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Pilot Work Related Stress (WRS), Effects on Wellbeing and Mental Health, and Coping Methods

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ABSTRACT

Objective: The objective of this study is to investigate the relationship between sources of work-related stress (WRS) for pilots, effects on wellbeing, and coping mechanisms.

Background: Recent studies have measured depression levels in pilots but not the relationship between depression levels and coping strategies.

Methods: An anonymous web-based survey was conducted with commercial pilots.

A regression model was advanced to analyze the relationship between each frequency level of each coping strategy and PHQ-9 Scores, and the Odds ratio was interpreted.

Results: Sources of WRS impact on the physical, social, and psychological health of pilots. Not all pilots are suffering. Over half met threshold for mild depression. Nearly 60% are using coping mechanisms to manage WRS and its impact on wellbeing. Pilots using coping mechanisms such as sleep management, taking physical exercise, and diet management were found to have lower depression severity levels.

The findings of this study underscore the need to advance new tools to enable pilot self-management of their health and wellbeing. This includes new training tools, enhanced checklists, and new digital tools to support wellbeing awareness, stress coping, and risk identification both inside and outside the cockpit.

Conclusions: Airlines and pilots need the right tools to safeguard the wellbeing and mental fitness of pilots and ensure flight safety. Pilots, airlines, and aviation regulators can learn from the existing use of coping strategies by pilots.

Introduction

Introduction to the Research Problem

Pilots experience many physiological, psychological, and environmental stressors (Cullen et al., 2016, 2017). Since the Germanwings 9525 accident in 2015, the issue of managing and supporting pilot mental health (MH) issues and addressing work-related stress (WRS) has been gaining increased attention. The European Aviation Safety Authority (European Union Aviation Safety Agency [EASA], 2019) has introduced new rulemaking in relation to the management of MH issues in pilots. More recently, the industry and pilot groups are

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addressing the promotion of positive wellbeing and the practice of healthy behaviors for aviation professionals (Cullen et al., 2020; Flight Safety Foundation, 2020).

People vary in relation to their ability to cope successfully with stress (including WRS). The practice of healthy behaviors strengthens the person's resistance to stress (Morimoto & Shimada, 2015). The substitution of maladaptive coping with more adaptive coping is an important component of therapeutic interventions for WRS. Common stress coping strategies include exercise, the practice of relaxation techniques and seeking social support and/or social participation.

Self-efficacy is defined as a person's belief that they can succeed in a specific situation. One's sense of self-efficacy can play a major role in how one approaches goals, tasks, and challenges – including the management of WRS. Research indicates that a high level of self-efficacy can help employees cope more effectively cope with WRS (Jordan et al., 2016). Further, the promotion of self-efficacy is a key element for success in interventions designed to reduce depressive symptoms in late life (Blazer, 2002).

Recent studies have measured depression levels in pilots (Pasha & Stokes, 2018; Wu et al., 2016), but the relationship between mental health outcomes and coping strategies has not been explored.

Past research by Cahill et al. (2019b, 2018, 2019a) has indicated the following:

(1) The job is a source of WRS and contributing to burnout.
(2) Sources of WRS have a negative impact on pilot wellbeing, performance, and safety.
(3) Pilots have normalized the level of suffering.
(4) Overall, pilots are coping well with sources of WRS – but there is a variance here.
(5) Some pilots are using physical exercise and sleep management strategies to support stress management and develop resilience.

Thus, it is necessary to explore pilot stress-coping practices in more detail, to understand whether coping abilities and the practice of stress coping behaviors influence the health of pilots.

Paper Introduction

This paper reports on the analysis of an anonymous web-based survey addressing pilot WRS and its impact on wellbeing, performance, and safety (N = 1059 pilots). Specifically, it focuses on findings pertaining to sources of WRS, impact of WRS on wellbeing (including MH), prevalence of depression/MH issues, use of coping strategies and the relationship between coping strategies and health outcomes – in particular, depression severity.

First, a background of this research is provided. The data collection and analysis methodologies are then presented. The findings of the online survey are outlined, including findings pertaining to WRS, the impact of WRS on pilot wellbeing, pilot depression severity levels, pilot-coping strategies, and the relationship between pilot-coping strategies and depression severity outcomes. The findings of this research are then discussed. This includes the implications in terms of new training concepts, new checklists for use both while on and off duty, new digital tools, and safety behavior frameworks. Finally, some preliminary conclusions drawn.

Theoretical Background

Eudaimonia, Positive Psychology & Resilience

In Aristotelian ethics, the concept "Eudaimonia" refers to the condition of human flourishing or "living well" (Kenny, 2011). This concept is taken up in "positive psychology" frameworks which focus on the positive aspects of the human experience that make life worth living and developing resilience (Seligman, 2002).

Resilience is defined as the 'demonstration of positive adaptation in the face of significant adversity (Fikretoglu & McCreary, 2012). According to Fikretoglu and McCreary (2012), it is a response to stressful circumstances as opposed to a trait or capacity residing in the person. The "Soldier Adaptation Model" provides a conceptual framework for conceptualizing resilience processes. As argued by Fikretoglu and McCreary (2012), a soldier's appraisal and coping responses influence the outcome of their experience of demanding events. This process is influenced both by the individual characteristics of the soldiers and by the characteristics of their organization (Bliese & Castro, 2003).

Wellbeing, Mental Health & Mental Wellbeing in Work

The concept of "wellbeing" refers to a person's overall health and wellbeing. As defined by Engel (1977), this span's their physical, social, and psychological/emotional health. In

The "Six-factor Model of Psychological Well-being" defines six factors that contribute to an individual's psychological well-being, contentment, and happiness (Ryff & Singer, 2006). This includes positive relationships with others, personal mastery, autonomy, a feeling of purpose and meaning in life, and personal growth and development (Ryff & Singer, 2006).

Mental health is a key part of our wellbeing. The World Health Organization (WHO) defines mental health as "a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community" (World Health Organisation [WHO], 2018, p. 1). Related to this, is the concept of "mental wellbeing at work." This is defined as the interaction between the working environment, the nature of the work and the individual' (National Institute for Health & Care Excellence [NICE], 2009, p. 8).

Stress & Work-Related Stress (WRS)

Work has the potential to negatively impact on mental health particularly in the form of stress. Stress is "any experience or sensation that creates physiological, psychological and behavioural imbalance within a person" (Flinchbaugh et al., 2015; Houtman & Jettinghoff, 2007; Lazarus, 1990). Research shows that prolonged stress is linked to psychological conditions such as anxiety and depression, as well as physical conditions such as heart disease, back pain, and headache.

Personal stressors refer to issues or events outside the workplace, like family problems, health challenges, or financial issues that can contribute to stress.

Work-Related Stress (WRS) is "the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities, and which challenge their ability to cope" (Leka et al., 2003, p. 3). Personal stressors can worsen WRS.

Self-Management of Health & Wellbeing

Self-management of health is a new strategy to managing health conditions including chronic health conditions. Individuals actively manage issues identified with their illness or condition. Overall, the emphasis is on the responsibility of the person – who in turn is supported by their family, work, community, and health service/providers.

