

# An update on stress, fatigue and wellbeing: implications for naval personnel

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## ABSTRACT

*The aim of the present article is to provide an update on recent research on stress, fatigue and wellbeing and discuss the implications for naval personnel. There is now considerable information on these topics in onshore civilian populations and some research on seafarers and other military personnel. This generic information can now be used to address these issues in naval personnel. In order to do this there is a need to consider specific naval contexts and to collect data to confirm the applicability of established methods and models to the navy.*

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**Key words: stress, fatigue, wellbeing, the Navy**

## INTRODUCTION

After World War II the navies of many countries played a key role in fundamental research on stress and fatigue. For example, in the MRC Applied Psychology Unit at Cambridge, United Kingdom, naval ratings frequently acted as volunteers in laboratory studies of effects of noise or sleep deprivation [1]. This research was eventually extended to investigate the operational context and to attempt to find countermeasures that would maintain operational efficiency [2–4]. In onshore civilian populations there has recently been an enormous increase in research on occupational stress, fatigue and wellbeing which has not been seen to the same extent in naval personnel.

## STRESS, FATIGUE AND WELLBEING IN THE NAVY

The literature on stress in the navy does cover topics other than military operational efficiency. For example, there has been research on the psychosocial and life stress characteristics of naval families [5] and on parenting stress in Navy active duty parents [6–8]. Recent research has continued to examine acute response to stress in samples of naval cadets and ratings [9–12]. Other research has evaluated methods of managing stress and shown that only educational stress briefs relevant for the target audience are

beneficial [13]. There has also been interest in the use of Virtual Reality methodologies to develop Stress Inoculation Training (SIT) and Posttraumatic Stress Disorder (PTSD) treatment [14]. Other research [15] has documented the stress of military members and their families during different periods of deployment (pre-deployment; mid-deployment; and post-deployment). All phases reported suicidal ideation at very high rates (> 2%). Some studies have focused on specific operational roles (e.g. navy aviation personnel [16–18]) whereas others have investigated all members of the crew [19]. There have been many studies of occupational stress and job satisfaction in civilian populations but relatively few in the Navy (e.g. [20]). Similarly, stress and ill-health has been frequently studied in the general population but little research has been carried out with naval personnel (e.g. [21–24]).

Many of the studies of stress in naval personnel have also investigated fatigue [2, 3, 18]. Again, research has either focused on specific roles (e.g. naval aviators [25]; commanding officers [26], watch-keepers [27, 28] or a range of crew members [29]) often in operational settings [30, 31] but sometimes in non-operational settings as well [32].

Research on the Navy and wellbeing has been more recent and much of it has considered negative outcomes such as mental health problems [33–37] and suicide [38, 39].

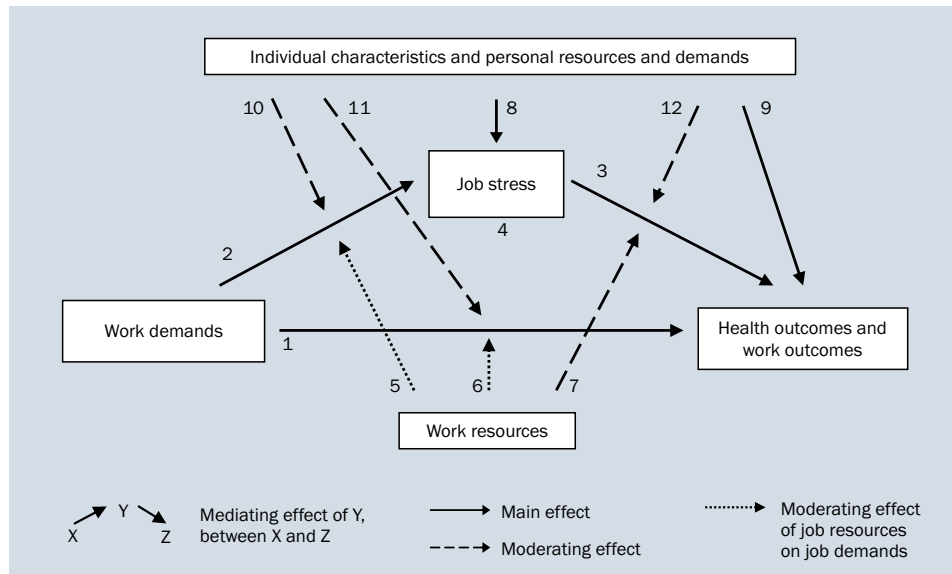


Figure 1. The Demands-Resources-Individual Effects model [48]

Comparisons have been made between specific roles (e.g. submariners) and a stratified sample of naval personnel [40]. However, other research has considered quality of life and extended this to naval nurses [41] and naval families [42]. The role of resilience and social support has also been investigated [43], as has the buffering effect of sense of belonging [44].

The next section discusses recent developments in stress, wellbeing and fatigue and considers the implication of these approaches for naval personnel.

