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# Factors affecting maritime pilots' health and well-being: a systematic review

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## ABSTRACT

**Background:** Maritime pilotage is a demanding occupation where pilots are required to perform complex procedures in sometimes unfamiliar working environments. These psychological stressors, in addition to the physical demands associated with the role (e.g., reduced sleep, boarding, and departing vessels), may over time have a damaging effect on pilots' physical and mental health. Therefore the aim of this paper was to systematically review the existing literature on maritime pilots' health and well-being.

**Materials and methods:** The databases academic search complete, MEDLINE and MEDLINE complete, PsycINFO, PsycARTICLES, PubMed, and ScienceDirect were searched from the earliest available record until 1 May 2015. From an initial pool of 167 manuscripts retrieved, only 18 were peer-reviewed original research and discussed topics associated with maritime pilots' health and well-being.

**Results:** In total, 29 factors associated with maritime pilot health and well-being were identified. These were loosely categorised into physical ( $n = 14$ ), psychosocial ( $n = 8$ ), and workplace issues ( $n = 7$ ). The most commonly investigated factors were blood pressure or heart rate, sleep or fatigue, smoking and alcohol consumption, perceived stress, and shift duration or cycle.

**Conclusions:** Findings from the review suggest that the prevention of cardiovascular diseases and associated cardio-metabolic risk factors seems to be of paramount importance, with ample evidence indicating that modern-day pilots present as being overweight or obese. What remains unknown is whether these physical factors are associated with variations in psychosocial functioning. Therefore, it is recommended that future pilotage investigations adopt a multidisciplinary approach to better quantify the impact of maritime pilotage on long-term health and well-being.

(Int Marit Health 2015; 66, 4: 220–232)

**Key words:** health, well-being, maritime, pilot, stress, fatigue, review

## INTRODUCTION

The maritime industry is one of the oldest in history, facilitating approximately 90% of the world's trade via the international shipping industry. In Australia, for example, 10% of the world's trade is managed across 70 ports, in one of the largest exclusive economic zones and world heritage coastlines [1]. Central to the survival of these industries are the seafarers who work long shifts, often in difficult conditions [2, 3]. One role that is critical to the maritime industry is the maritime pilot who operates at the land-sea interface [4]. Typically, maritime pilots are responsible for the safe

navigation of vessels through restricted and challenging waterways [5], often operating in isolation, and completing long shifts in sometimes unfamiliar working environments. To this end, maritime pilots are often responsible for ensuring the continuity of a nation's trading agreements, in addition to preserving sensitive environmental regions. Accordingly, maritime pilotage is recognised as a stressful and autonomous occupation that requires extended periods of attention, and moderate physical fitness [6].

A closer examination of the role suggests that maritime pilotage can impact the psychophysiological health and



**Table 1.** Database search strategy

Search 1	In title or abstract or subject heading: "Maritime Pilot*" OR "Sea Pilot*" OR "Ship Pilot*" OR "Port Pilot*" OR "Coastal Pilot*" OR "Marine Pilot*" OR "Off-shore Pilot*"
Search 2	In title Pilot* (Ti) AND "maritime" in title or abstract or subject heading
Search 3	A manual search including: "pilot*" AND "river" OR "canal" etc.

well-being of the individual, resulting in sleep problems [7], cognitive disturbances and attentional deficiencies [4], and physical harm through injury [8]. Historically, data indicate that maritime pilots are at a high risk for cardiovascular diseases (CVD), the associated cardio-metabolic risk factors, and mental health problems [9]. Often, prevalence rates for CVD far exceed those reported in normative population data [9]. Recent industry reports suggest that the maritime industry is growing at an unprecedented rate, resulting in increased commercial pressures and demands on the various individuals working in this context [5, 10]. The subsequent increase in the number of reported accidents and incidents in the last 10 years is a possible consequence of this commercial growth [11]. For maritime pilots, the exponential growth of the industry manifests in longer shift durations and shorter turn-around times at port. Yet despite the industry's growth, research pertaining to understanding the health and well-being of maritime pilots in this evolving environment has not been a priority, with greater attention paid to other roles such as seafarers [12] and coast guard officers [13, 14]. The lack of empirical research on maritime pilots since the seminal work of Cook and Shipley [6] suggests that consolidation of the available evidence on pilot health and well-being is well-overdue.

Subjective well-being refers to the self-evaluation of a collection of diverse phenomena, including judgements about life satisfaction, work satisfaction, feelings, mood, and emotions [15]. There is an emerging body of evidence that is based on diverse methodologies which state that subjective well-being directly affects physical health. The converging evidence demonstrates that subjective well-being and physical health are inextricably linked [15]. These interactions appear evident across a number of physical (e.g., vitality, global health, sleep quality, and CVD) and psychosocial factors (e.g., job performance and satisfaction, marital status, and psychological dysfunction) related to health and well-being [16]. Therefore, the psychophysical relationship between factors of health and well-being may be critical in explaining the current state of maritime pilots. While much evidence exists on the physical and psychological health and well-being of seafarers [17, 18], there seems a lack of such knowledge about maritime pilots. What is required is a comprehensive appraisal of the current knowledge, with a view to guide future inquiry. Therefore, the aim of this systematic review was to examine the available empirical

literature and assess the current knowledge pertaining to maritime pilots' health and well-being.

