employed by the (then) Directorate of Naval Health Services, Canberra. All cases were confirmed by a manual search of Service Medical Documents. Inclusion as a case required histological confirmation of the case by an independent histopathologist. The reported date of a confirmed diagnosis was used for chronological placement of cases. Period of Service has been calculated from the date of enlistment recorded on the Entry Medical Examination contained in Service Medical Documents. Only those personnel enlisted in the Royal Australian Navy as sailors on full time Service during the defined period, from 31 December 1986 to 1 January 1992, were included. All cases initially intended to be included as cases following the confirmation of histopathological diagnosis were retained as cases throughout analysis.

Information regarding the Royal Australian Navy population (numbers of personnel by age and employment categories) during the incident period of years were provided by the Directorate of Personnel -Navy. From these lists, population person-years data were derived. Ordinal data were created based on standard five yearly groupings from the yearly categories provided. This permitted indirect age standardisation[13] and comparison of the Navy rates of melanoma to those recorded by the Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries as of the general population of Australia. This most recent available data was used under the a priori assumption that rates would not vary significantly in the years immediately following, over which the Navy rates were generated.

Indirect age standardisation was applied as the Navy population is notably skewed towards excluding children and the elderly. This was considered to cause variable bias based on the evidence available regarding the general incidence of melanoma. Age is a significant and enduring risk factor towards melanoma and therefore requires control. The indirect method of standardisation was considered the most appropriate given the incidence of the disease being observed.

From age standardised categories, expected rates of melanoma were found for the Navy group from Australian population rates and compared to observed rates for the Navy using the Poisson distribution[14]. A similar method was used for those age groups greater than 29 years. Superficial analysis of the Navy rates of melanoma revealed an apparent preponderance of cases from the employment categories largely holding duties in the engine spaces when deployed to sea. The group is referred to as "Stokers" and includes personnel from the categories (at that time) of Marine Hull Engineering Sailors, Marine Propulsion Engineering Sailors, and Electrical Propulsion Engineering Sailors. The method of analysis was then further used for the categories of employment based on primary duties in the engine spaces and a consequent low occupational ultraviolet exposure. Standardised incident ratios (SIR) were calculated.

Results

Between the years of 1987 and 1991 inclusive, a total of 62010 person years were recorded. From this period, 14 cases of melanoma were reported and confirmed on histological examination of excision specimens. Based on indirect age standardisation of the Australian rates of melanoma, between nine and ten cases were expected.

From the power generated from the number of person years observed, it is not possible to discern a statistical difference ($p>0.05$) between the incidence of melanoma in the Navy and the general population of Australia. The Standardised Incident Ratio of sailors is 149.1 relative to the Australian population.

Calculation of the power associated with the investigation of the melanoma rate from the Navy with that of the Australian population suggested a low (< 0.10) probability of a β error ($Z\beta = 3.19$).

From the age groups of Navy members older than 29 years, a significantly greater number of cases of melanoma were apparent compared to the general population of Australia as ten cases were observed while four (4.23) cases were expected (SIR = 236, 95% confidence intervals = 4.795, 18.390, $p = 0.0233$).

Within the Navy, the population of "Stokers" included 13519 person years of observation. The Stokers experienced a significantly greater number with seven cases of melanoma reported in this period; however, fewer than three cases (2.08) were expected after indirect age standardisation from the Australian population (C.I.95% = 2.814, 14.423, $p=0.011$). This indicates a Standardised Incident Ratio for Stokers of 336.5 compared to the Australian population.

For those Stokers aged greater than 29 years, four cases were recorded while no more than one (0.91) case was expected from indirect age standardisation of the Australian population data, resulting in a SIR of 439 (C.I.95% = 1.090, 10.242, $p=0.028$).

The group of Stokers was compared to the rest of the Navy without age standardisation as it was considered that the distribution of ages would be comparable. No more than two (1.95) cases of melanoma were expected in the group of Stokers based on the rates for the rest of the Navy, whereas seven cases were recorded. Again using Poisson probability, this was found to be a significant difference between the groups (C.I.95% = 2.814, 14.423, $p=0.008$). The (non-standardised) Incident Ratio of Stokers for melanoma on the background of the other serving sailors was 359.