### RECENT APPROACHES TO STRESS AT WORK

The aim of this section is to review some of the research on stress and wellbeing at work that has been carried out in the last 10–15 years. The general approach adopted here is described in more detail in Smith [45, 46]. The starting point for this is a case definition of work-related stress [47] and this research considered the feasibility and possible nature of a case definition of work-related stress that is suitable for application in a variety of stakeholder domains.

### A CASE DEFINITION OF OCCUPATIONAL STRESS

A case definition is needed in occupational health research as the basis for surveillance, and for monitoring the effectiveness of interventions. Cox et al. [47] examined definitions already applied in studies of work-related stress. They then identified key stakeholders and collected information on (I) the case definitions employed in their various fields and (II) their views on the feasibility of developing

a single case definition that could cover all areas but remain consistent with epidemiological case definitions.

A case definition was arrived at by consensus across stakeholder groups and this case definition required the person to report:

- high levels of stress;
- unreasonable job characteristics;
- mental health problems;
- work-related problems (e.g. high sick-leave);
- the above to be work related and not due to confounding factors.

Cox et al. [47] suggested that this definition could be used for research purposes and it is supported by recent models of occupational stress. One such model, the Demands-Resources-Individual Effects (DRIVE) model [48] is described in the next section.

### THE DRIVE MODEL OF STRESS

This model is shown in Figure 1. It has many of the features of earlier models of stress but puts a greater emphasis on individual characteristics and personal resources. The basic model included factors from the Demand-Control-Support (DCS) model, the Effort-Reward Imbalance (ERI) model, coping behaviours, and attributional explanatory styles as well as outcomes including anxiety, depression, and job satisfaction. These variables were categorised as work demands, work resources (e.g. control, support), individual differences (e.g. coping style, attributional style), and outcomes, although the model is intended as a framework into which any relevant variables can be applied [48]. The simple DRIVE model proposed direct effects on outcomes by each of the other variable groups, as well as a moderating

effect of individual differences and resources on demands. A more complex version (the enhanced DRIVE model) was also developed to acknowledge a subjective element and included perceived stress as well as further interactive effects. Research using the DRIVE model has supported the direct effects of these variable groups on outcomes, although little support was found for interactions [49, 50]. Stronger support of direct effects compared to interactions has also been found in research on other models such as the DCS model, where reviews have shown that the buffering effect of control and support are less frequently found than the direct effects of these variables on outcomes. Research has also shown that many of the effects of job characteristics are mediated through perceived stress [51, 52].

The presence of independent effects of risk factors has led to another important methodological feature of stress research, the combined effects approach.

### COMBINED EFFECTS OF OCCUPATION HAZARDS

There has been much previous research on a large number of workplace hazards, and for the most part the nature and effects of such factors have been considered in isolation. Such an approach is not likely to be representative of the real-life workplace where employees are often exposed to multiple hazards. For example, individuals are very unlikely to work in a noisy environment that does not also expose them to other stressors that have considerable potential to harm. There is limited information on the combined effects of these hazards on health and safety. Indeed, there have been no systematic literature reviews, no attempt to produce a coherent framework for studying these factors, and a dearth of studies using a variety of methods to investigate the topic.

The combined effects approach (see [53, 54]) involved summing the number of negative job characteristics (or absence of positive job characteristics) to which a person is exposed. This “Total Negative Score” was then sub-divided into quartiles and logistic regressions used to examine associations between this score and the outcomes. Table 1 shows the associations between the total negative score and high stress at work. The lowest quartile was set as the comparison group and the odds ratios show that the likelihood of being in the high stress group increases as one goes from quartile 2 to quartile 4.

The above results show a linear relationship between total negative job characteristics and perceived stress at work. Mental health outcomes and accidents at work can also be examined in this way. Other results showed that a measure of exposure to combinations of workplace factors (the Negative Occupational Factors Score) was associated with a number of health and safety outcomes, many of which were consistent across different industry sectors. Some

**Table 1.** Associations between the total negative factors score (split into quartiles) and being in the high stress category (defined as reporting being very or extremely stressed at work).

	Odds ratio	Confidence interval
1 <sup>st</sup> quartile	1.00	
2 <sup>nd</sup> quartile	1.60	1.32–1.93
3 <sup>rd</sup> quartile	2.08	1.72–2.53
4 <sup>th</sup> quartile	3.84	3.17–4.66

of the associations were due to perceived stress at work whereas others were direct effects. The combined effects approach has also been shown to be important in assessing specific problems in certain occupations (see section on seafarers’ fatigue). In addition, it has strong implications for the development of stress management standards. Similarly, one can use the approach to examine wellbeing at work and address the question of what is a good job (or what factors are associated with greater wellbeing and/or the absence of negative outcomes) and research on this topic is described in the next section.