## MATERIALS AND METHODS

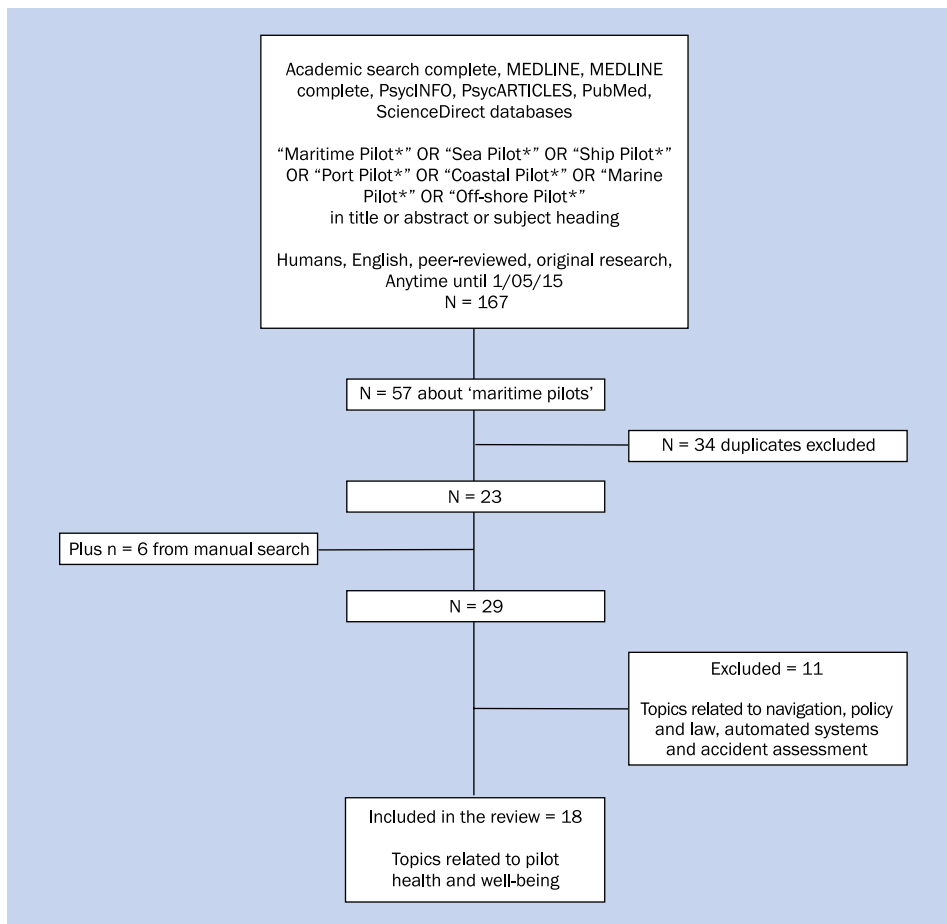
The study was designed as per the PRISMA guidelines for systematic reviews and meta-analyses [19]. An electronic search was conducted using the following databases: academic search complete, MEDLINE, MEDLINE complete, PsycINFO, PsycARTICLES, PubMed, and ScienceDirect. Three search strategies were adopted and are outlined in Table 1. Databases were searched from the earliest available record up to 1 May 2015, with results limited to human and English language; relevant article links were also explored. Only articles which were peer-reviewed, original research, and discussed topics associated with maritime pilots' health were included. Articles to do with international law, risk management or assessment, and various technological advances as determined from the title and or abstract were excluded from the final selection. The selection of studies is detailed in Figure 1.

## RESULTS

From the initial 167 articles retrieved from database searches, only 57 were actually about 'maritime pilots'. Of these, 34 were excluded as duplicates. A manual search yielded an additional 6 new articles which were included in the penultimate step (n = 29). Eleven manuscripts were excluded because they were not about topics relating to maritime pilots health and well-being; therefore a final 18 studies were included in the analysis. Following a detailed examination of each article the aim, measures and methodology of each study were summarised and are presented in Table 2. Emerging from this process were 29 factors associated with maritime pilot health and well-being that were further investigated. These were loosely categorised into physical (n = 14), psychosocial (n = 8), and workplace issues (n = 7). These factors, and the frequency of which they were reported, are documented in Table 3.

## DISCUSSION

The aim of this review was to employ the PRISMA guidelines to systematically appraise the available empirical evidence on maritime pilot health and well-being. In doing so, the manuscript aimed to provide a consolidated account of the current knowledge on pilot health and well-being with



**Figure 1.** Selection of studies flow chart

a view to inform future research endeavours. The findings revealed that a wide array of methods and measures were employed to assess maritime pilot health and well-being, with a clear preference for utilising physiological measures (e.g., heart rate [HR], fatigue) to document the pilot state. Equally evident was the lack of attention on psychological well-being, specifically the prevalence on psychological dysfunction (e.g., anxiety, depression) among pilots.