To confirm that the age distribution of Stokers was not significantly different the rest of the Navy with respect to these calculations, a sensitivity analysis was conducted by repeating the procedure with age standardisation on the age profile of the remainder of the Navy. A significant difference remains between the cases expected among the Stokers and that recorded (cases expected = 1.72, observed cases and confidence intervals as above, $p=0.004$). The standardised incident ratio with this procedure is calculated to be 412.

The Navy personnel other than Stokers were found to have a Standardised Incident Ratio (with respect to the Australian population) of 111. This is not of significance. Calculation of power for this comparison was not deemed necessary given the previous results.

Discussion

In recent years, the Royal Australian Navy has maintained an active role in the tropics around Australia with deployments, exercises and two permanent Naval bases in the area. Recognition of the risks confronted from increased solar ultraviolet exposure has prompted active promotion of sun protection measures.

This investigation has been to assess the rate of melanoma among the members of the Royal Australian Navy. As the population of the Navy is quite obviously skewed in terms of age, standardisation is necessary for valid comment. Despite an increased standardised incident ratio for Naval personnel on crude rates, the difference found between the Navy rates of melanoma and those of the general Australian population, after age standardisation, is not significant.

Is Naval Service associated with increased risk of melanoma?

The power generated from the Navy population sample as a part of the Australian population control indicate that the numbers in the Navy are sufficient to observe a reasonable increase in melanoma rate if it were to be present. From this crude analysis, it is assumed that enlistment in the Royal Australian Navy is not associated with increased risk of melanoma.

Clearly, it is possible that the increased risk observed in the group with greater age (>29 years) is completely related to the well-known risk factor of age; however, the SIR is greater compared to the Australian population. Age is a surrogate measure for duration of service, albeit a rather loose indicator and laden with potential biases. Nevertheless, the greater SIR of sailors older than 29 years indicates that their Naval Service can not be excluded as being associated with this higher risk.

Biases in Navy selection

The Navy is selective in the enlistment of personnel. Enlisting generally healthy individuals may cause a bias towards the null for the overall rates of melanoma for serving personnel.Considering the greater risk associated with more prolonged service after age standardisation of the data, a bias towards the null would tend to mask a greater rate of melanoma associated with Naval Service, some aspect of it, or an occupational group within the population of sailors. Other selection biases may be operating such as ethnicity[15] with selection for those more prone to melanoma. While this is likely to be a bias away from the null, increasing the apparent risk from Naval Service, it is not possible to determine the extent to which it is influence results.

A serious potential confounding bias is the possibility of differential ultraviolet radiation exposure in childhood between the Australian public and those recruited for Navy, or between members of the Stoker group and the remainder of the Navy. This proposes that an apparent modulating effect of adult occupational ultraviolet radiation exposure may indeed be due to an incidental inverse association of childhood ultraviolet radiation exposure[16-18], and adult occupational ultraviolet radiation exposure such that the childhood exposure is the only truly causative association with the outcome of skin cancer and melanoma.

Adequate control of this potential confounding is logistically difficult as an assessment of childhood ultraviolet radiation exposure requires retrospective assessment with the concurrent recall and interpretative biases. The assumption made in this instance is that the groups of comparison have a normally distributed childhood exposure approximating equivalence. This may or may not be a valid assumption. It could be argued that the preponderance of Caucasian Naval personnel reflects an apparent bias in childhood exposure to solar ultraviolet light exposure. Nevertheless, within Navy, there is no apparent selection bias towards being a Stoker related to childhood ultraviolet exposure.

Stokers

"Stokers" are those members serving in categories whose duties at sea are predominantly below decks in the engine spaces, having a low occupational ultraviolet radiation exposure. A notable elevation of risk was found for this group, most distinct when compared to the risk of melanoma for the remainder of the Navy (SIR 412, $p<0.01$).

These research findings are supportive of other research indicating a lack of direct association melanoma risk[19] and cumulative ultraviolet radiation exposure as well as a possible protective role from occupational exposure to ultraviolet radiation[20]. There are several possible confounding associations potentially influencing this relationship, including concurrent exposures to artificial light sources and solvents in the workplace.