Pilots & Depression Severity

An anonymous study of commercial airline pilots in Brazil found the prevalence of pilots with common mental disorders (CMD), such as mixed anxiety and depression, to be 6.7% (Feijó et al., 2012). A 2016 study of pilot mental health indicated that 12.6% of respondents met the threshold for experiencing depression in the last fortnight (Wu et al., 2016). Research undertaken by Bor et al. (2017) suggests that common psychological problems in pilots include adjustment disorder, mood disorder, anxiety and occupational stress, relationship problems, sexual dysfunction, and alcohol problems. Further, a systematic review of 20 studies examining depression in airline pilots found that the prevalence of major depressive disorder experienced by commercial airline pilots ranged from 1.9% to 12.6% (Pasha & Stokes, 2018).

Safety-II & Behavior-Based Safety

Safety-II emphasizes the value of using both proactive and predictive safety/risk management approaches (Hollnagel, 2014; Hollnagel et al., 2015). Central to Safety-II concepts is the importance attributed to learning from normal operations, including when things go well. Safety-II is underpinned by open communication (for example, cockpit briefings and debriefing) and teamwork between crew members (Hollnagel, 2014; Hollnagel et al., 2015).

Behavioral-based safety (BBS) is a defined as a "reinforcement action taken by an organization's management to identify the immediate and root causes of unsafe behavior and then apply corrective measures to reduce unsafe actions by employees" (Safeopedia, 2020, p. 1). It involves a partnership between management and employees that continually focuses an employees' attention on their daily safety behaviors (Cooper, 2009).

Safety/Risk, Management, Pilot Wellbeing & Mental Health: The Regulatory Approach

The objective of an airline Safety Management System (SMS) is to provide a structured management approach to control safety risks in operations (European Union Aviation Safety Agency [EASA], 2018; Skybrary, 2019). In theory, an SMS addresses all risks. According to ICAO Doc 9859 (2013), an SMS may include both proactive and reactive methods and techniques. The term "Safety II" is not defined in ICAO's (2013) recommendations. However, ICAO's (2019) "Global Aviation Safety Plan," refers to the future implementation of predictive risk management practices by 2027.

Crew Resource Management (CRM) training is mandated for all pilots and is a key component of an airline's SMS. Typically, this includes information about the practice of "safety behaviors" and associated Crew Resource Management (CRM) theories (EASA,

2017a, 2017b). As argued by Cahill et al. (2019b), CRM training largely relates to certain bio-medical aspects of health (for example, fatigue), the avoidance of unsafe substances (for example, alcohol, and drugs), and certain socio-cognitive dimensions of performance (for example, crew teamwork). Safety behavior is conceived from an operational perspective (while on duty). Currently, it is not in framed in terms of maintaining a healthy lifestyle, which has implications in terms of pilot performance and flight safety (Cahill et al., 2019b).

Pilot health and fitness (including mental health) is assessed annually in accordance with mandatory rules regarding aero-medical assessment (Bor et al., 2010). There are very clear guidelines concerning the impact of a psychiatric disorder on pilots (Dickens, 2016). All regulatory bodies distinguish between conditions that result in mandatory exclusion from flying, and those that allow a pilot to fly under controlled conditions (Dickens, 2016).

Recently, EASA introduced new rules pertaining to pilot mental fitness (EASA, 2019). These rules span three key areas – psychological testing of aircrew pre-employment in line flight, access to a psychological support/peer support resource, and substance abuse testing on a random basis. European airlines are required to demonstrate compliance with these rules by 2021.

Airline Approaches to Managing Pilot Health & Wellbeing

Airlines follow existing guidance pertaining to aeromedical assessment of pilots, as mandated by the regulatory authorities. The health of a commercial airline pilot is assessed annually. Licenses and flying privileges can be suspended if serious health problems (including MH issues) are detected. Given that their license is at stake, pilots are likely to under report MH issues. Further, pilots are not likely to approach aeromedical examiners for help.

Presently, the primary focus of airline wellbeing interventions pertains to the management of crew fatigue and alertness (Cahill et al., 2019a). Risks pertaining to crew fatigue are monitored as part of airline SMSs (Cahill et al., 2019b). Currently, sources of WRS and wellbeing factors (spanning the three pillars of wellbeing) are not properly defined within existing airline safety management systems (Cahill et al., 2019a).

Stress management forms part of an airline's Crew Resource Management (CRM) syllabus as defined by EASA (2017a). Specific stress management modules have been successfully implemented and positive outcomes realized (Moriarty, 2015). However, the guidance material does not explicitly mention WRS and techniques for managing WRS/wellbeing issues across the three pillars of wellbeing. Moreover, the guidance does not address the links between the home/work interface, and stress coping behaviors while on and off duty.

Following from Crew Resource Management (CRM) and Threat & Error Management (TEM) concepts, pilots follow strict procedures in terms of crew briefing at the pre-flight planning and briefing stage (Cahill, 2010). However, existing airline briefing processes do not address WRS/wellbeing issues. Moreover, specific pre-flight checklists (i.e. standard operating procedures – SOP) do not include human factors checks in relation to crew wellbeing and the joint crew state (Cahill, 2010).

In addition, some airlines provide psychological support using a peer-support service (Atherton 2019). As reported by Atherton (2019), this includes American Airlines, British Airways, Lufthansa, KLM and Qantas have provided peer support services for several years.

Pilot Stress Coping, Training & Operational Tools

Currently, pilots adopt their own coping mechanisms, relying on themselves as opposed to their employers (Cahill et al., 2019a). Past research undertaken by authors indicates that some Pilot self-manage their health and wellbeing – with some using sleep diaries and adopting exercise routines (Cahill et al., 2018).

Several pilot checklists have been advanced to address pilot risk assessment at an operational level (and fitness for flight). This includes the I'm Safe Checklist (Houston, 2019) and the Personal Minimums Checklist (Federal Aviation Authority [FAA], 2009, 2020). However, these do not address the three pillars of wellbeing.

Materials & Methods

Survey Design

An anonymous web-based survey was completed by commercial pilots over a fifteen-month period (between 7 November 2018 and 24 January 2020). Participants were invited to participate in an anonymous web-based online survey examining the effects of work-related stress (WRS) on pilot wellbeing, and the associated impact on performance and flight safety. The survey also investigated coping methods, attitudes to talking about mental health issues, and perceptions of the airline role in relation to managing WRS and wellbeing issues.

The survey incorporated several standardized instruments to measure levels of common mental health issues which have been widely validated and have good psychometric properties. These are these Patient Health Questionnaire –9 (PHQ-9; Kroenke et al., 2001), the Oldenburg Burnout (Demerouti et al., 2003), and the Oldenburg Burnout (Modified Instrument; Demerouti et al., 2019). Further, the survey design also drew upon prior research undertaken by the authors pertaining to a biopsychosocial model of pilot wellbeing, the factors that can positively and negatively influence a pilot's physical, mental and social health, and the ensuing impact on pilot performance and flight safety (Cahill et al., 2018; Cullen et al., 2017).

First, pilots received background information about the study. They then completed the electronic consent. Following this, they completed questions for each of the nine sections (part 2 to part 10). This was followed by a debriefing which included contacts information for relevant support groups and Pilot Support Groups.