In reviewing the 18 empirical manuscripts, it was also apparent that two of the articles captured did not actually meet the aim of the current review [20, 21]. For example, while the Kim et al. [20] study included pilots as part of their sample, they failed to detail their pilot demographics separate to the maritime officers also recruited as participants. Rather, pilots were referred to in the context of a control group in an experimental simulation task examining the effect of alcohol on simulated ship handling [20]. Likewise, Van Damme [21] also failed to provide a descriptive account of the participants interviewed in his examination of pilot post-traumatic stress disorder. Rather, the article provided an overview of the disorder, and recommendations for possible treatment. Therefore, while both these studies met

the inclusion criteria, they will not be discussed any further. Hence, what follows is a linear discussion of the various factors related to maritime pilot health and well-being. It is recognised that many of these factors co-exist; however, the authors have chosen to present the findings in such a manner to better illustrate the unique contribution each makes to the literature. Consideration for the multidimensional nature of maritime pilot health and well-being will be addressed in the final section.

### FACTORS ASSOCIATED WITH PHYSICAL HEALTH

A total of 14 physical health factors were identified in the reviewed articles, including factors such as the presence of injury or illness, and response to physical tests (e.g., exercise, galvanic skin response). Of these, the most common were blood pressure (BP) or HR, smoking, alcohol consumption, sleep or fatigue, and CVD. In several cases, factors such as smoking and alcohol consumption were discussed in the context of CVD risk factors.

BP and HR were the most frequently cited physiological health and well-being factors. Two studies reported evidence of variability in HR or BP, either during or following pilotage,

**Table 2.** Summary of articles reviewed presented chronologically by publication date

Reference	Number of participants	Type of pilots	Mean age $\pm$ SD	Study purpose	Method	Measures
Chambers and Main (2015)	50	Australian maritime pilots	51.42 $\pm$ 9.81 y	Comparison of fatigue and coping strategies between maritime and aviation pilots	Online questionnaire	Symptoms of fatigue checklist, coping strategies checklist and vitality scale
Kaya Ozbag and Ceyhun (2014)	100	Turkish marine pilots	N/A	Investigate the mediating effect of job satisfaction on work-family conflict	Questionnaire	Work-family conflict, job satisfaction, and turnover intentions
Rutledge (2014)	44 in 1988; 27 in 2012	Scottish River Forth pilots	53 y in 1988; 50 y in 2012	Comparison of maritime pilotage medical examination data from 1988 and 2012	Comparison of data from medical examinations	Medical examination records
Scovill et al. (2012)	388 mariners (specific number of pilots not disclosed)	Unites States inland waterway merchant marine captains and pilots	44 y	Cross sectional study of mariner health characteristics	Comparison of data from the USCG physical assessment from 2003–2010	Treadmill stress test (Standard Bruce Test Protocol) USCG medical exam
Ferguson et al. (2008)	17 (1/3 of the population)	Australian coastal pilots (Barrier reef)	55.9 $\pm$ 8.0 y	Examination of the impact of brief, unscheduled naps during work shifts for coastal pilots	Field study of sleepiness	Self-report sleep and work diary Palm PVT task to record alertness while at work aboard ships
Andresen et al. (2007)	434 (26.8% response rate)	European maritime pilots	N/A	Examination of job satisfaction for European maritime pilots	Questionnaire	Relationship between working unusual hours, physical strain and job satisfaction
Darbra et al. (2007)	77	Australian and New Zealand pilots	50 y	Cross sectional study of safety culture and hazard risk perception of maritime pilots	Interviews and questionnaire	Safety culture and hazard risk perception
Griffiths and Ellis (2007)	1	European pilots	37 y	Case study of visual conversion disorder	Case study	Medical records
Kim et al. (2007)	118 officers Pilots = N/A	Officers and pilots	N/A	Assess the drinking status of maritime officers, and examine the effect of alcohol on simulated ship handling	Questionnaire and simulated task	Survey of current drinking habits and education Simulated navigational ability
Meere et al. (2005)	130	Flemish pilots	47.5 $\pm$ 7.7 y	Cross sectional study of occupational accidents and injuries sustained by maritime pilots	Questionnaire	Body mass index; pilotage history; number of reported accidents; various measures of health; safety culture and the organisation
Van Damme (2003)	N/A	Maritime pilots	N/A	Assess the prevalence of PTSD in maritime pilots to aid prevention of PTSD	Interviews	N/A
Saarni et al. (1996a)	135	Finnish sea pilots	51 y	Examine the cardiovascular risk factors for Finnish sea pilots	Laboratory study	Bicycle-exercise test, cholesterol, blood pressure, ECG
Saarni et al. (1996b)	262	Finnish sea pilots	N/A	Retrospectively examine of the mortality rate of Finnish sea pilots	Examination of medical data	Medical and death records

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**Table 2. cont.** Summary of articles reviewed presented chronologically by publication date

Reference	Number of participants	Type of pilots	Mean age $\pm$ SD	Study purpose	Method	Measures
Sparks (1992)	93	Masters, mates, and pilots	44 y	Survey of health, social, and performance indices related to shift work	Questionnaire	Demographics, personal habits, lifestyle, job, health, psychological status, sleep and eating patterns, and shift schedule
Cook and Cashman (1982)	8	United Kingdom ship pilots	N/A	Field study of stress and physical health during pilotage	Field study of stress and physical health	Stress and ectopic beats (ECG); Eysenck personality inventory Pilotage workload (e.g., shift duration)
Cook and Shipley (1980)	7	United Kingdom ship pilots	40–50 y	Field study of pilotage health during working hours	Field study of fatigue	Self-reported questionnaire on tension, alertness, and freshness; clinical thermometers for temperature assessment; ECG; reaction time; galvanic skin response
Shipley and Cook (1980)	150 diary study; 55 questionnaire	United Kingdom ship pilots	46.5 $\pm$ 8.6 y	Cross sectional study of working scheduling problems and social consequences related to maritime pilotage	Interviews, questionnaires, and diary surveys	Work scheduling problems and social consequences; duty times and time off; organisational work-scheduling systems; job satisfaction and job fit; sleep problems; marital satisfaction (personal lives)
Zorn et al. (1977)	5	German sea pilots	N/A	Comparison of mortality rates associated with ischaemic heart disease	Urine analysis for catecholamines	Ischaemic heart disease and work stress