While the literature reviewed indicates a possible association of artificial light sources (Arc welders, sun lamps, sterilisers, printing equipment and fluorescent lights), it is at best a weak association[21-25]. When considered collectively the hypothesis can be discounted[26]. Further, Stokers are not routinely exposed highly to these sources in the course of their duties.

Duties in engine spaces when deployed to sea are rather ubiquitously associated with occupational exposure to solvents and this exposure could be considered greater than that of Naval members in general. Accounting for solvent exposure is a difficult problem in terms of research design; however, the literature reviewed observing the effect of occupational exposure to solvents in the petroleum and oil industries[27-29] and from industries using PCB[30,31] on the rate of melanoma, did not support confounding from this source.

These conventional potential confounding influences have been concluded to be unrelated to the observed association.

Conclusions

This research has not supported an increased risk of melanoma for sailors arising from ultraviolet radiation exposure. Nevertheless, within the Naval population, some cumulative exposure with Service may be increasing risk of melanoma as those sailors over the age of 29 years have an increased risk of melanoma compared to the Australian population. Closer investigation suggests that within the Navy, the risk of melanoma is also greater among those whose primary duties at sea are in engine spaces, protected from natural ultraviolet radiation. In conclusion, occupational ultraviolet radiation exposure does not seem to be related to increased melanoma risk within the Royal Australian Navy; however, some other factor in Service may be related.

References

1. Brown J, Kopf AW, Rigel DS, Friedman RJ. Malignant melanoma in World War II veterans. Int J Derm 1984; 23(10): 661-663.
2. Lancaster HO. Some geographical aspects of the mortality from melanoma in Europeans. MJA 1956; (1):1082-1087.
3. Schreiber MM. Exposure to sunlight: effects on the skin., Comprehensive Therapy 1986; 12: 38-42.
4. Green A, Beardmore G, Hart V, Leslie D, Marks R, Staines D. Skin cancer in a Queensland population. J Amer Acad Derm 1988; 19(6): 1045-1052.
5. MacLennan R, Green AC, Macleod GR , Martin NG. Increasing incidence of cutaneous melanoma in Queensland, Australia. J Nat Cancer Inst 1992; 84(18): 1427-32.
6. Green A, Siskind V. Geographical distribution of cutaneous melanoma in Queensland. MJA 1983;(1): 407-410.
7. Armstrong BK, Kricker A. How much melanoma is caused by sun exposure? Melanoma Res 1993; 3(6): 395-401.
8. Reif J, Pearce N, Fraser J. Cancer risks in New Zealand farmers. Int J Epidem 1989; 18(4): 768-774.
9. Garbe C. The German melanoma register and environmental risk factors implied. J Cancer Res Clinical Oncol 1991; 117 (Supp 2): 66.
10. Brownson RC, Reif JS, Chang JC, Davis JR. Cancer risks among Missouri farmers. Cancer 1989; 64(11): 2381-2386.
11. Fincham SM, Hansen J, Berkel J. Patterns and risks of cancer in farmers in Alberta. Cancer 1992; 69(5): 1276-1285.
12. Elwood JM, Koh HK. Etiology, epidemiology, risk factors, and public health issues of melanoma. Curr Opinion Oncology 1994; 6(2): 179-87.
13. Lilianfield AM, Lilianfield DE. Foundations of epidemiology (2nd ed.). New York: Oxford University Press; 1980.
14. Gardner MJ, Douglas GA. Statistics with confidence. London: British Medical Journal; 1989.
15. Khlat MA, Vail A, Parkin M, Green A. Mortality from melanoma in migrants to Australia: variation by age at arrival and duration of stay. Amer J Epidem 1992; 135(10): 1103-13.
16. Marks R. Epidemiology of non-melanoma skin cancer and solar keratoses in Australia: a tale of self-immolation in Elysian fields. Australasian J Derm 1997; 38(Supp 1): S26-9.
17. Marks R. Skin cancer -- childhood protection affords lifetime protection. MJA 1987; 147(10): 475-6.
18. Moise AF, Buttner PG, Harrison SL. Sun exposure at school. Photochem Photobiol 1999; 70(2): 269-74.
19. Green AD, Whiteman D, Frost C, Battistutta D. Sun exposure, skin cancers and related skin conditions. J Epidem 1999; 9(6 Supp): S7-13.
20. Garland FC, White MR, Garland CF, Shaw E, Gorham ED. Occupational sunlight exposure and melanoma in the US Navy. Arch Environ Health 1990; 45(5): 261-267.
21. Dircks R, Goldsmith P, McCosker N. Skin Cancer in the workplace J Occ Health Safety - Australia and New Zealand 1987; 3(1): 53-60.