Pilots were recruited using social media platforms such as LinkedIn and Twitter.

The survey was powered by the SurveyMonkey service and did not collect any identifying information about the person. Further, no internet protocol (IP) addresses were collected. It was assumed that each participant was a pilot and only completed one survey. Several questions in the survey required knowledge that would only be readily available to pilots. An active pilot (coauthor in this study: PC) reviewed surveys for potential non-pilot participants. All surveys passed this screening. Ethics approval was granted by the School of Psychology, Trinity College Dublin (TCD), Ireland.

Survey Structure, Topics & Inclusion of Specific Survey Instruments

The survey was divided into eleven sections as follows:

- Part 1: Briefing & Consent
- Part 2: About You/Personal Details
- Part 3: About Your Job
- Part 4: Overall Health
- Part 5: Job Satisfaction & Sources of Work-Related Stress
- Part 6: Coping Strategies
- Part 7: Work & Impact on Wellbeing
- Part 8: Work & Impact on Performance/Safety
- Part 9: Mental Health (Attitudes, Talking About Mental Health & Experience)
- Part 10: Airline Practices & Promoting Pilot Wellbeing/Mental Health
- Part 11: Thank You & Debriefing

Survey instruments were embedded in parts 4 and 7. Part 4 elicited feedback about the participant's overall health. Questions were posed in relation to sleep, exercise and diet. This section also incorporated the "Patient Health Questionnaire-9 (PHQ-9)" – a nine-item questionnaire used to measure and detect/diagnose depression severity (Kroenke et al., 2001). The PHQ-9 was chosen as it is both sensitive and specific in its diagnoses (Kroenke et al., 2001).

Part 7 elicited feedback about work and impact on wellbeing. Here, there was focus on eliciting feedback about burnout. As conceived by Demerouti et al. (2001), burnout consists of two main symptoms. This includes, high levels of exhaustion and a distant/cynical attitude toward work (Demerouti et al., 2001). As such, this section included questions derived from the Oldenburg Burnout instrument (OLBI 8; Demerouti et al., 2003), and the Oldenburg Burnout (Modified Instrument; Demerouti et al., 2019). According to Demerouti et al., the OLBI has been shown to be a better predictor of long-term health than of depression and anxiety (Demerouti et al., 2019).

Overview of Data Analysis

The purpose of the data analysis was (1) identify sources of WRS and wellbeing impact, (2) measure depression levels in pilots, (3) to examine the use of coping strategies (CS), and (4) to examine the relationship between coping strategies used by pilots and their mental health – specifically depression severity levels.

- In relation to (1), sources of WRS and wellbeing impact were reported based on pilot self-reported data.
- In relation to (2), depression levels were scored using the PHQ-9 depression severity scale (Kroenke et al., 2001). Please see Appendix A for an example of this.
- In relation to (3), we examined prevalence of pilots using CS and the most frequently used CS.
- In relation to (4), an ordered logistic regression model was advanced to explore the relationship between the PHQ-9 scores and each of the coping strategies for WRS (i.e. those listed in the survey).

Please note that thus-far, the data analysis has not addressed burnout.

Ordered Logistic Regression Model & Interpreting the Odds Ratio

The objective was to model the relationship between each frequency level of each coping strategy and PHQ-9 Scores. Following this, we interpreted the Odds ratio, to assess statistically significant coping strategies. Logistic regression is a statistical method for analyzing a dataset in which there are one or more independent variables that determine an outcome. The outcome is measured with a dichotomous variable (in which there are only two possible outcomes). The response variable Y is assumed to be binary (i.e. either a failure or success). In our case, we took the 2 outcomes of the response variable to be: (1) Pilot has a PHQ-9 score below 10 ($Y_i = 0$) or (2) Pilot has a PHQ-9 score of at least 10 ($Y_i = 1$). See Appendix A: PHQ Scores & Depression Severity. We are interested in drawing inferences on coping strategies and how they're related to Depression Severity levels. That is co-relation not causality (coping strategy causing the PHQ score to be below 10 or vice versa). This analysis does not consider interaction between different coping methods.

Interpretation of results addressed the odds ratio. If the Odds Ratio is less than 1, then it's associated with a probability of having a lower depression severity level. Statistically significant coping strategies were set at $p = .05$. For more, please see Appendix C. It should be noted that the p-value tells us only whether a coping strategy at a certain frequency level was statistically significant. The odds ratio is what tells us whether that coping strategy is associated with a higher (if > 1) or lower (<1) depression severity level.

Results

Participant Profiles

1059 pilots completed the online survey (128 female and 895 male). 36 pilots did not give their gender. 77.5% (n = 821) completed the PHQ. Overall, survey respondents can be described as male (87.5%), full time (86.9%), married or cohabiting with partner (71.3%), and based in home country (80.2%). Table 1 below provides a summary of respondent ages. Table 2 provides a summary of respondent time working as a commercial pilot.

In general, the Pilots surveyed were a reasonably healthy population in terms of their health behaviors. Most participants reported obtaining between 7 and 8 hours sleep on non-duty days (37.5% reported 8 hours of sleep, while 28.4% reported 7 hours). Respondents reported obtaining considerably less sleep during duty periods (41.4% obtaining 6 hours, and 26.4% 7 hours, 12% 8 hours). The vast majority exercise regularly (24.7% three times a week, 19.9% twice a week, and 18.3% once a week). Further, the majority reported eating

Table 1. Ages of respondents.

<25	25–35	36–45	46–55	56–65	NA
4.6%	26.5%	30.7%	25.9%	11.7%	0.7%

Table 2. Time working as a pilot.

<2 years	2–5 years	6–10 years	11–15 years	16–20 years	21–25 years	26–30 years	30 years
5.7%	10.4%	15.5%	15.1%	16.0%	12.2%	11.3%	13.8%

a healthy diet (87.8%) while off duty, although that number is lower when pilots were on duty (38.5% said they had a healthy diet on workdays).

Experience of WRS

As indicated in Figure 1, the majority of pilots reported that WRS sources have an impact on their performance – 63.7% (468) agree, and 19.7% (145) strongly agree that certain WRS sources have an impact on their performances.

Sources of WRS

As indicated in Figure 2, the top four sources of WRS are working irregular hours, working anti-social hours, divergence of values between pilots and management and working long duties.