ECG – electrocardiography; N/A – not available; PTSD – post-traumatic stress disorder; PVT – psychomotor vigilance task; SD – standard deviation; USCG – United States Coast Guard; y – years

with findings revealing that HR varied across pilotage passages [6], and peaked when pilots were performing stressful pilotage tasks [6, 22]. Further results indicated that HR irregularities were more frequent during pilotage compared to rest [22], and that HR returned to baseline during extended periods of pilot inactivity [6]. The remaining investigations that cited HR or BP as a physical factor of pilot health either reported medical screening records [23–27], or treatment of high BP [8]. These investigations revealed approximately 50% of pilots suffered from high BP [23, 24], with 25% requiring medication to alleviate the illness [8]. In sum, these findings suggest that pilotage is a stressful occupation, whereby pilots exhibit stress responses when undertaking specific occupational tasks that are unique to their role (e.g., berthing). Moreover, a high percentage of pilots suffer from poor health outcomes.

While these results provide a snapshot of the pilot population, there are two critical limitations associated with this collective evidence.

First, much of the reported field data is dated and does not consider the impact of the contemporary demands of

the maritime industry, such as dealing with the increased size of modern vessels and shorter turn-around times [10].

Second, much of the evidence relies upon medical screening data, and not field assessment of physical health. Utilising existing medical records to determine the impact of pilotage on physical health is also problematic as the screening is often conducted as part of the pre-employment check, and typically fills a cultural, not occupational need [27]. While subsequent medical checks are often conducted on pilots, these medical exams have been criticised as failing to prevent health-related occupational risks [27]. Given medical screenings typically occur before the pilot commences work, and that the testing is typically not performed under work conditions, these data do not reflect how pilots respond to workplace stressors, *in situ*. Therefore longitudinal, multidisciplinary research that holistically captures the psychophysical responses to pilotage in occupational contexts is required.

### Fatigue

Another commonly cited physical factor of health and well-being for pilots were sleep issues and fatigue. Only one

**Table 3.** Various factors associated with maritime pilot health and well-being

	Physical factors (n = 14)														Psychosocial factors (n = 8)								Workplace issues (n = 7)							
Reference	CVD	Sleep/fatigue	Fitness test/vitality	BP/HR	Injury/illness	Body mass index	Stomach issues	Temperature	Cholesterol	GSR	Smoking	Alcohol	Caffeine	Reaction time	(Perceived) stress	Job satisfaction	Coping	Anxiety	Alertness	Tension	Personality	Marital/family conflict	Safety culture/work environment	Social activity/holidays	Worker benefits	Shift duration/cycle	Remuneration	Workplace training	Commercial pressure	TOTAL
Chambers and Main (2015)	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	3
Rutledge (2014)	-	-	-	+	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Kaya Ozbag and Ceyhun (2014)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	3	
Scovill et al. (2012)	-	-	+	+	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
Ferguson et al. (2008)	-	+	-	-	-	+	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
Andresen et al. (2007)	-	+	-	-	+	-	+	-	-	-	-	-	-	-	+	+	-	+	-	-	-	+	-	+	+	+	+	-	11	
Darbra et al. (2007)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	4	
Griffiths and Ellis (2007)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	3	
Kim et al. (2007)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Meere et al. (2005)	+	+	-	+	-	+	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	+	-	-	9	
Van Damme (2003)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	2	
Saarni et al. (1996a)	+	-	+	+	+	+	+	-	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	9	
Saarni et al. (1996b)	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
Sparks (1992)	+	+	-	+	+	-	+	-	-	-	+	+	-	-	-	+	-	-	-	-	-	+	+	-	+	-	-	-	11	
Cook and Cashman (1982)	-	-	-	+	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	6	
Cook and Shipley (1980)	-	-	-	+	-	-	-	+	-	+	-	-	-	+	-	-	-	+	+	-	-	-	-	-	+	-	-	-	7	
Shipley and Cook (1980)	-	+	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	+	-	+	-	+	-	-	8	
Zorn et al. (1977)	+	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>TOTAL</b>	<b>5</b>	<b>7</b>	<b>3</b>	<b>8</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>7</b>	<b>6</b>	<b>1</b>	<b>2</b>	<b>6</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>7</b>	<b>1</b>	<b>1</b>	<b>1</b>

(+) indicates factor was or (-) was not investigated in a manuscript; BP – blood pressure; CVD – cardiovascular diseases; GSR – galvanic skin response; HR – heart rate

investigation measured sleep during pilotage, with findings revealing that Australian Barrier Reef pilots averaged 1.4 h of sleep during an average shift length of 39.5 h [7]). Two investigations also examined psychomotor performance to reliably measure on-shift fatigue and vigilance, with neither study finding a difference in performance as a function of fatigue [6, 7]. However, Cook and Shipley [6] did reveal a severe drop in self-reported alertness following the pilotage passage, and speculated that the drop may have been even more dramatic if not for the existing maritime culture (i.e. pilots typically avoid showing weakness). Three possible explanations are provided to interpret the findings: 1) that pilots took naps at appropriate times to mitigate fatigue [7], 2) that pilots relied on an effort of will or additional resources to complete the measures [6], and 3) that a practice effect may have occurred on the psychomotor task [6].