22. Lynge E. Occupational mortality and cancer analysis. Public Health Rev 1990, 18(2): 99-116.

23. Lynge E, Thygesen L. Use of surveillance systems for occupational cancer: data from the Danish National System. Int J Epidem 1988; 17(3): 493-500.

24. McLaughlin JK, Malker HSR, Blot WJ, Ericsson JLE, Gemne G, Fraumeni JF. Malignant melanoma in the printing industry. Amer J Indust Med 1988; 13(2): 301-304.

25. Swerdlow AJ, English JSC, Mackie RM, O'Doherty CJ, Hunter JAA, Clark J, Hole DJ. Fluorescent lights, ultraviolet lamps and risk of cutaneous melanoma. BMJ 1988; 297(6649): 647-650.

26. Anonymous. Fluorescent lighting and malignant melanoma. Health Physics 1990; 58(1): 111-112.

27. Christie D, Robinson K, Gordon I, Bisby J. A prospective study in the Australian petroleum industry. II. Incidence of cancer. Brit J Indust Med 1991; 48(8): 511-514.

28. Marsh GM, Enterline PE, McCraw D. Mortality patterns among petroleum refinery and chemical plant workers. Amer J Indust Med 1991; 19(1): 29-42.

29. Ingram AJ. Review of chemical and UV light-induced melanomas in experimental animals in relation to human melanoma incidence. J Toxicol 1991; 12(1): 39-43.

30. Sinks T, Steele G, Smith AB, Watkins K, Shults RA. Mortality among workers exposed to polychlorinated biphenyls. Amer J Epidem 1992; 136(4): 389-398.

31. Mazzuckelli LF, Schulte, PA Notification of workers about an excess of malignant melanoma: a case study, Amer J Indust Med 1993; 23(1): 85-91.

Creating Environmental and Occupational Health

*Derek R. Smith**

**1st edition, xxi+170 pp, paperback with illustrations (available as Hardcover), ISBN 978-1921364129, Sydney, Darlington Press, 2010.*

Journal publications and their citations have become the common currency of academia, which has led to the development of such measures as the *h*-index and the *m*-parameter.[1] In the field of environmental and occupational health (EOH), this is also the case and the field is well endowed with a number of high quality journals. These journals have a history, not just in their genesis, but also in their evolution towards publications of acknowledged high standing. Today, this journal standing is increasingly coming under the microscope in the form of bibliometrics.[2] Indeed, in recent years, there are whole books appearing devoted to this area.[3] This First Edition of *Creating Environmental and Occupational Health* is a unique publication examining the development of EOH journals and for perhaps the first time focuses on how their impact is measured.

Creating Environmental and Occupational Health has a table of Contents, List of Tables, List of figures, a Foreword by Past President of the American College of Occupational and Environmental Medicine-Tee L. Guidotti, a Preface, Acknowledgments, a dedication, four Chapters, 18 Sections, References for the four chapters, three Appendices, an About the Author and a comprehensive Index. It also includes 62 Tables and 18 Figures. The handbook is compact and consistent in its presentation. The front cover has a basic but functional design. The back cover has a brief description of the purpose of the book, as well as an extract of a quotation glowing of the author from the Foreword of the book, together with the ISBN and barcode. Chapters include "Historical development of academic journals in environmental and occupational health"; "Historical development of the Archives of Environmental and Occupational Health", "Highly cited articles in Environmental and Occupational Health", and "A bibliometric analysis of the Archives of Environmental Health". There are also three Appendices, namely "1. Some notable Editorial Board members associated with the international journals of Environmental and Occupational Health", "2. Some notable editors associated with the Archives of Environmental and Occupational Health and its predecessor journals" and "3. Prior publications related to this book".