Wellbeing Issues Experienced Due to the Job

As indicated in Figure 3, the job has effects across the three pillars. The main impact is on bio pillar (sleep, musculoskeletal symptoms), and social sphere (family life, participating in social events), but also impacts on MH. Sleep difficulties (81.0%) were reported as the most common wellbeing issue that respondents either attributed to the job or believed to be worsened by the job. This is followed closely by musculoskeletal symptoms (73.5%) and

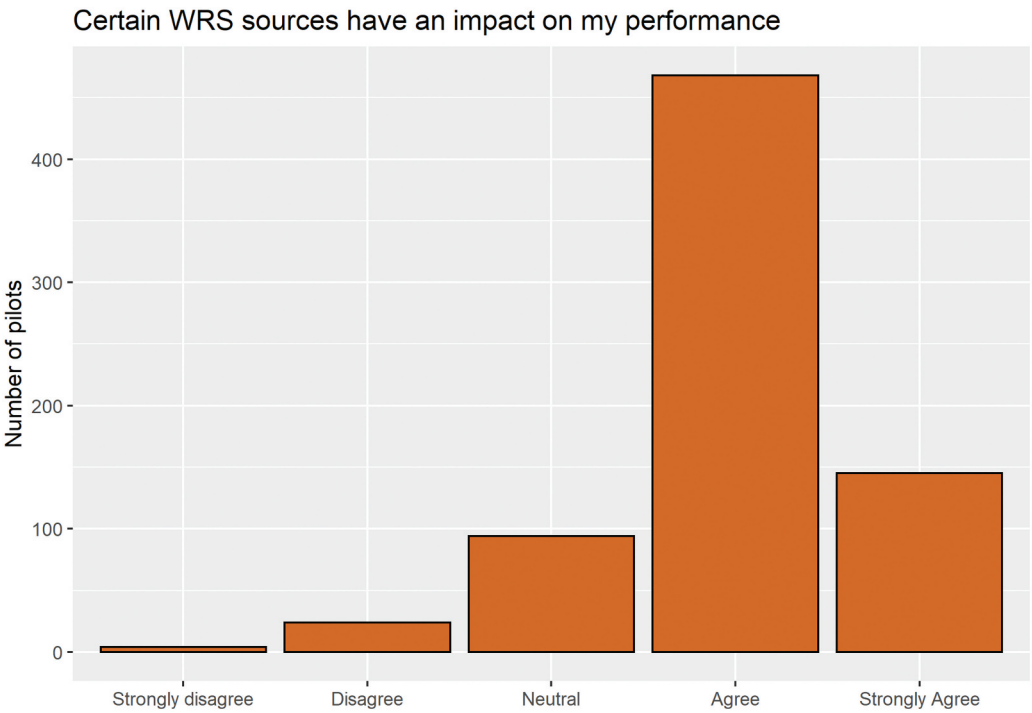

Figure 1. Pilot experiences of work-related stress (WRS).

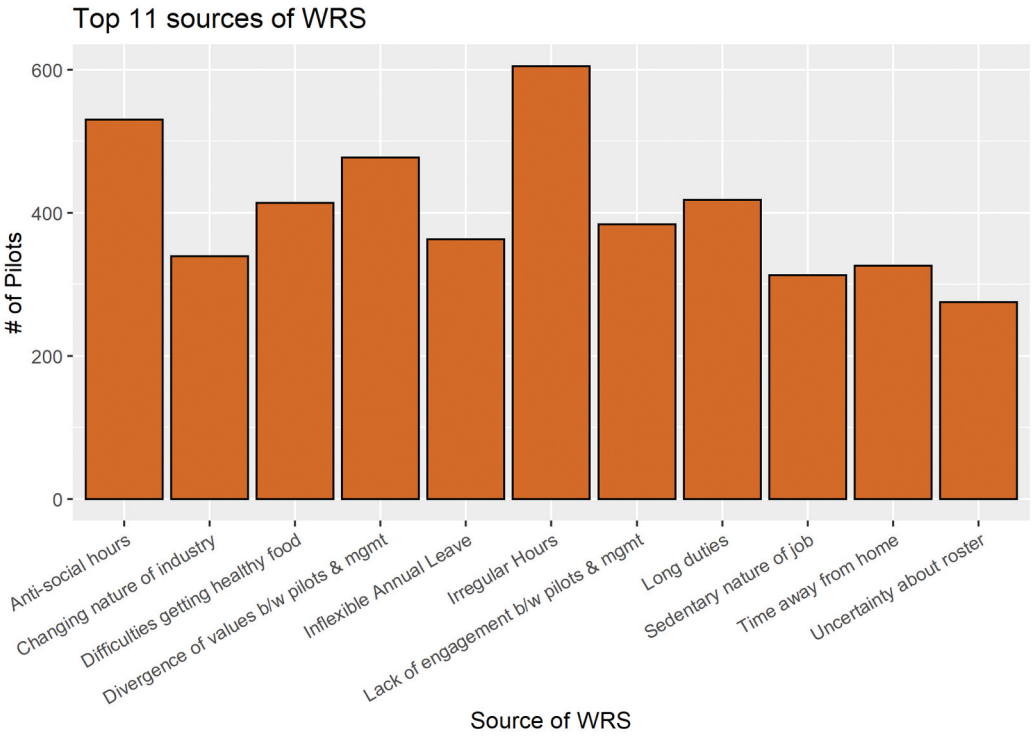

Figure 2. Sources of work-related stress (WRS).

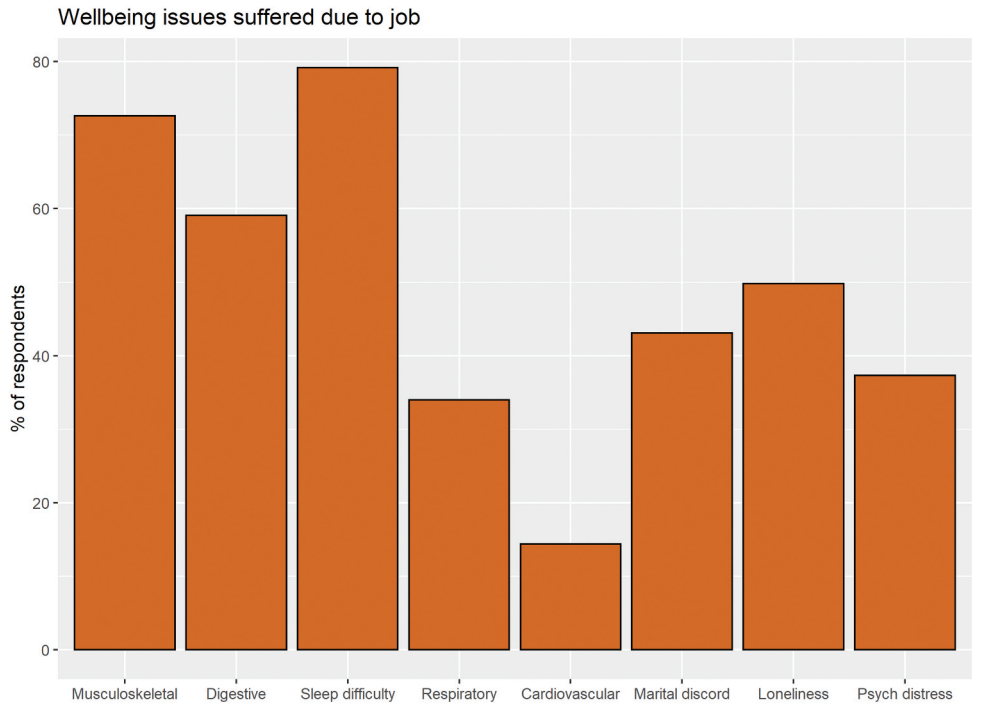

Figure 3. Wellbeing issues suffered due to the job.

then digestive symptoms (58.5%). Other impacts include social isolation (49.9%), marital/family discord (42.9%), respiratory symptoms (32.3%), and psychological distress (36.9%).