Of the remaining studies that investigated fatigue, all relied on self-report measures to assess fatigue [4, 5, 8, 26, 28, 29]. Results from these studies revealed that as pilots became more fatigued, they reported greater cognitive dysfunction (e.g., lost concentration), emotional disturbance (e.g., became grouchy or irritable), physical effects (e.g., experienced a decrease in energy), and sleepiness (e.g., felt sleepy [3]). Moreover, self-reported fatigue scores at the end of a coastal pilotage shift were significantly higher compared to the start of the passage [7], and in another instance, approximately a third of pilots indicated that they were unable to catch up on lost sleep [29]. In terms of managing fatigue, only one study reported on fatigue risk management systems employed across Australian ports [5]. Their findings revealed that a variety of risk management systems were used, and that various commercial pressures often resulted in a lack of adherence to fatigue management protocol (e.g., managers failed to adequately inspect the fatigue risk management system data).

Collectively, these results suggest that maritime pilots often experience fatigue as a consequence of the role (e.g., long shift, challenging tasks), a finding that is consistent with other seafarer [17] and industry contexts [30]. One apparent difference between pilots and other seafarers that may contribute to fatigue is the working environment. Compared to other seafarers, who spend considerable amounts of time aboard the same vessel, pilots move between vessels considerably more frequently. These transitional adjustments may in turn contribute to overall fatigue; the continual movement between vessels, and associated environmental unfamiliarity, may result in accumulated fatigue. While untested, this hypothesis may explain experiential differences in fatigue of maritime personnel.

In reviewing the maritime pilotage literature on fatigue, three main conclusions emerged. First, regardless of how fatigued the pilots perceived themselves, they seemingly maintained adequate vigilance across the duration of

a shift. In other words, the evidence suggested that the objective measures of fatigue failed to identify any differences whereas the subjective self-report measures were able to detect changes in fatigue. The implication of this finding is substantial, as it highlights the need for future research to incorporate self-report measures in the assessment of pilotage fatigue.

Second, there was a lack of standardised measurement tools utilised by researchers to assess fatigue. At present, there are a number of valid and reliable self-report measures that provide an accurate account of occupational sleepiness and fatigue (e.g., Epworth Sleepiness Scale [31], Pittsburgh Sleep Quality Index [32]). Future research in this context should utilise these measures to allow for comparisons within, and between industries.

Third, the review highlighted an absence of evidence on fatigue risk management systems in pilotage. With the exception of Darbra et al. [5], little evidence regarding the use and effectiveness of fatigue risk management systems was available. Given the variety of fatigue risk management systems in use, and the extensive research on fatigue management in other fields [33], it seems necessary to compare these systems and assess their effectiveness in monitoring and managing maritime pilot fatigue.

### Body mass index

Another frequently cited physical health factor was body mass index (BMI). Only one field study reported the BMI of pilots, where it was noted that the average pilot was overweight [7]. Other investigations again relied on medical records to determine BMI, with results revealing that between 53% [8] and 64% [24] of participants were classified as overweight or obese. Furthermore, the percentage of overweight and obese pilots had risen from 45% to 67% in the last 20 years [23]. These data are slightly higher than comparative normative data that revealed in 2011 42% of adult males were overweight [34]. Only 2 investigations attempted to record diet, noting that for 61% of pilots work interfered with eating habits [29], and 40% were dissatisfied with their eating patterns [24]. However, these findings are dated and do not reflect the increasing global trend for fast foods and ever changing diets. Therefore, these data are concerning, particularly when considering the challenging nature of maritime pilotage (e.g., climbing a pilot ladder), and give rise to three possible conclusions.

First, given the nature of the pilotage role, particularly the long shifts on board vessels, a more detailed exploration of pilot eating habits is warranted to investigate whether high caloric snack foods and or caffeinated beverages are being consumed in the absence of regular meals.

Second, the lack of investigation on the impact of BMI on pilots' capacity to fulfil the physical requirements of the



role requires further attention, as there may be unknown occupational health and safety implications.

Third, the lack of evidence on interventions aimed at reducing pilot BMI also requires amending.

### Cardiovascular disease and related issues

The most significant health outcome cited in the reviewed literature was CVD, with early reports revealing that cardiac mortality risk was significantly higher for maritime pilots compared to the general population [9]. Complementary findings indicated that the maritime pilot mortality rate, as a consequence of CVD and ischaemic heart disease, was slightly higher than normative populations in Finland, England, and Germany [35]. Other reviewed articles [8, 24, 26] investigated several CVD risk factors, including smoking, alcohol consumption, and physical activity or fitness and reported some alarming findings. For example, 45% of mariners, including pilots, had combined cholesterol categorised as borderline high or high; 50% of pilots recorded very poor fitness score, with a further 21% reporting poor fitness [24]. Elsewhere, it was reported that 52% of participants consumed alcohol on work days [26]. The evidence regarding smoking was mixed across the studies. For example, Zorn et al. [9] reported that 80% of pilots were smokers, whereas Shipley and Cook [29], and Scovill et al. [24] noted that 44% and 41% of their respective samples smoked. In contrast to these reports, Meere et al. [8] reported that nearly 85% of their pilot sample did not smoke, and Rutledge [23] noted that the percentage of pilots who smoked had dropped from 41% to 7% in the last 20 years, suggesting that in Europe, the number of pilots who smoke may be on the decline. Nevertheless, despite these encouraging findings regarding a decline in smoking, the evidence suggests that maritime pilots are a CVD at-risk working population.