### WELLBEING AT WORK: WHAT IS A GOOD JOB?

There is a huge amount of research on negative job characteristics, occupational stress and mental health problems. However, positive and negative emotions are not just the opposite ends of a continuum, and the absence of negative emotion does not mean the presence of positive emotion. Recent approaches (e.g. [55]) have suggested that “Work is good for you.” However, detailed consideration of the literature suggests that it is the absence of work that is bad for you. Indeed, work per se is not necessarily going to be good – but good work is good for you [56]. This then leads to the question of what is a good job. This could be answered in many different ways (e.g. from an economic point of view). However, within the present context the question is what psychosocial characteristics associated with work are associated with positive outcomes. A literature review [57] showed that, compared to the negative effects of work, there is very little published evidence on its positive effects. Indeed, the literature on positive aspects has many problems, such as a lack of theory, lack of data to support views and weak methodology. Measures of wellbeing are mainly outcomes and do not reflect the “wellbeing process”, which is necessary to understand the topic.

Secondary analyses of large-scale surveys [58] compared the effects of the presence and absence of positive/negative job characteristics. For example, the analyses considered questions such as: “Is the presence of social support good, the absence of social support bad, or are

**Table 2.** Associations between the good job score (shown as quartiles) and positive mental health (a median split into high/low groups)

	Odds ratio
Low good job	1.00
Second quartile	2.89
Third quartile	5.24
High good job	22.83

both true?” This was done by splitting the scores into tertiles (three equal parts), using the mid-value as the reference value, and examining whether equal and opposite changes occurred at opposite ends of the continuum. The results from these analyses showed that dose response did not occur for all types of association. This shows that one must examine both ends of the continuum – presence of positive features and absence of negative features – rather than inferring the effects of one from the other. Additional survey data, including positive job characteristics, appraisals and outcomes were also collected [59]. The major question addressed was what predicts positive outcomes? Again, a combined effects approach was used and the “good job score”, which best predicted positive outcomes (e.g. good health; wellbeing), was the sum of the presence of positive job characteristics and appraisals and the absence of negative characteristics and appraisals. An example of this can be seen in Table 2. This shows that those with the highest good job score were nearly 23 times more likely to be in the high positive health group than those in the lowest good job category.

These pieces of research showed that there is a need for a multi-dimensional model of wellbeing at work that measures a wide range of job characteristics, job attitudes, individual characteristics and outcomes. This has been addressed by developing surveys involving short measures of a large number of concepts, and an example of this approach has been the development of the Wellbeing Process Questionnaire (WPQ) which has been used to address many of the above issues [60].

### DEVELOPMENT OF THE WELLBEING PROCESS QUESTIONNAIRE (WPQ)

This relates back to the case definition of occupational stress, the DRIVE model and the measurement of wellbeing. Research on the WPQ showed that single items are often highly correlated with longer scales. This means that it is possible to have a single question measuring perceived stress, single items measuring job characteristics, and single items measuring health outcomes. In addition, possible confounding factors (e.g. personality, life outside of work)

can be measured by single items. The single questions provide examples of the concept being measured and responses are made using a scale of 1–10 which allows a greater potential range of responses. An example is shown below:

- “Job Demands: I feel that I do not have the time I need to get my work done (for example I am under constant time pressure, interrupted in my work, or overwhelmed by responsibility or work demands)”
- Response: on a 10-point scale from Disagree strongly to Agree strongly

An initial study with a sample of University staff showed significant correlations between single items and full scales (average correlation for work characteristics: 0.7; average for personality: 0.66). The predictive validity was examined by testing the Job Demands-Control-Support and Effort-Reward Imbalance models with full scales and single items. Very similar results were obtained (i.e. predictive validity of single items is comparable to full scales; at risk groups based on the models can be identified with single items). This approach also allows removal of overlapping constructs. Using single items enables one to use many more concepts but these often overlap and one can determine which variables remain in the model after all have been entered into the regression. Using this technique the following constructs remained in the model: Negative job characteristics: Demands; Effort; Over-commitment. Positive job characteristics: Rewards; Control; Support; Consultation on change; Good supervisor relationship. Positive life circumstances: Uplifts; Flourishing; Social support. Negative life circumstances: Hassles. Positive Personality: Optimism; Self-esteem; Self-efficacy; Emotional stability. Negative Coping: Avoidance; Self-blame; Wishful thinking.

Using the above variables selective effects were observed. Only certain variables predicted specific outcomes. For example, work characteristics were more important for job satisfaction and job stress, whereas personality is a better predictor of positive and negative affect. A great deal of research is in progress using the approaches described here to address additional themes. First, research has investigated stress and wellbeing at work in different sectors (call centres; the police; offshore; healthcare professionals). Second, additional constructs have been examined to see how these fit into the model (ethnicity; personality; and religion). Third, different outcomes have been investigated to determine whether the approach is appropriate for them (musculo-skeletal disorders; accidents and incidents). The research has also been extended internationally to determine which effects are general and which may be culture specific. Future research will also include using the approach to evaluate interventions that change working practices and offer occupation support [61]. The general approach outlined here is that there are some ge-

**Table 3.** Signs and symptoms of different levels of fatigue

Likely level of fatigue	Signs/symptoms
<b>Early warning signs of fatigue</b> which should prompt people to look out for more conclusive evidence of fatigue	Fidgeting Rubbing the eyes
<b>Signs of moderate fatigue</b> suggesting performance is being affected. Take these seriously – it is not necessary to fall asleep to make a critical error	Frequent yawning Staring blankly Frequent blinking
<b>Signs of severe fatigue.</b> Liable to brief uncontrollable “micro-sleeps”, risk of errors very high	Nodding head Difficulty keeping eyes open and focused Long blinks

neric models of stress and wellbeing that can be applied to a range of different occupations. Quite often the difficult part is knowing how a specific context translates into the more generic concepts. This will now be discussed in detail by considering seafarers' fatigue.