Although psychological distress was ranked the third lowest in terms of wellbeing impact, most respondents indicated that the environment in which Pilots work can contribute to the onset of or worsen an existing mental health issue (58.4% participants agreed, while 33.5% strongly agreed).

Prevalence of Depression

77.5% of survey respondents (821 pilots) answered the questions that were used to calculate the PHQ-9 score. As indicated in Figure 4, not all pilots are suffering. The results suggest that 43.0% are not experiencing depression, while 40.0% met the threshold for mild clinical depression. A very low number met the threshold for moderately severe (4.4%) or severe depression (1.6%). The average PHQ-9 score was 6.03, while the median score was 5 (i.e. half of the pilots had a score greater than 5). 25% of the pilots had a PHQ-9 score greater than 8. 8.4% of pilots (n = 877) rated their mental/emotional health as being either Bad or Very Bad (8.4% of respondents). For a full breakdown of depression severity levels in the dataset, please see Appendix B.

Pilots seem self-aware of the state of their mental health – the PHQ-9 scores accurately reflected the self-reported mental health states, as shown in Figure 5 below.

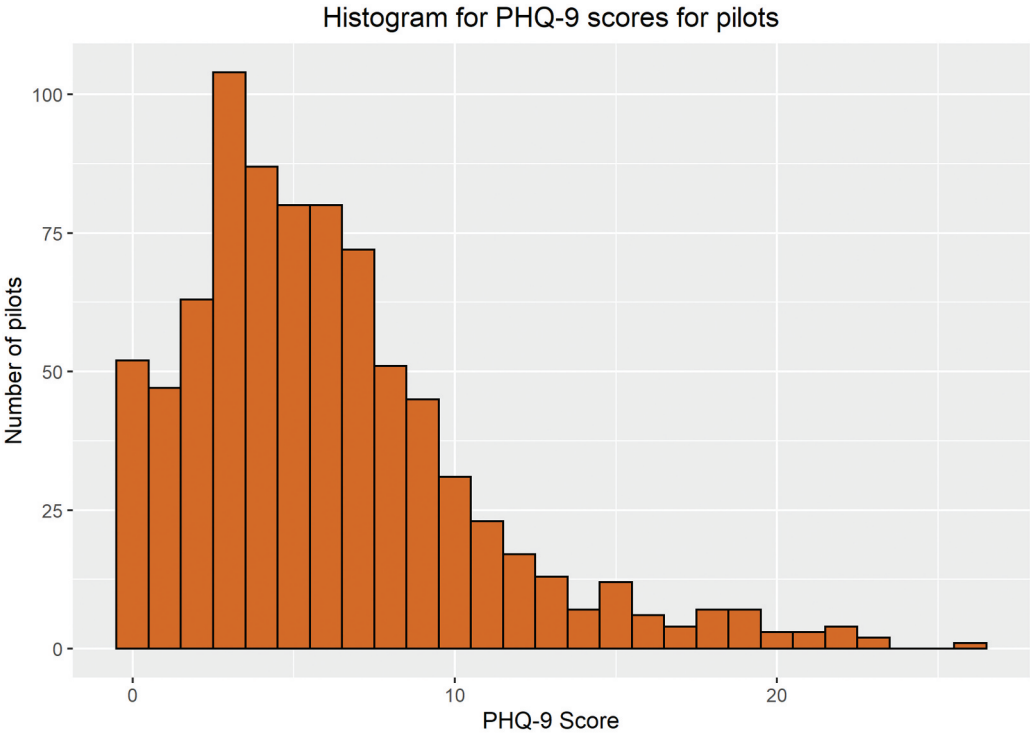

Figure 4. PHQ-9 scores for pilots.

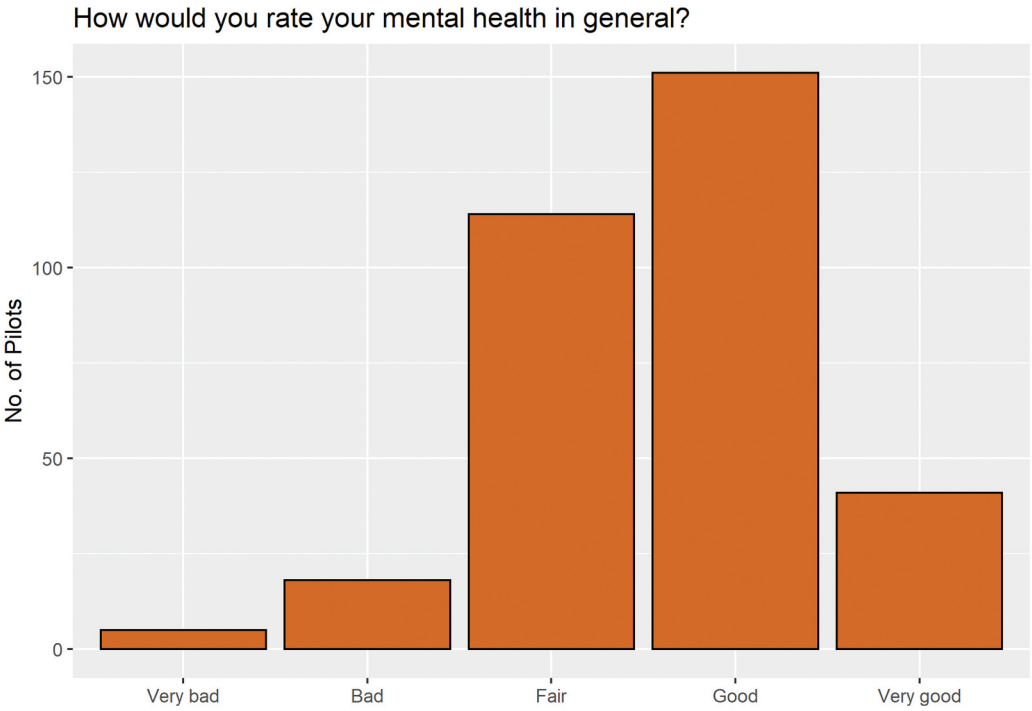

Figure 5. Self-reported mental health.

Pilots of all ages suffer equally – there is no evidence that any age group suffers to a greater or less degree. There was no evidence for PHQ-9 scores differing across operation types. There was no visible relationship between roster type and PHQ-9 scores.

Prevalence of Coping Strategies

Pilots were questioned as to whether they had any coping strategies that helped them deal with WRS. 783 answered this question. The majority of pilots are using CS (59.3% using CS, 40.7% not using CS).

Most Frequently Reported/Used Coping Strategies

As depicted in Figure 6, the top coping strategy appears to be Exercise (11.7% once a month, 8.0% 2–3 times per month, once a week 14.3%, Several times a week 46.2%, Daily 11.8%). This was followed by focusing on sleep/relaxation (5.09% once a month or less, 6.03% 2–3x a month, 11.3% once a week, 39.4% several times a week, 26.1% daily). Focusing on diet was third (7.1% once a month or less, 5.9% 2–3 times per month, 10.3% once a week, 39.8% several times per week, 20.8% daily).