### Conclusions on physical health factors

These combined data on maritime pilot health support the notion that pilots are at a high risk of developing chronic disease, particularly chronic heart disease. Moreover, these data suggest that pilotage is a stressful occupation. While these findings imply that pilots are susceptible to a number of physical health issues, several limitations were identified.

First, much of the available field data is dated, and relied upon small sample sizes, thereby restricting the generalisability of these findings to contemporary pilots. While larger sample sizes may attract more robust findings, the feasibility of recruiting larger sample sizes may be limited.

Second, recent increases in ship size and commercial demands (e.g., short turn-around times) may impact pilot health [11]. For example, the increasing size of ships may place additional demands on pilots with respect to accessing the bridge. If modern pilots are part of an ageing

population, are unfit, are required to carry personal protective equipment on each passage, and possess a number of CVD risk factors, it is imperative that future research examine the physiological impact of performing pilotage. It remains unknown whether any combination of these factors negatively impacts on pilot health.

Third, while the current evidence suggests that maritime pilotage is a stressful occupation, no evidence indicated whether physical health (i.e., poor health) impacted upon actual pilotage performance. Therefore, in light of the aforementioned points, it is crucial that investigations of maritime health utilise multidisciplinary approaches to ascertain how health may impact occupational demands (e.g., utilising simulators to test the psychophysical relationships between health and pilotage performance). Finally, there was a lack of evidence related to improving the physical health of maritime pilots (e.g., health interventions or initiatives). The lack of intervention research aimed at improving pilots' current physical state is alarming, given the inherent risks associated with the role (e.g., potential for widespread environmental disasters), and pilots' potentially dire state of health as outlined in the reviewed literature. Research in other specialised occupations (e.g., aviation, medicine) has attempted to design intervention protocols to tackle some of the presenting issues (e.g., improve diet, and reduce fatigue) experienced by workers, including seafarers [36, 37] and aviation pilots [38]. Therefore, intervention investigations are essential to provide crucial evidence that enables pilots to function optimally both on and off-shift.

### FACTORS ASSOCIATED WITH WELL-BEING

In examining the manuscripts for psychosocial factors of pilot well-being, it was apparent that less attention was paid to these factors, compared to physical health factors. Nevertheless, a total of 8 psychosocial factors of pilot well-being were identified in the reviewed manuscripts. Of all the factors identified in the review, the most frequently reported were perceived stress, job satisfaction, and marital or family conflict.

#### Perceived stress

A total of 6 studies investigated the perceived stress of maritime pilotage. Results revealed that the vast majority of European pilots reported work stress as the main cause of many health problems, including fatigue and insomnia [28]. When prompted, nearly 30% of these pilots attributed these issues to working at night, and a further 21% attributed the outcomes to variable weather [28]. Elsewhere, pilots reported experiencing high levels of stress [8], which was supported by physiological data [9] that revealed significant elevations in catecholamine levels from pre- to post-pilotage shift. As testament to the magnitude of stress associated with pilotage (i.e., the impact of stress on performance),

a maritime pilot case study revealed how psychological stress manifested as a visual impairment for a harbour pilot [39]. The outcome of this pilot's stress was a reduction in his performance (e.g., vessel grounding) and ultimately loss of life (i.e., through suicide). Collectively, these multidisciplinary findings provide support for the notion that pilotage is a stressful occupation, with challenges that are seemingly unique to the role (e.g., berthing vessels).

### Job satisfaction

Four of the reviewed articles investigated job satisfaction. While some of the evidence suggested that pilots were satisfied in their roles [26, 29, 40], a number of issues related to job dissatisfaction were identified for many pilots. These issues included the long and unsocial work hours (e.g., night-shift, working public holidays), little advanced warning of being required for duty, and waiting for job to start [29]. Other issues identified included the physical consequences of working long hours, and the reduction in quality of life [28]. In an investigation of job satisfaction, one article reported that worker satisfaction predicted employee turnover, such that dissatisfied pilots had greater intentions to leave their current role [40]. However, with the exception of Kaya Ozbag and Ceyhum's [40] findings, it remains unknown whether pilots low in job satisfaction have reduced well-being and shorter careers in pilotage.

### Marital or family conflict

To date, much of the available evidence appraised the pilots' perceptions of well-being independent of other relationships. However, four investigations examined the relatedness between marital or family conflict and pilotage. Similar to the pilots' perceptions, results indicated that pilots' wives were dissatisfied with the irregular work hours, complained of disturbed sleep, had irregular meal-times, and experienced difficulty planning various social activities (e.g., holidays, appointments [29]). More recently, findings revealed that pilots who were married reported greater job satisfaction [28]. Furthermore, lower levels of family conflict predicted greater job satisfaction, while high levels of conflict predicted greater turnover [40]. However, two caveats of the aforementioned research were identified. First, the specific source of the conflict was unclear [40]. For example, it is plausible that a bi-directional relationship exists between family conflict and job satisfaction, thereby requiring further investigation. Second, only one article [26] explicitly assessed the role of social support provided by others to pilots. Given the physical and psychosocial demands of pilotage, an exploration of maritime pilots' social support and the impact on pilot well-being is required.