### SEAFARERS' FATIGUE

Fatigue has been identified as a cause in major accidents such as the Herald of Free Enterprise disaster and although there is relatively little information on recognising and managing fatigue specific to the seafaring industry, there is much that can be learned from guidance devised for other sectors. For example, the Health and Safety Executive has produced various guides of its own on managing fatigue and also identifies Office of Rail Regulation guidance as being transferable to other safety critical industries. This includes Table 3 on the signs and symptoms of fatigue.

Despite an awareness that seafarers might be at particular and perhaps greater risk of fatigue than other workers because of the way that they work, until recently there has been very little research focused on them. The Cardiff Programme was one of the first studies intended to begin to fill this gap. It was designed to begin to build up a knowledge base on seafarer fatigue to:

- predict worst case scenarios for fatigue, health and injury;
- develop best practice recommendations;
- produce advice for seafarers, regulators and policy makers.

To achieve this the research included: a questionnaire survey of working and rest hours, and physical and mental health; a diary survey in which seafarers recorded their day-to-day sleep quality and work patterns; and on-board assessments of alertness and performance (such as reaction time). The questionnaire survey identified a large number of specific aspects of seafaring that were associated with fatigue. These included, for example, poor sleep quality, negative environmental factors (such as heavy seas and poor weather), high levels of job demands and stress, frequent

port visits, exposure to physical hazards (such as fumes and noise) and long working hours. In particular, the survey showed that it was those who reported the greatest number of these factors that were most at risk of fatigue. In addition, seafarers who reported fatigue were more likely than seafarers who did not report fatigue to also report having poorer health, poorer well-being and reduced concentration levels, and to report having been involved in a collision. The on-board assessments showed that particular aspects of seafaring work, identified in the questionnaire and diary surveys as being risk factors for fatigue, had a detrimental impact on seafarers' levels of alertness and performance. For example, exposure to noise, working at night and a great number of days into tour were all associated with lower alertness levels and poorer performance. The diary study showed that fatigue increased most steeply during the first week of a tour. It then steadied but remained relatively higher than it was at the start of the tour. In order to consider recovery from fatigue, the survey also extended into leave. This showed that fatigue typically does not return to pre-tour levels until the second week of leave.

The Cardiff Programme showed that the potential for seafarers to experience fatigue is high because of the number of fatigue risk factors they are exposed to, many of which are unique to seafaring. More significantly, however, it made clear the importance of considering fatigue risk factors in combination – which of course, reflects the reality of seafarers' day-to-day working experience. The consequences can be felt by individual seafarers not only in the short-term (in terms of fatigue symptoms including, for example, confusion, tension and loss of concentration), but also in the longer-term (being associated with the development of poorer physical and mental health and reduced well-being). They also impact on vessels, crews, cargos and the environment (for example as a result of collisions).

Smith et al. [62] describe risk factors for ship collisions and groundings. These included:

- fatigue;
- alcohol/substances;
- illness;



- uncertainty about responsibilities;
- communication problems;
- poor communication between ships and/or authorities;
- distraction;
- poor bridge design;
- inadequate means of navigation;
- inadequate use of navigational aids;
- overload;
- alarms suppressed/ignored/misinterpreted;
- lack of personnel;
- external pressures;
- poor weather conditions.

Two important conclusions can be drawn from the list above. First, accidents are caused by multiple inter-related factors. For example, a lack of personnel may lead to an accident when weather conditions have been poor, as the crew have become fatigued. Fatigue in turn will lead to an increased likelihood of distraction, poor communication and overload. Secondly, in terms of reducing the likelihood of accidents, it's important to distinguish between causal and symptomatic factors. Whilst fatigue is a cause of accidents, it sits in a chain of events and is rarely the initial, triggering factor. By contrast, core systemic factors such as manning need to be the focus of intervention.

### THE WAY FORWARD

A main recommendation from the Cardiff fatigue research was that seafarers' fatigue should be treated as a health and safety issue. Demonstrating that fatigue is a multi-factorial process with wide ranging significant consequences also makes it clear that addressing fatigue requires a multi-level approach. Making specific, isolated recommendations to one level of the industry will have limited effect unless the bigger picture is considered. For example, it might be suggested to crew members that they ask for assistance if they feel fatigued. A broader perspective would recognise that this may not be possible if the ship is under-manned. The reason the ship is under-manned may be because of market conditions and competition with other companies who operate with fewer crew. The reason for ships having fewer crew may be because of competition between flag states for registration, which has allowed manning levels to decrease. Recommendations which ignore these wider factors will be of little value to the industry. At the highest level, international legislation is essential in combating excessive working hours. The evidence suggests that existing efforts to date have been inadequate. Establishing standards both for measuring fatigue and for recording and auditing actual working hours would undoubtedly accelerate progress. As the research has shown, fatigue is much more than working hours, but knowing how long seafarers are working is critical in terms

of evaluating how safe operating standards are, and current working hours recording systems have been shown to be inadequate.