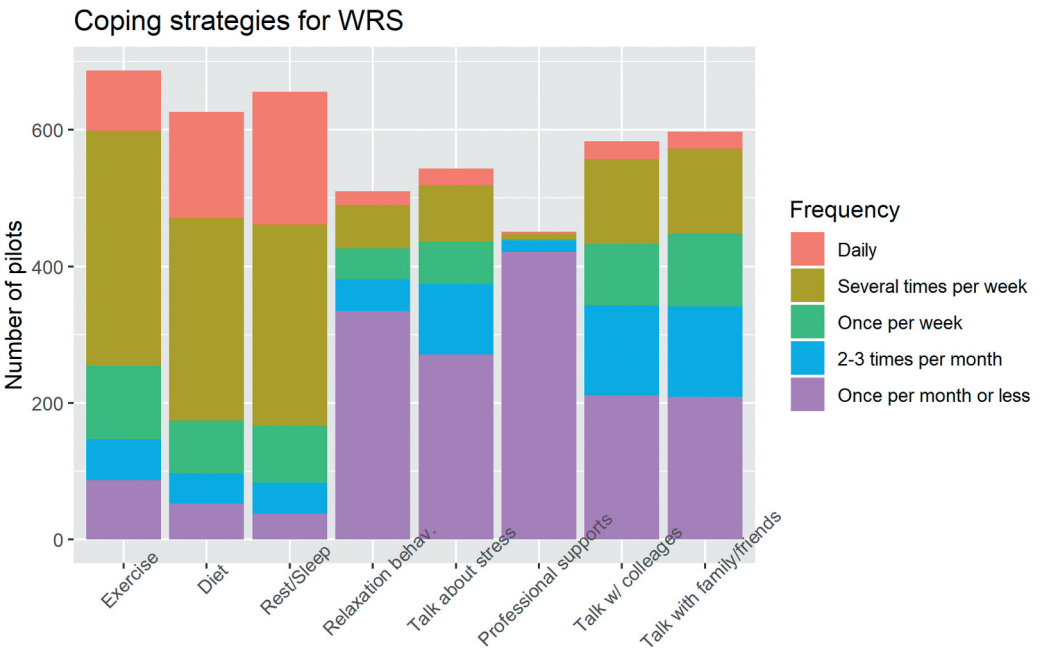

Figure 6. Coping strategies for WRS.

Coping Methods & PHQ Scores

Table 3 below presents the distribution of PHQ scores for using and not using CS. As indicated in Table 3, there was not much of a difference between the two groups.

This was followed by a one-way ANOVA to determine whether the average PHQ scores differed across the two groups. We found no evidence of this being the case (see boxplot depicted in Figure 7 below).

Coping Strategies & PHQ Scores

The three coping strategies associated with odds of having a higher depression severity level are:

(1) Discussing WRS with colleagues 2–3 times a month
(2) Focusing on relaxation behavior once a week
(3) Focusing on relaxation behavior several times a week

The coping strategies most associated with lower depression severity levels are

(1) Focussing on sleep daily
(2) Focussing on exercise several times a week
(3) Focussing on exercise daily
(4) Focussing on exercise 2 to 3 times a month

Table 3. Distribution of pilots using and not using CS and PHQ-9 scores.

	Yes	No
Count	464	319
Percentage	59.2%	40.8%
Avg PHQ-9 Score	5.86	6.31

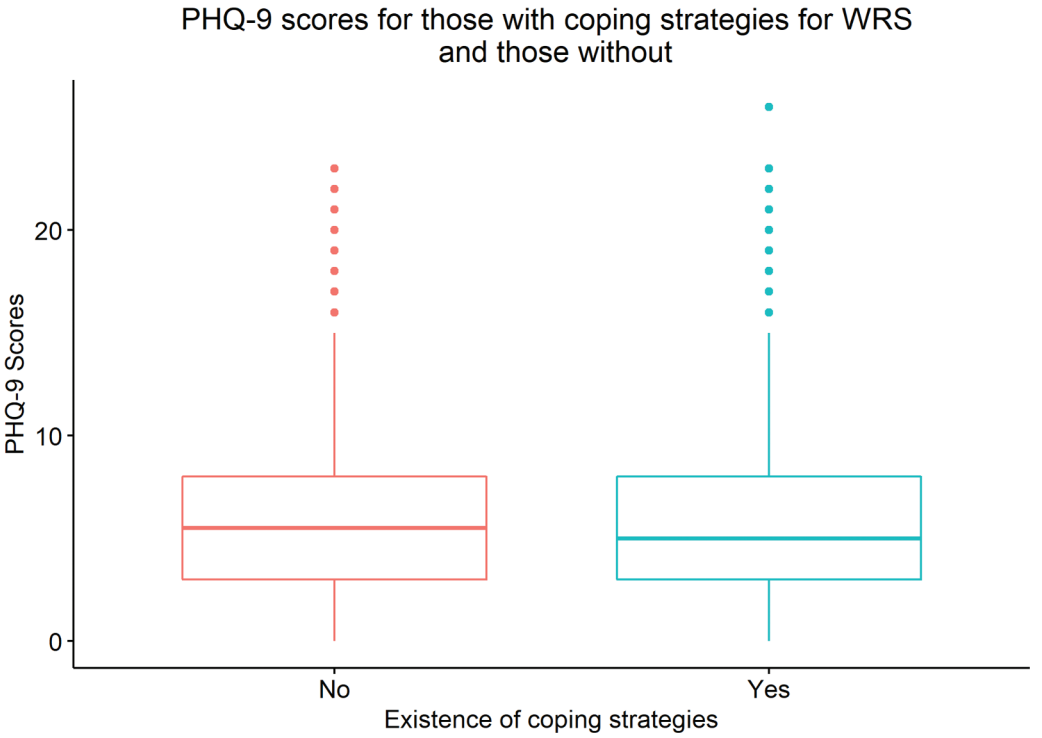

Figure 7. Boxplot – existence of coping strategies and depression severity.

All the statistically significant "focusing on sleep" frequency levels (F3 and F4) are associated with lower PHQ severity levels.

For a full list of statistically significant coping strategies – please see Appendix C.

Discussion

Coping

This research presents a picture of pilots that are coping and adopting strategies to enable them to cope with different sources of WRS. Fatigue and sleep management is a key strategy, along with exercise and the management of diet. These strategies enable some pilots to cope in a work environment that is detrimental for others. To this end, we would recommend that pilots use these strategies to manage WRS/wellbeing challenges (including MH) and increase their resilience.

It should be noted that the regression model tells us about the probability of the strategy making a difference to depression severity. The impact of using individual coping mechanisms to manage specific sources of stress (and associated contributory factors to depression outcomes) is not known. Further, this model is on a "per strategy" basis and does not include the interaction between strategies. Potentially, those pilots with the best outcomes may be using one or more coping strategies. If this relationship is better understood, then further lessons might be learned in terms of the application of specific strategies.

Further, an understanding of pilot-coping strategies might underscore interventions at different levels. Potential interventions are likely to be multi-component, spanning different socio-technical dimensions (i.e., training, culture, technology, and process design). These are discussed in more detail below.