### Conclusions on psychosocial well-being factors

The collective evidence on maritime pilot psychosocial well-being suggests that pilots are somewhat satisfied with the role, but experience stress as a consequence of pilotage. As was the case with the physiological evidence, there are several conclusions that can be drawn from the available well-being evidence.

First, the impact of stress on actual pilotage performance was not reported. Within the medical profession, the pressure to maintain optimal performance can increase stress, resulting in depression and the adoption of poor coping strategies [41]. Given that psychological stress can substantially impact one's ability to work, further investigation of the influence of stress on actual maritime pilotage performance is required to advance the field.

Second, in order to accurately measure and compare maritime pilotage stress within the maritime industry (e.g., seafarers) and between industries (e.g., aviation pilots), future research must again adopt standardised measures to facilitate subsequent comparison (e.g., the Perceived Stress Scale [42]).

Third, the lack of attention paid to mental health issues requires immediate attention. Elsewhere, it is reported that psychological dysfunction (e.g., anxiety, depression) as a consequence of occupational stress is a significant issue for individuals and organisations [43]. While pursuing this line of inquiry is imperative, a caveat to overcome is the challenging maritime context. Traditionally, expressing weakness is shunned in the maritime context, which may result in an under-reporting of factors such as emotional disturbance and mental health issues [29]. This cultural practice represents a potential hurdle for future research in this context. Collaborative agreements between research institutions and industry bodies will facilitate the generation of more meaningful and accurate evidence that lead to practical outcomes. Equally, anonymous data collection through online surveys may also facilitate this process.

### FACTORS ASSOCIATED WITH THE WORK ENVIRONMENT

In sum, 7 work-related factors that contributed to the physical health and well-being of pilots emerged from the reviewed articles. Some of these factors included increased commercial pressures and variations in workplace training (e.g., shorter turn-around times [5]), the presence or absence of social activities for pilots [29], and work-related benefits and remuneration [28]. The most commonly cited work-related factor was the influence on the shift cycle and or duration on pilot health and well-being.

### Shift duration and cycle

The duration of pilotage shift-cycles was reported in 7 of the reviewed articles. In addition to the aforementioned fatigue experienced by pilots, these findings confirmed that the length of a job, and the shift cycle varied considerably [6, 22]. For example, the average time to complete one pilotage passage varied from 2.5 h [29] to 39.5 h [7]. The demands of pilotage shift work are consistent with other occupations, including the medical profession. For example, doctors experience heavy workloads, comprised of long shift and unpredictable hours, which can result in psychological stress [41]. Given the diversity of pilotage requirements (e.g., differences in port requirements, vessel types) it is apparent that a standardised shift cycle or roster is unrealistic. However, future research could 1) explore improvements to ship-forecasting and working arrangements [29], 2) investigate the plausibility, and subsequent benefits of napping while on-shift [8, 28], and 3) assist in the examination of workplace policy on the impact of shift work on pilotage health and well-being [28]. A longitudinal analysis of shift-cycle on pilot health and well-being may also uncover further issues that could inform amendments to current practice.

### Physical work environment

Three of the reviewed articles described the impact of the work environment on pilot health, with findings revealing that pilots often worked in uncondusive operational environments (e.g., poor bridge quality [5]), which likely contributed to a number of workplace accidents, including those attributed to human error [8]. Given that pilots often complete long passages and shifts in such environments, it is crucial that more evidence be compiled on how these conditions impact pilots' long-term health and well-being. For example, two studies of maritime pilot workload, not captured in the current review process, demonstrated that exposure to unfavourable working conditions (e.g., pilot boat noise) significantly contributed to the health problems experienced by pilots, including sleep disturbance [44, 45].

### Conclusions on work environment factors

The review of pilots' working environment revealed that the shift cycle and physical working conditions present as factors that may affect pilot health and wellbeing. In examining these factors, two main limitations were identified.

First, there was a lack of research investigating the impact of long-term exposure to these environmental work factors on physical health and psychosocial well-being. Evidence that uncovers the impact of these factors on pilots, and offers strategies to assist pilots in managing the challenges of the pilotage working environment are required. For example, of the 18 articles reviewed, only one cited

training as a work-related factor that may positively impact health and well-being. Darbra et al. [5] reported that 71% of pilots had completed a bridge resource management course (BRM), yet no evidence was available that quantified the effectiveness of BRM on improving pilotage performance. Before such training is advocated globally, research is required to determine the extent to which BRM impacts the pilot's ability to execute his or her role (i.e., improve performance), and in doing so, cope with the aforementioned environmental work stressors.

Second, there was an absence of research examining the impact of modern bridge design and related technologies on pilot health and well-being as many of the reviewed studies are dated. For example, modern pilots have an array of electronic navigational tools to assist them during pilotage. What remains unknown is whether the implementation of these tools has an impact on physical health and or psychological well-being. Specifically, 1) whether contemporary pilots, who rely on electronic chart display and radar, are more sedentary on-shift if they are no longer required to move about the bridge to obtain best line of sight, and 2) whether the long-term demands associated with monitoring these dynamic displays and maintaining situation awareness for extended periods of time impairs pilot health and well-being.