Creating Environmental and Occupational Health is well researched. Chapter 1 examines the history of nine EOH journals. Clearly, the focus is on international named journals in this field, although clearly EOH literature is published in other journals, especially where there is a desire by the author to publish in higher impact journals or specialist journals, for example in toxicology, cancer research or infection control. It is interesting that the Australian based *Journal of Health, Safety and Environment* (formerly the *Journal of Occupational Health and Safety: Australia and New Zealand)* does not rate a mention in the index, although this journal has not achieved significant international exposure, such as through PubMed listing. There is a very interesting Table (Table 1.2, page 5), which lists some of the early books and other publications in EOH, and it is made all the more interesting by the fact that *De morbis artificum* diatribe by Bernardino Ramazzini does not head the list chronologically, but rather *Concerning the poisonous, evil vapours* by Ulrich Ellenbog. The remaining chapters (Ch. 2-4) focus on three major EOH journals, examining different key aspects, including their history, highly cited papers and their bibliometric analysis, respectively. There are numerous quotable remarks in this book. One personal favourite of relevance to all journal editors is:

> "A watershed in journal performance occurs when its impact factor exceeds one, indicating that, on average, its articles are being cited more often than they are being published." (Ch, 4; p. 94)

The book is extremely well referenced with about 40 pages of references for the four chapters.

The author, Professor Derek R. Smith, is a rapidly rising star in EOH. His biography states that he is "Professor of Environmental and Occupational Health, Deputy Director (Research) of the Central Coast Campus and Director of the WorkCover New South Wales Research Centre of Excellence; all at the University of Newcastle in New South Wales, Australia." (p 163). He has published more than 200 journal papers. A Google.com search confirms

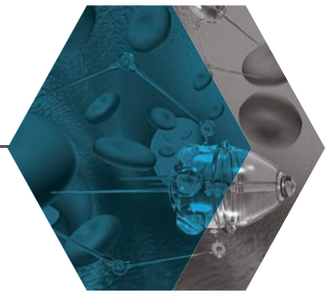
on the first couple of pages that he is a recipient of numerous awards, including the Sidney Sax Medal endorsed by the Public Health Association of Australia (Queensland Branch); named a Distinguished Alumni by James Cook University; and an Award for Research Excellence, University of Newcastle. The National Library of Australia Cataloguing-in-Publication entry indicates that this has all been achieved before the age of 40.

Creating Environmental and Occupational Health is not meant to be a textbook of EOH. The book's title suggests many things, but indeed it is examining one of the key instruments by which EOH is created, which is the journal literature. It examines the history and bibliometrics of several of the key journals in the field and it is essential reading for all academics and researchers in EOH, as well as other significant contributers to the literature in this field. It will also be of interest to those working in or wanting to gain a better understanding of bibliometrics, as it is a useful case study in this area, which has applications to most other fields in health and science. The book will also appeal to postgraduate research students in EOH, who want to rapidly gain an understanding of the major peer-reviewed journals in the field. *Creating Environmental and Occupational Health* is a first in EOH internationally and is sure to become a classic book in years to come, perhaps one to add to other historical classics in EOH as listed in Table 1.2 (p 5).

Reviewer: Peter A Leggat, MD, PhD, DrPH, FAFPHM, FFPH RCP(UK), FACTM, FACRRM, Professor and Deputy Head, School of Public Health, Tropical Medicine and Rehabilitation Sciences, James Cook University, Townsville, Queensland, Australia, and Visiting Professor, School of Public Health, University of the Witwatersrand, Johannesburg, South Africa. Email. Peter.Leggat@jcu.edu.au.

References

1. Hirsch JE. An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences* (USA) 2005; 102: 16569-16572.
2. Van Raan T. Bibliometrics: Measure for measure. *Nature* 2010; 468: 763.
3. De Bellis N. Bibliometrics and Citation Analysis: From the Science Citation Index to Cybermetrics. Lanham, Maryland, USA: Scarecrow Press, 2009.



20TH ANNIVERSARY

MILITARY HEALTH SHAPING THE FUTURE

2011 AMMA CONFERENCE

COMMEMORATING 20 YEARS OF AMMA

21–23 OCTOBER 2011

CROWN CONFERENCE CENTRE
MELBOURNE VICTORIA

REGISTRATION OPEN NOW.

ONLINE AT www.amma.asn.au

www.jmvh.org