Training

Current training does not focus on the promotion of resilience and the development of coping skills (i.e. learning how to be resilient to challenges and practice self-management techniques)- linking to preventative mental health approaches. Overall, the objective of such training should be to increase a pilot's ability to cope. Pilots need to be trained in terms of (a) awareness of stress/WRS and its impact on wellbeing including MH, (b) MH awareness, (c) stress coping methods and self-managing wellbeing, (d) risk identifying in relation to their own wellbeing/MH (i.e. detecting potential for problem and managing this). Educational strategies are required to promote learning about personal health, maintaining work-family balance, and using coping strategies that suit the person and specific occupational and home/work interface demands. Pilots might also benefit from training in meditation and mindfulness. Such training might go beyond traditional classroom formats and include online materials and the use of serious games or other interactive formats.

New Checklists (On & Off Duty)

This research indicates the requirements for augmenting existing checklists for use by pilots – both while on and off duty. Typically, pilots use checklists as part of the operation – both pre-flight, during and post flight. Amendments to existing pre-flight checklists are required for use by pilots as part of their pre-flight briefing (i.e. in the cockpit and/or the crew briefing room), so that they can both individually and jointly evaluate their health and wellbeing. Table 4 below provides an example of an extended version of the "I'm Safe

Table 4. Enhanced I'm safe checklist.

I	Illness & Wellbeing	Do I have an illness or any symptoms of an illness? Am I feeling good/well? How is my overall health and wellbeing? Physical health? Emotional/ Psychological Health? What's my mood and attitude like?Social Health? Have I seen family/ friends? Getting help/support if needed?
M	Medication	Have I been taking prescription or over-the-counter drugs?
S	Stress & Stress Coping	Am I under psychological pressure from the job? Worried about financial matters, health problems or family discord?Am I actively managing my stress? Exercise? Social? Do I need help?
A	Alcohol	Have I been drinking within eight hours? Within 24 hours?
F	Fatigue	Am I tired and not adequately rested? Have I been managing my sleep?
E	Eating & Exercise	Am I adequately nourished and hydrated? Am I taking physical exercise?

Checklist" (Houston, 2019). The items in red indicate the additional content included in the checklist.

Overall, this augmented checklist addresses a positive definition of wellbeing and not simply illness. The objective is to nudge the pilots to assess (1) their health status in relation to all three pillars of wellbeing, and (2) how they are coping (i.e. use of coping strategies). In relation to (1), this includes current emotional (i.e. mood and attitude) and social state. Further, physical exercise is also incorporated. In relation to (2), stress coping is included alongside stress levels. As demonstrated in this research, the practice of healthy behaviors (i.e. use of coping strategies such as sleep management, taking physical exercise and manging diet and nutrition) is associated with lower depression levels.

Further, checklists might be developed for use by pilots while off duty – linking to the management of the home/work interface. Again, it is proposed that the checklist items would link to the findings of this analysis – in terms of (1) and (2) as defined above. For an example of this, please see Table 5.

New Digital Tool (Inside & outside the Cockpit)

This research underscores the need for new digital tools to support pilot self-management of wellbeing and safety behavior. This might involve the advancement of a mobile phone App with different wellness functions. For example, the App might include the following functions:

(1) Promote awareness of WRS and its impact on wellbeing (including MH)
(2) Support the development and maintenance of coping skills
(3) Enable pilot routine self-assessment of their own wellbeing – linked to auto-harvested and self-reported data
(4) Enable pilot reporting of their wellness information to the airline (i.e. integrated with airline SMS and flight planning/rostering systems)
(5) Enable pilot management of crisis situations (access to supports – including in person support)

In relation to (3), the implementation of a self-assessment function might take various forms. For example, it might be simple reminder to pilots to assess their current state and what they are doing to manage this (i.e. nudge to use coping strategies). In this way, it would promote the use of healthy behaviors/coping strategies which this research has identified as being associated with lower depression levels. A more sophisticated version might provide

Table 5. Reporting wellbeing management across the three pillars.

Pillar	Example	How Am I Doing? Current Rating/Status? (Good, Ok, Poor)	What Can I Do to Improve this? What Am I Currently Doing to Improve this?
Biological	Sleep, Diet, Exercise		
Psychological	Attitude to life, Mood, Stress Management, Use of Coping Strategies		
Social	Support Network, Social Support		

a wellbeing score based on data integrated from diverse sources (for example, sleep and exercise data auto-harvested from a Fit-Bit or other wearable device that the pilot may use) and data self-reported by the pilot.

Pending pilot consent and appropriate protections, wellbeing data might be shared in a de-identified format with the pilot's airline, so that it could be used from an operational and safety management perspective. Individual pilot data might be aggregated at a fleet level, to ensure optimum flight planning and rostering/scheduling of crew. Moreover, data pertaining to pilot wellbeing could be incorporated in safety/risk assessments and safety promotion activities. Lastly, specific data might be shared with aeromedical examiners, to support fitness to fly assessments, pending pilot agreement. This would necessitate common agreement and strategies across the key stakeholders (i.e. pilots, airlines, aeromedical examiners, regulators etc.) as to the appropriate use of personal and health data for the purpose of preventing and managing wellbeing issues amongst pilots, while also addressing issues pertaining to fitness to fly. The requirements for such tools are discussed in more detail in a separate paper (Cahill et al., 2020).

EASA Rule Making & Stakeholder Tools/Perspectives

Airlines and pilots need the right tools to safeguard the wellbeing and mental fitness of pilots and ensure flight safety. This research indicates the existing regulation is not going far enough. From an ethos perspective, the focus should be on prevention (and not simply detection), and the promotion of all three pillars of wellbeing and not simply psychological wellbeing.

As defined previously, the existing IR do not address interventions at the pilot self-management level. Further, they are conceived from an operational perspective and do address WRS and associated risks from the perspective of managing the work/life interface. It is not likely that EASA can mandate the use of new self-management tools by pilots. However, these might be considered as "best practice" and considered in terms of EASA's Guidance Material pertaining to safety promotion and CRM training.

Existing CRM and stress management training might be strengthened to include the practice of healthy behaviors across the three pillars, fostering coping ability and skills, the application of specific coping strategies, and risk identification both inside and outside the cockpit.

Currently, sources of WRS and wellbeing factors (spanning the three pillars of wellbeing) are not properly defined within existing airline SMS's. From a safety/risk management perspective, airline safety management systems should manage human factors risks linking to the three pillars of wellbeing. Critically, existing fatigue risk management systems (and by implication airline rostering/flight planning systems) need to be extended to consider the relationship between fatigue risk and the other dimensions of a pilot's wellbeing. As noted above, this would require making use of a pilot's wellbeing data within the airline SMS.

Safety Behavior

This research calls for a new framework in relation to defining safety behavior for pilots. This framework should be underpinned by (1) a focus on pilot wellness – the "biopsychosocial," (2) on managing the home/work interface and the intersections between the two

which impacts wellness and (3), on the relationship between WRS, pilot wellbeing, performance, and safety. Overall, the management of health and wellbeing both inside and outside work should be considered a core safety behavior. This follows a collective approach to "behavior-based safety" and has implication at an operational level (i.e. design of airline processes and systems) and pilot level (i.e. self-management of heath while on and off duty). Behavior change for both pilots (i.e. employees) and airlines (i.e. employers), with support from the regulator, is required. At a conceptual level, this is in line with a systematic approach to human factors and Safety-II concepts.