## SUMMARY AND FUTURE RESEARCH DIRECTIONS

The aim of this review was to examine the current empirical literature pertaining to the health and well-being of maritime pilots. While some informative industry reports were identified during the search for relevant research (e.g. [46]), the focus was on peer-reviewed research articles. Following standardised systematic review processes, a total of 18 articles were assessed for factors related to maritime pilots' physical health and psychological well-being. The review identified a number of methodologies adopted to examine pilot health and well-being (e.g., interviews, cross-sectional survey, and ambulatory assessment). Furthermore, the review revealed that there was an emphasis on physiological (n = 14) compared to psychosocial factors (n = 8). In addition to these factors, this review highlighted a number of work-related factors (n = 7) that influence pilot health and well-being. In sum, there appeared to be a strong preference for examining physiological factors of pilot health, with little field-based evidence available on pilot well-being.

It is clear that advancing the existing knowledge pertaining to maritime pilot health and well-being must be a priority, and needs to be supported by rigorous scientific investigation. A critical limitation of this paper is the quality of the reviewed research. The small and low level evidence studies included in our review should not be considered as

compromising the standard of the review, nor a criticism of the existing research. For example, many of the 18 studies reviewed included small sample sizes that inhibited the generalisability of the findings. Rather, these studies reflect some of the challenges of researching in this context (e.g., participant recruitment) and a lack of awareness of the importance of the maritime pilot health and well-being. Therefore, the current study draws attention to the importance of pilots in the maritime industry, and highlights the need for further research in this highly specialised context. Hence, five recommendations are proposed to guide future investigations into maritime pilotage.

First, multidisciplinary approaches (e.g., physiology, psychology, and performance) should be adopted by researchers to generate more meaningful data on maritime pilots. Since the pioneering work of Cook and Shipley [6], there have been a number of developments within the maritime context that have increased the complexity of pilotage, thereby limiting the generalisability of these findings. For example, the increased reliance on technological navigational aids [47], coupled with rising commercial pressures [10], suggests that new evidence is required in order to better understand whether these changes impact pilot health and well-being. Adopting multidisciplinary approaches, supported by sufficiently powered sample sizes, will lead to an improved understanding of the impact of pilotage on long-term health and well-being. It is anticipated that such investigations will yield more meaningful data on the biopsychosocial associations inherent in health and well-being, which in turn may facilitate the development of viable strategies to tackle dysfunctional pilot health and well-being.

Second, researchers are encouraged to use relevant theoretical frameworks where appropriate to guide their investigative endeavours. The adoption of such frameworks will empower researchers to explore questions and test hypotheses with greater rigour. For example, one model that seems befitting of the maritime context is the job demand-control (-support) model (JDC [48, 49]). In adopting this model, researchers would be able to explore the strain hypothesis of the JCD model in relation to a variety of mental (e.g., life satisfaction, depression) and physical health (e.g., physical activity) outcomes [50].

Third, there is a disproportionate understanding of maritime pilot well-being compared to physical health that needs to be immediately addressed. While the reviewed articles contributed valuable knowledge towards pilot health, they generated scant knowledge of the psychological and social factors that impact upon pilots. For example, the lack of knowledge on pilot mental health (e.g., presence or absence of psychological dysfunction) is concerning, particularly given that the physical health evidence suggests these individuals are performing stressful tasks, and are at risk

of CVD. Given that other highly specialised industries (e.g., medicine) have identified the link between occupational stress and various mental health issues (e.g., depression, anxiety [51]), such investigations need to be prioritised to advance maritime pilotage knowledge.

Fourth, intervention research that specifically targets maritime pilot health and well-being initiatives is required. It is clear that maritime pilots are a unique group of workers who are distinct from other maritime, and transportation personnel. For example, maritime pilots do not experience the same issues of isolation and limitations to recreation activities as seafarers [2], nor do they adopt similar fatigue coping strategies as aviation pilots [4]. Any interventions that target health and well-being related issues should therefore be sensitive to the contextual demands faced by maritime pilots. In doing so, these interventions should empower pilots to take responsibility for maintaining their health and well-being [29]. Specifically, evidence that demonstrates strategies to reduce exposure to known risk factors of CVD (e.g., smoking, obesity) and or mental health issues (e.g., anxiety, depression, and burnout), which leads to improved pilot health and optimal performance, is required.

Finally, a review of career and education practices for maritime pilots may yield greater insight into the movement of pilots into, and out of the occupation. For example, a contemporary review of working arrangements and shift rosters may reveal issues related to pilot workload and fatigue management that could influence pilot retention. Education on pilotage career pathways and alternative training methods (e.g., simulation) may be an area of further inquiry; as new educational pathways emerge and trainee pilots are fast-tracked, an exploration of these vocational developments is required. Likewise, given the seemingly aging demographic of pilots, evidence-based strategies to recruit, train, and retain pilots is essential. In sum, intervention research on health and well-being initiatives for maritime pilots that are supported by multidisciplinary approaches will mark the next wave of investigative inquiry.

## DISCLAIMER

It should be noted that the views of the authors expressed in the submitted article are their own and not an official position of either institution or funder.

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