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ORIGINAL ARTICLE

Interventions to support the management of work-related stress (WRS) and wellbeing/mental health issues for commercial pilots

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Abstract

Research indicates that sources of work-related stress (WRS) impact on the physical, social, and psychological health of pilots. Furthermore, specific features of the job can increase a pilot's risk in relation to developing a mental health (MH) issue. It is impossible to remove all stress from the work life of pilots. A high stress situation may not necessarily be detrimental to the person, once they have learned to cope with it in a healthy manner. Nonetheless, risk pertaining to WRS need to be effectively managed by a pilot's employer. Therefore, it is important to identify solutions at an airline and pilot self-management level. This paper reports on the findings of human factors research undertaken with commercial pilots pertaining to work-related stress (WRS) and its impact on wellbeing, performance, and safety. The findings of a series of co-design workshops and a follow-up anonymous survey were analysed to identify potential solutions at (1) an airline and (2) pilot self-management level. Potential solutions are framed in relation to six impact scenarios. Furthermore, they are located within the existing regulatory framework, including the latest implementation rules (IR), acceptable means of compliance (ACM), and guidance material (GM) as outlined by the European Union Aviation Safety Agency (EASA 2019). Proposed interventions should promote wellbeing and positive mental health while also addressing suffering and mental ill health. Airline interventions might focus on enhancing existing Safety Management System (SMS) approaches to better manage risks pertaining to WRS, advancing new tools to enable wellbeing briefing, risk assessment, and reporting, and training pilots in relation to MH awareness, risk identifying behaviour, and coping strategies. Furthermore, new role/functions might be introduced to support the implementation and management of WRS/wellbeing/MH safety/risk processes at an airline level. Requirements for new digital tools to support pilot awareness of WRS/wellbeing/MH, self-management of WRS/wellbeing/MH and risk identification both inside and outside the cockpit are also proposed. Some of recommendations arising in this research require changes to the existing rule-making and/or modification to existing AMC and GM.

Keywords Safety · Airline safety management systems · Pilot mental health · Work-related stress (WRS) · Stress management · Wellbeing · Risk assessment · Self-management and performance

Abbreviations

AMC	Acceptable means of compliance
BALPA	British Airline Pilots Association
CAA	Civil aviation authority
CMD	Common mental disorders
CRM	Crew resource management
CBT	Cognitive behavioural therapy
EAAP	European Association of aviation psychologists
EASA	European Union aviation safety agency
ECA	European Cockpit Association
ECT	Electroconvulsive therapy
ESAM	European Society of Aerospace Medicine
EU-OSHA	European Agency for Safety and Health in Work
ESARRs	Eurocontrol Safety Regulatory Requirements (ESARRs)
EU	European Union
FRMS	Fatigue risk management system
GM	Guidance material
IFALPA	International federation of airline pilots associations

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IATA	International air transport association
ICAO	International Civil Aviation Organisation
IR	Implementing rules
MH	Mental health
NICE	National Institute for Health and Clinical Excellence
RM	Risk management
SM-ICG	Safety Management International Collaboration Group ()
SMS	Safety management system
SPI	Safety performance indicators
SRM	Safety risk management
SARPs	Standards and recommended practices
PHQ	Patient health questionnaire
TEM	Threat and error management
UAS	Undesired aircraft states
WCQ	Ways of coping questionnaire
WHO	World Health Organisation
WRS	Work-related stress

1 Introduction

1.1 Introduction to the research problem

Commercial aviation is a 24/7 business. The travelling public expects low-cost tickets and flexible flight schedules. This puts pressure on the operation (including flight scheduling and crew rostering) and has an impact for pilots. Pilots work anti-social hours and their working schedules are continuously changing. This can make it difficult to maintain regular 'healthy lifestyle' routines and access support and treatment.

Research indicates that sources of work-related stress (WRS) affect the physical, social, and psychological health of pilots. Recent studies demonstrate that pilots are suffering with the same wellbeing issues as the general population (particularly those relating to mental health), and possibly to a larger extent (Pasha and Stokes 2018; Wu et al. 2016). Overall, these studies have attempted to measure the prevalence of wellbeing issues (including mental health issues) and to understand the factors that contribute to this. However, these studies fall short in terms of providing a rich picture of the lived experience of pilots, and the complex relationship between individual wellbeing factors as conceptualized in the biopsychosocial approach (Engel 1977). In addition, there has been little emphasis on understanding/identifying the following: (1) the relationship between WRS, pilot wellbeing, and safety, (2) how pilots adapt to WRS and associated coping/self-management techniques, (3) the role of other stakeholders (including airlines and the aviation authorities) in terms of supporting pilots and managing this problem, and (4) potential solutions at different levels.