### TO FINISH WITH A POSITIVE MESSAGE

Recent research on stress, fatigue and wellbeing has some clear implications for naval personnel. Audit tools are now available and can be used to assess these factors over time. Longitudinal studies are important because they provide a clearer indication of causal links and such studies have been carried out successfully using the measuring instruments described in this paper. These measuring instruments should include surveys, diaries and objective measurement of cognitive performance and physiology. Indeed, the development of microbiological techniques suggests that a simple objective stress test may be getting closer. Objective cognitive testing can now also be carried out in remote locations and this can be supported by other forms of mobile recording.

Developments in education and training will also help those who are working away from home. Use of appropriate working away strategies can improve quality of life and subsequent wellbeing [63]. This can now be developed into an educational programme that enables better coping with being away from home. Stress or fatigue training has also now become more sophisticated and one successful approach [64] has the following format:

1. Education – providing appropriate information about stress or fatigue;
2. Personal relevance – getting the person to consider their own stress and fatigue;
3. Nudges to prevent or reduce these problems – consider small manageable changes rather than trying to completely change the job;
4. Personal commitment – this is a crucial part of training which will lead to use of the approach at a later date.

### REFERENCES

1. Broadbent DE. Decision and Stress. Academic Press, London 1971.
2. Lieberman HR, Tharion WJ, Shukitt-Hale B, et al. Effects of caffeine, sleep loss, and stress on cognitive performance and mood during U.S. Navy SEAL training. *Sea-Air-Land. Psychopharmacology (Berl)*. 2002; 164(3): 250–261, doi: [10.1007/s00213-002-1217-9](https://doi.org/10.1007/s00213-002-1217-9), indexed in Pubmed: [12424548](https://pubmed.ncbi.nlm.nih.gov/12424548/).
3. Tharion WJ, Shukitt-Hale B, Lieberman HR. Caffeine effects on marksmanship during high-stress military training with 72 hour sleep deprivation. *Aviat Space Environ Med*. 2003; 74(4): 309–314, indexed in Pubmed: [12688447](https://pubmed.ncbi.nlm.nih.gov/12688447/).
4. Harris W, Hancock PA, Harris S. Information Processing Changes Following Extended Stress. *Military Psychology*. 2005; 17(2): 115–128, doi: [10.1207/s15327876mp1702\\_4](https://doi.org/10.1207/s15327876mp1702_4).
5. Eastman E, Archer R, Ball JD. Psychosocial and Life Stress Characteristics of Navy Families: Family Environment Scale and Life Experiences Scale Findings. *Military Psychology*. 2009; 2(2): 113–127, doi: [10.1207/s15327876mp0202\\_4](https://doi.org/10.1207/s15327876mp0202_4).