Limitations

Survey participants were recruited using social media. There may be issues pertaining to self-selection of candidates (i.e. bias in relation to interest in wellbeing). Survey data were self-reported. There is a potential bias in terms of the respondent's own perception. Further, survey data is cross-sectional in nature. The results can only be used to evaluate the sample for the time-period during which this data was collected. Thus, no cause-and-effect relationship can be drawn from the findings. Additional research (for example, one to one interview with pilots) is required to unpack specific WRS issues and wellbeing factors as emerged in both the workshop and survey feedback.

As noted previously, the model does not tell us whether a coping strategy made a difference. Strategies are associated with lower or high depression severity levels only. To assess the effectiveness of a coping strategy, would require significant observation of pilots over a period of time (while controlling all other variables) and asking them to use certain coping mechanisms to see whether they might make a difference over the time period. Further, the regression model is on a per strategy basis – it does not consider interactions between different strategies.

This research reflects the perspective of one stakeholder group (namely pilots). As such, it needs to be validated with other stakeholder groups. This might include clinicians, occupational health and safety experts, airline management, and the aviation authorities. Moreover, there is a specific requirement to engage with both airlines and the aviation authorities, in terms of advancing a road map for rulemaking and the implementation of solutions at an airline level.

Areas for Further Analysis

As noted previously, our current model is on a "per strategy" basis. A future analysis will focus on interactions across coping methods.

Exercise and sleep management at different frequency levels are being associated with lower depression severity levels. It is not currently clear how frequency relates to the likelihood of it being associated lower depression severity. Further analysis will address how frequency links with the likelihood of the strategy being associated with lower depression severity.

The existing analysis uses the pilots PHQ-9 scores as our response variable. For future research, it would be interesting to use other variables lining to the data collected in the survey. As such, the next phase of data analysis will address engagement, emotional exhaustion, and burnout.

In addition, participatory co-design activities will also be undertaken with different stakeholders to address wellbeing interventions (training, checklists, digital tools) at different levels (pilot, airline, regulator).

Lastly, the job of being a commercial pilot has some positive effects. Further, certain technical and non-technical aspects of the "flying task" has positive wellbeing implications (Cahill, 2010). Additional research may address the positive impacts of the job (in addition to sources of WRS and its negative impacts).

Conclusion

All stress cannot be removed from the work-life of pilots. A high-stress situation is not always detrimental for a person's wellbeing. The use of coping strategies such as managing sleep and exercise enables a person to manage WRS in a healthy manner and build resilience.

The wellbeing of pilots is being negatively affected by certain sources of WRS. Strategies such as sleep management and taking regular physical exercise enable some pilots to cope in a work environment that is detrimental for others. Critically, these strategies enable pilots to increase their resilience to wellbeing challenges (including MH challenges) and are associated with lower depression severity levels.

This research has led to evidence-based recommendations for interventions to promote wellbeing (including positive mental health and mental wellbeing) in the workplace, both at an airline level and pilot self-management level (including while on and off duty). Overall, airline organizations might increase their support for preventative mental health treatment, and supporting pilot training in relation to adopting healthy behaviors, using specific coping strategies, and risk identifying behavior. Future research might address the introduction of new training tools, checklists, and digital tools, to support pilot management of specific sources of WRS both inside and outside work.

The results of this study should be interpreted with potential limitations in mind. Next steps will involve further analysis of survey data – in particular, in relation to pilot burnout. Participatory co-design activities will also be undertaken with stakeholders to define the requirements for new training tools, checklists, and digital tools, along with a suitable implementation approach.

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Appendix A. Scoring of depression severity levels

Score	Depression Severity
0–4	Minimal/None
5–9	Mild
10–14	Moderate
15–19	Moderately severe
20–27	Severe

Appendix B. Breakdown of depression severity in dataset

Depression Severity	No of pilots
None	353 (43.00%)
Mild	328 (40.00%)
Moderate	91 (11.08%)
Moderately Severe	36 (4.38%)
Severe	13 (1.58%)

Appendix C. Ordered logistic regression model

The results of the model are as follows. Frequency levels as F1 = 2–3 times a month, F2 = Once per week, F3 = Several times a week, F4 = Daily. This is just for the sake of quickly typing up the results.

Highlighted in green are the statistically significant coping strategies at $p = .05$.

Parameter	Value	Std Error	t-value	p-value	Odds Ratio
Exercise – F1	−0.66	0.32	−2.04	.04	0.52
Exercise – F2	0.23	0.25	−.92	.3	1.26
Exercise – F3	−0.77	0.22	−3.50	.0004	0.46
Exercise – F4	−0.69	0.29	−2.37	.01	0.50
Diet – F1	0.50	0.36	1.39	.17	1.09
Diet – F2	0.31	0.30	1.04	.30	1.37
Diet – F3	0.34	0.22	1.50	.13	1.40
Diet – F4	−0.42	0.27	−1.5	.12	0.66
Sleep – F1	0.50	0.36	1.39	.17	1.65
Sleep – F2	−0.44	0.30	−1.45	.15	0.66
Sleep – F3	−0.46	0.24	−1.02	.05	0.63
Sleep – F4	−0.89	0.26	−3.36	.0007	0.41
Relaxation behavior – F1	−0.009	0.32	−0.03	.98	1.00
Relaxation behavior – F2	0.49	0.30	1.63	.10	1.64
Relaxation behavior – F3	0.46	0.24	−1.92	.05	2.50
Relaxation behavior – F4	0.09	0.48	0.18	.86	1.09
Talk about stress – F1	−0.09	0.23	−0.34	.74	0.92
Talk about stress – F2	0.19	0.30	0.65	.5	1.21
Talk about stress – F3	0.04	0.28	0.15	.8	1.04
Talk about stress – F4	0.47	0.44	1.06	.29	1.60
Organized supports – F1	0.30	0.49	0.61	.54	1.35
Organized supports – F2	0.38	1.19	0.32	.70	1.47
Organized supports – F3	−0.34	0.76	−0.44	.66	0.72
Organized supports – F4	−1.06	1.32	−0.90	.42	0.35
Discuss w/ colleagues – F1	0.04	0.21	0.21	.83	1.05
Discuss w/ colleagues – F2	−0.31	0.25	−1.24	.22	0.73
Discuss w/ colleagues – F3	−0.20	0.25	−0.80	.42	0.82
Discuss w/ colleagues – F4	0.92	0.44	2.07	.03	2.51
Discuss w/ fam/fr – F1	−0.05	0.22	−0.22	.83	0.95
Discuss w/ fam/fr – F2	−0.3	0.25	−1.22	.22	0.74
Discuss w/ fam/fr – F3	−0.04	0.26	−0.17	.86	0.96
Discuss w/ fam/fr – F4	−0.12	0.45	−0.26	.80	0.89
β_{10}	−1.09	0.21	−5.08	4×10^{-7}	
β_{20}	0.99	0.21	4.64	3×10^{-6}	
β_{30}	2.34	0.25	9.38	7×10^{-21}	
β_{40}	3.70	0.35	10.31	6×10^{-21}	