Employers (i.e., airlines) have a duty to their employees (i.e., pilots). It is expected that they exercise due care by putting in place the necessary protective and preventive measures, to manage risks to health and safety in work. Research pertaining to airline engagement and attitudes to wellbeing indicates that airlines are not adequately addressing wellbeing risks. In a recent European study investigating safety culture with > 7000 pilots, only 17% of participants reported that their organisation cared about their wellbeing, and 21% felt that fatigue was taken seriously within their organisation (Reader et al. 2016).

Self-management of health is a new strategy to managing health conditions including chronic conditions. Individuals actively identify challenges associated with their condition/illness and actively manage these. Overall, the emphasis is on the responsibility of the person, in conjunction with working with health providers. A high level of self-efficacy can help employees to cope more effectively cope with work-related stress. Past research with nurses has demonstrated that higher levels of self-efficacy coupled with social support facilitate healthier lifestyles and healthier coping behaviours for nurses (Jordan et al. 2016). Furthermore, recent research indicates that organisational wellness programmes created to promote healthy living habits have led to improvements in workers' health and job satisfaction and a decrease in worker absenteeism (Goetzel et al. 2014).

Evidently, interventions/solutions are required for pilots and airlines to tackle issues pertaining to WRS and its impact on pilot wellbeing, performance, and safety. Arguably, the issue of understanding and managing Pilot health and wellbeing and identifying solutions/interventions to managing sources of WRS and allied outcomes (i.e., wellbeing, performance, and safety outcomes), can be treated as a wicked problem (Conklin 2005). As with other wicked problems, the conceptualisation of the problem (i.e., sources of WRS and the associated impacts on wellbeing, performance, and safety) influences (1) how the problem is framed and (2) the generation of solutions.

Potential interventions are likely to be multi-component, spanning different socio-technical dimensions (i.e., training, culture, technology, and process design). Such interventions must adapt to local contexts (Conklin 2005). Furthermore, organisational change takes time and is often piece-meal (Morris et al. 2011). In the aviation context, change often follows from the requirement to demonstrate compliance to new rules defined by the aviation authority.

1.2 Paper overview

This paper reports on the findings of two studies addressing WRS and the impact of the job (i.e., lived experience of being a commercial pilot) on pilot wellbeing, and the ensuing impact on pilot performance and flight safety. As

this research addresses sources of WRS and their impact on pilot wellbeing, performance, and flight safety, the negative impact of the job is considered. Furthermore, the paper presents some preliminary requirements for interventions to support the management of WRS and associated risks at an airline level and pilot self-management level. The requirements are predicated on an analysis of the literature and field research with pilots. Specifically, the requirements are framed in relation to the existing regulatory framework (European Agency for Safety and Health in Work 2019), and the six impact scenarios which emerged in this research.

First, a background to this research is provided. Both workshop and online survey methodologies are presented. The findings of both the workshops and the online survey are outlined, including findings pertaining to WRS, the impact of WRS on pilot wellbeing, the ensuing impact on pilot performance and flight safety, and pilot coping strategies. Potential solutions at an airline and pilot self-management level are then proposed. The research findings are discussed and some preliminary conclusions drawn.

2 Background to problem

2.1 Wellbeing and mental health

The term "wellbeing" includes various aspects of the way people feel about their lives, including their jobs and their relationships with the people around them. Medical, psychological factors, and family and social factors (including working conditions) are some of the determinants affecting a person's health and wellbeing (Engel 1977). None of these factors in isolation will definitively lead to wellness or illness. Rather, the interrelationships between all three pillars lead to a given outcome.

The World Health Organisation (WHO) defines mental health as 'a state of wellbeing 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'(2018). A mental health illness generally means the presence a diagnosed psychiatric condition using an accepted diagnostic manual (WHO 2005). Mental ill health includes a spectrum of disorders, some of which can be debilitating and impact on a person's daily functioning (including their ability to work). The experience of distress and disability is closely associated with the definition of a mental disorder (Telles-Correia et al. 2018).

The concept of mental wellbeing is linked to that of mental health. Mental wellbeing is defined 'as a dynamic state in which the individual is able to develop their potential, work productively and creatively, build strong and positive relationships with others, and contribute to their community. It is enhanced when an individual is able to fulfil their personal and social goals and achieve a sense of purpose in society' (Foresight Programme 2008). Critically, certain MH illness such as anxiety and depression can have a negative impact on mental wellbeing.

'Mental wellbeing at work' is determined by the interaction between the working environment, the nature of the work, and the individual (NICE 2009). Work can have negative effects on mental health, particularly in the form of stress.