6. Kelley ML, Herzog-Simmer PA, Harris MA. Effects of military-induced separation on the parenting stress and family functioning of deploying mothers. *Military Psychology*. 1994; 6(2): 125–138.
7. Tucker M, Kelley M. Social Support and Life Stress as Related to the Psychological Distress of Single Enlisted Navy Mothers. *Military Psychology*. 2009; 21(suppl. 2): S82–S97, doi: [10.1080/08995600903249198](https://doi.org/10.1080/08995600903249198).
8. Yablonsky AM, Yan G, Bullock L. Parenting Stress After Deployment in Navy Active Duty Fathers. *Mil Med*. 2016; 181(8): 854–862, doi: [10.7205/MILMED-D-15-00302](https://doi.org/10.7205/MILMED-D-15-00302), indexed in Pubmed: [27483524](https://pubmed.ncbi.nlm.nih.gov/27483524/).
9. Morgan CA, Rasmussen AM, Wang S, et al. Neuropeptide-Y, cortisol, and subjective distress in humans exposed to acute stress: replication and extension of previous report. *Biol Psychiatry*. 2002; 52(2): 136–142, indexed in Pubmed: [12114005](https://pubmed.ncbi.nlm.nih.gov/12114005/).
10. Herrera V, Guarino L. Emotional sensitivity, stress, and perceived health in Venezuelan marines. *Universitas Psychologica*. 2008; 7(1): 185–198.
11. Hansen AL, Johnsen BH, Thayer JF. Relationship between heart rate variability and cognitive function during threat of shock. *Anxiety Stress Coping*. 2009; 22(1): 77–89, doi: [10.1080/10615800802272251](https://doi.org/10.1080/10615800802272251), indexed in Pubmed: [18781457](https://pubmed.ncbi.nlm.nih.gov/18781457/).
12. Sandvik AM, Bartone PT, Hystad SW, et al. Psychological hardness predicts neuroimmunological responses to stress. *Psychol Health Med*. 2013; 18(6): 705–713, doi: [10.1080/13548506.2013.772304](https://doi.org/10.1080/13548506.2013.772304), indexed in Pubmed: [23458268](https://pubmed.ncbi.nlm.nih.gov/23458268/).
13. Greenberg N, Langston V, Fear NT, et al. An evaluation of stress education in the Royal Navy. *Occup Med (Lond)*. 2009; 59(1): 20–24, doi: [10.1093/occmed/kqn142](https://doi.org/10.1093/occmed/kqn142), indexed in Pubmed: [19001068](https://pubmed.ncbi.nlm.nih.gov/19001068/).
14. Wiederhold BA, Wiederhold MD. From SIT to PTSD: Developing a Continuum of Care for the Warfighter. *PsycEXTRA Dataset*. 2006, doi: [10.1037/e695432011-001](https://doi.org/10.1037/e695432011-001).
15. McNulty PA. Reported stressors and health care needs of active duty Navy personnel during three phases of deployment in support of the war in Iraq. *Mil Med*. 2005; 170(6): 530–535, doi: [10.7205/milmed.170.6.530](https://doi.org/10.7205/milmed.170.6.530), indexed in Pubmed: [16001607](https://pubmed.ncbi.nlm.nih.gov/16001607/).
16. Alkov RA, Borowsky MS, Gaynor JA. Stress coping and the U.S. Navy aircrew factor mishap. *Aviat Space Environ Med*. 1982; 53(11): 1112–1115, indexed in Pubmed: [7150172](https://pubmed.ncbi.nlm.nih.gov/7150172/).
17. Alkov RA, Gaynor JA, Borowsky MS. Pilot error as a symptom of inadequate stress coping. *Aviat Space Environ Med*. 1985; 56(3): 244–247, indexed in Pubmed: [3985904](https://pubmed.ncbi.nlm.nih.gov/3985904/).
18. Belland KM, Bissell C. A subjective study of fatigue during Navy flight operations over southern Iraq: Operation Southern Watch. *Aviation, Space, and Environmental Medicine*. 1994; 65(6): 557–561.
19. Rahe R, Mahan J, Arthur R, et al. The Epidemiology of Illness in Naval Environments. *Military Medicine*. 1970; 135(6): 443–452, doi: [10.1093/milmed/135.6.443](https://doi.org/10.1093/milmed/135.6.443).
20. Sarason IG, Johnson JH. Life stress, organizational stress, and job satisfaction. *Psychol Rep*. 1979; 44(1): 75–79, doi: [10.2466/pr0.1979.44.1.75](https://doi.org/10.2466/pr0.1979.44.1.75), indexed in Pubmed: [461626](https://pubmed.ncbi.nlm.nih.gov/461626/).
21. Ribin RT, Gunderson EK, Doll RE. Life stress and illness patterns in the US Navy. I. Environmental variables and illness onset in an attack carrier's crew. *Arch Environ Health*. 1969; 19(5): 740–747, indexed in Pubmed: [5350443](https://pubmed.ncbi.nlm.nih.gov/5350443/).
22. Doll RE, Rubin RT, Gunderson EK. Life stress and illness patterns in the US Navy. II. Demographic variables and illness onset in an attack carrier's crew. *Arch Environ Health*. 1969; 19(5): 748–752, indexed in Pubmed: [5350444](https://pubmed.ncbi.nlm.nih.gov/5350444/).
23. Rubin RT, Gunderson EK, Arthur RJ. Life stress and illness patterns in the US Navy. 3. Prior life change and illness onset in an attack carrier's crew. *Arch Environ Health*. 1969; 19(5): 753–757, indexed in Pubmed: [5350445](https://pubmed.ncbi.nlm.nih.gov/5350445/).
24. Rahe R, Mahan J, Arthur R, et al. The Epidemiology of Illness in Naval Environments. *Military Medicine*. 1970; 135(6): 443–452, doi: [10.1093/milmed/135.6.443](https://doi.org/10.1093/milmed/135.6.443).
25. Neri D, Shappell S. The Effect of Combat on the Work/Rest Schedules and Fatigue of Naval Aviators During Operations Desert Shield and Desert Storm. *Military Psychology*. 2009; 6(3): 141–162, doi: [10.1207/s15327876mp0603\\_1](https://doi.org/10.1207/s15327876mp0603_1).
26. Shattuck NL, Matsangas P. A 6-month assessment of sleep during naval deployment: a case study of a commanding officer. *Aerosp Med Hum Perform*. 2015; 86(5): 481–485, doi: [10.3357/AMHP.4140.2015](https://doi.org/10.3357/AMHP.4140.2015), indexed in Pubmed: [25945667](https://pubmed.ncbi.nlm.nih.gov/25945667/).
27. Shattuck NL, Matsangas P. Operational assessment of the 5-h on/10-h off watchstanding schedule on a US Navy ship: sleep patterns, mood and psychomotor vigilance performance of crewmembers in the nuclear reactor department. *Ergonomics*. 2016; 59(5): 657–664, doi: [10.1080/00140139.2015.1073794](https://doi.org/10.1080/00140139.2015.1073794), indexed in Pubmed: [26360772](https://pubmed.ncbi.nlm.nih.gov/26360772/).
28. Skornyakov E, Shattuck NL, Winsler MA, et al. Sleep and performance in simulated Navy watch schedules. *Accid Anal Prev*. 2017; 99(Pt B): 422–427, doi: [10.1016/j.aap.2015.11.021](https://doi.org/10.1016/j.aap.2015.11.021), indexed in Pubmed: [26691014](https://pubmed.ncbi.nlm.nih.gov/26691014/).
29. Lewis Shattuck N, Matsangas P, Moore J, et al. Prevalence of Musculoskeletal Symptoms, Excessive Daytime Sleepiness, and Fatigue in the Crewmembers of a U.S. Navy Ship. *Mil Med*. 2016; 181(7): 655–662, doi: [10.7205/MILMED-D-15-00279](https://doi.org/10.7205/MILMED-D-15-00279), indexed in Pubmed: [27391619](https://pubmed.ncbi.nlm.nih.gov/27391619/).
30. Hardaway C, Gregory K. Fatigue and Sleep Debt in an Operational Navy Squadron. *The International Journal of Aviation Psychology*. 2005; 15(2): 157–171, doi: [10.1207/s15327108ijap1502\\_3](https://doi.org/10.1207/s15327108ijap1502_3).
31. Grech MR, Neal A, Yeo G, et al. An examination of the relationship between workload and fatigue within and across consecutive days of work: is the relationship static or dynamic? *J Occup Health Psychol*. 2009; 14(3): 231–242, doi: [10.1037/a0014952](https://doi.org/10.1037/a0014952), indexed in Pubmed: [19586219](https://pubmed.ncbi.nlm.nih.gov/19586219/).
32. Li H, Chen Y, Zhang L, et al. Sleep during navigation and its effects on fatigue and neurobehavior. *Chinese Mental Health Journal*. 1999; 13(5): 295–296.
33. Williams RA, Hagerty BM, Yousha SM, et al. Factors associated with depression in navy recruits. *J Clin Psychol*. 2002; 58(4): 323–337, indexed in Pubmed: [11920688](https://pubmed.ncbi.nlm.nih.gov/11920688/).
34. Bridger RS, Dew A, Brasher K, et al. Chronic and acute psychological strain in naval personnel. *Occup Med (Lond)*. 2009; 59(7): 454–458, doi: [10.1093/occmed/kqp104](https://doi.org/10.1093/occmed/kqp104), indexed in Pubmed: [19783756](https://pubmed.ncbi.nlm.nih.gov/19783756/).
35. Klefataras G, Psarra E. Meaning in Life, Psychological Well-Being and Depressive Symptomatology: A Comparative Study. *Psychology*. 2012; 03(04): 337–345, doi: [10.4236/psych.2012.34048](https://doi.org/10.4236/psych.2012.34048).
36. Rose ML. Deployment status and social support as predictors of anxiety, depression, and stress in navy wives. *Dissertation Abstracts International*, 75(1-A(E). 2014; Section A: Humanities and Social Sciences: 75(1-A(E)).
37. Hooff MV, McFarlane AC, Davies CE, et al. The Australian Defence Force Mental Health Prevalence and Wellbeing Study: design and methods. *Eur J Psychotraumatol*. 2014; 5, doi: [10.3402/ejpt.v5.23950](https://doi.org/10.3402/ejpt.v5.23950), indexed in Pubmed: [25206944](https://pubmed.ncbi.nlm.nih.gov/25206944/).
38. Stahl MA. Stress and suicide in the military: service-specific risk factors. *Advances in Psychology Research*, edited by S. P. Shohov. 2004; (Hauppauge, NY, US: Nova Science Publishers), (30): 155–192.
39. Bush NE, Reger MA, Luxton DD, et al. Suicides and suicide attempts in the U.S. Military, 2008–2010. *Suicide Life Threat Behav*. 2013;

- 43(3): 262–273, doi: [10.1111/sltb.12012](https://doi.org/10.1111/sltb.12012), indexed in Pubmed: [23330611](https://pubmed.ncbi.nlm.nih.gov/23330611/).
40. Brasher KS, Dew ABC, Kilminster SG, et al. Occupational stress in submariners: the impact of isolated and confined work on psychological well-being. *Ergonomics*. 2010; 53(3): 305–313, doi: [10.1080/00140130903067763](https://doi.org/10.1080/00140130903067763), indexed in Pubmed: [20191405](https://pubmed.ncbi.nlm.nih.gov/20191405/).
  41. Puksta NA. Quality of life in relation to stressful life events, daily hassles, and coping responses among midlife, female navy nurses. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, 57(1-B). 1996; 0242.
  42. Mustillo S, Wadsworth SM, Lester P. Parental deployment and well-being in children: results from a new study of military families. *Journal of Emotional and Behavioral Disorders*. 2016; 24(2): 82–91.
  43. Cunningham CA. The role of resilience and social support in predicting post-deployment adjustment in navy personnel. *Dissertation Abstracts International: Section B: The Sciences and Engineering*. 2015.; 75(12-B(E)).
  44. Sargent J, Williams RAHB, Lynch-Sauer J, et al. Sense of belonging as a buffer against depressive symptoms. *Journal of American Psychiatric Nurses Association*. 2002; 8(4): 120–129.
  45. Smith AP. A holistic approach to stress and well-being. *Occupational Health (At Work)*. 2011; 7(4): 34–35.
  46. Smith AP. A holistic approach to stress and well-being. Part 2: Stress at work: models, practice and policy. *Occupational Health (At Work)*. 2011; 8(1): 33–35.
  47. Cox T, Griffiths A, Houdmont J. Defining a case of work-related stress. *Health and Safety Research Report 449*. HSE Books, Sudbury 2006.
  48. Mark GM, Smith AP. Stress models: A review and suggested new direction. In: Houdmont J, Leka S. ed. *Occupational Health Psychology: European Perspectives on research, education and practice*. EA-OHP series, Vol 3 (Nottingham University Press), 2008: 111–144.
  49. Mark G, Smith AP. Effects of occupational stress, job characteristics, coping and attributional style on the mental health and job satisfaction of university employees. *Anxiety, Stress and Coping*. 2011; 25: 63–78, doi: [10.1080/10615806.2010.548088](https://doi.org/10.1080/10615806.2010.548088).
  50. Mark G, Smith AP. Occupational stress, job characteristics, coping, and the mental health of nurses. *Br J Health Psychol*. 2012; 17(3): 505–521, doi: [10.1111/j.2044-8287.2011.02051.x](https://doi.org/10.1111/j.2044-8287.2011.02051.x), indexed in Pubmed: [22107162](https://pubmed.ncbi.nlm.nih.gov/22107162/).
  51. Galvin, J., 2016. A multi-method approach to researching stress and mental health in two groups of healthcare students: nursing students and trainee clinical psychologists. PhD Thesis, Cardiff University. <http://orca-mwe.cf.ac.uk/id/eprint/98616>.
  52. Nelson, K. 2017. Behind the frontlines: occupational stress and well-being in Jamaican police officers. PhD Thesis, Cardiff University. <http://orca-mwe.cf.ac.uk/id/eprint/99877>.
  53. Smith A, McNamara R, Wellens B. Combined effects of Occupational Health Hazards. HSE Contract Research Report 287. HSE Books, 2004.
  54. Smith AP, McNamara R, Wellens BT. A holistic approach to stress and well-being. Part 3: Combined effects of job characteristics on stress and other outcomes. *Occupational Health (At Work)*. 2011; 8(2): 34–35.
  55. Waddell G, Burton AK. *Is work good for your health and well-being?* The Stationery Office, Norwich 2006.
  56. Smith AP, Wadsworth E. A holistic approach to stress and well-being. Part 5: what is a good job? *Occupational Health (At Work)*. 2011; 8(4): 25–27.
  57. Wadsworth EJK, Chaplin KS, Allen PH, et al. What is a Good Job? Current Perspectives on Work and Improved Health and Well-Being. *The Open Occupational Health & Safety Journal*. 2010; 2(1): 9–15, doi: [10.2174/1876216601002010009](https://doi.org/10.2174/1876216601002010009).
  58. Wadsworth EJK, Chaplin KS, Smith AP. The work environment, stress and well-being. *Occup Med (Lond)*. 2010; 60(8): 635–639, doi: [10.1093/occmed/kqq139](https://doi.org/10.1093/occmed/kqq139), indexed in Pubmed: [20844057](https://pubmed.ncbi.nlm.nih.gov/20844057/).
  59. Smith AP, Wadsworth EJK, Chaplin K, Allen PH, Mark G. The relationship between work/well-being and improved health and well-being. Report 11.1. IOSH, Leicester 2011.
  60. Williams GM, Smith AP. A holistic approach to stress and well-being. Part 6: The Wellbeing Process Questionnaire (WPQ Short Form). *Occupational Health (At Work)*. 2012; 9(1): 29–31.
  61. Smith AP, Cowap D. A holistic approach to stress and well-being. Part 4: Reducing stress and sick leave by providing occupational support. *Occupational Health (At Work)*. 2011; 3: 19–21.
  62. Smith AP, Allen PH, Wadsworth E. Crew manning and fatigue Pockett. In: Pockett D, Patraiko D. ed. *Navigational accidents and their causes*. The Nautical Institute, London 2015: 1–7.
  63. Smith A, Smith H, Jelley T. Studying Away Strategies: Well-being and Quality of University Life of International Students in the UK. *Journal of Education, Society and Behavioural Science*. 2018; 26(4): 1–14, doi: [10.9734/jesbs/2018/43377](https://doi.org/10.9734/jesbs/2018/43377).
  64. Smith AP, Jones G, Evans D, Bowen G. Training to prevent and manage fatigue in the rail industry. In: Charles R, Wilkinson J. ed. *Contemporary Ergonomics and Human Factors*. Chartered Institute of Ergonomics and Human Factors 2018: 118–123.