In relation to the management of mental wellbeing and common mental health problems, the National Institute for Health and Clinical Excellence (NICE) recommends a range of psychological therapies (referred to as the Stepped Care Model) to treat people with depression and anxiety disorders (NICE 2011). As depicted in Fig. 1, Stepped Care is a five-step system of delivering and monitoring treatments. The

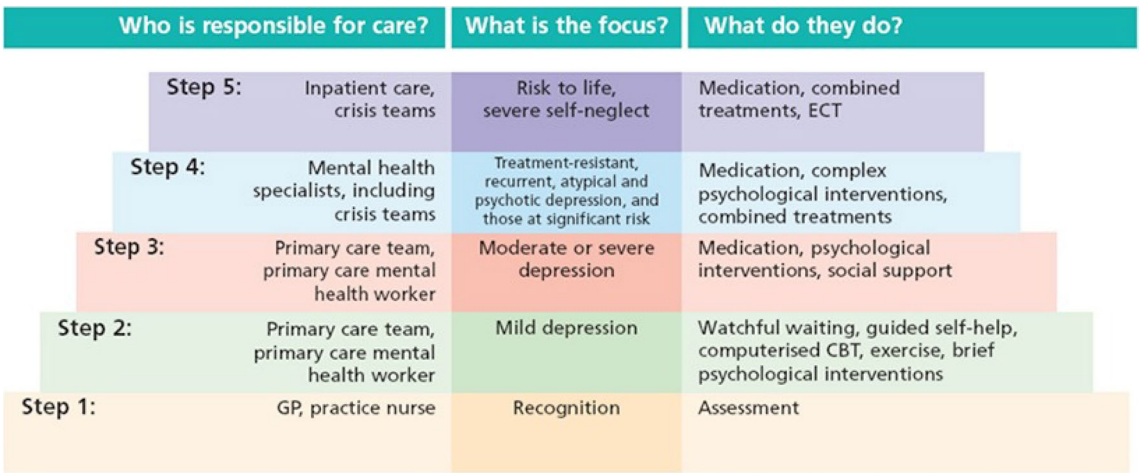

Fig. 1 Stepped care model (Source: https://wellbeinginfo.org/self-help/mental-health/stepped-care/)

patient is first provided with the most effective and least resource intensive treatment. Treatments are 'stepped up' or 'stepped down' as clinically required. Interventions can include one or a mix of the following: assessment, psychosocial education and guided self-help, social support, medication, Cognitive Behavioural Therapy (CBT), and Electroconvulsive Therapy (ECT).

2.2 Stress and work-related stress

Stress is any experience or sensation that creates physiological, psychological, and behavioural imbalances within a person (Flinchbaugh et al. 2015; Houtman and Jettinghoff 2007; Lazarus 1990). Stress is not a medical condition. However, 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 (NICE 2019). Self-assessment scales are used to promote awareness in relation to stress, to determine the degree and type of stress that is being experienced, and to assess how well stress coping skills are working. These include the Perceived Stress Scale (Cohen et al. 1983) and the Ardell Wellness Stress Test (Ardell 1977).

Work-Related Stress (WRS) is defined as 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). Things outside the workplace, like family problems, or debt can be responsible for stress (personal stressors). A person experiencing stressful life events may find that he/she is less able to cope with the demands of work, even though work is not the cause and/or may not have been a problem before.

Workplace stress is becoming more prevalent across different occupations, including those working in 'high stress occupations' such as nurses, paramedics, teachers, and firefighters. Around half of European workers consider stress to be common in their workplace, and it contributes to around half of all lost working days (European Agency for Safety and Health in Work 2019). Like many other issues surrounding mental health, stress is often misunderstood or stigmatised (European Agency for Safety and Health in Work 2019).

Critically, individuals vary in relation to their ability to cope successfully with stress, including WRS. Stress coping is an important psychological construct which moderates/mediates the relationship between stressors and behavioural outcomes such as flying performance (Joseph 2016). Humans use either adaptive or maladaptive strategies to cope with stress. The substitution of maladaptive coping with more adaptive coping is an important component of therapeutic interventions and prognoses.

Monat and Lazarus (1991) define stress management as a general treatment approach, such as good nutrition and exercise, to a wide variety of adaptations and health problems. Common stress coping strategies include exercise, the practice or relaxation techniques (i.e., deep breathing, yoga, and meditation), and seeking social support and/or social participation/engagement. The practice of healthy behaviours strengthens the person's resistance to stress (Morimoto and Shimada 2015). As such, stress management and the practice of healthy behaviours underpins wellness and a healthy lifestyle. Several instruments are used to assessing coping ability. These include the Ways of Coping Questionnaire (WCQ) (Folkman and Lazarus 1988), the COPE Inventory (Carver et al. 1989) and the Stress Coping Resources Inventory (Matheny et al. 1993).

2.3 Pilot job, types of operations, and lived experience

Pilots are both "shift-workers" and "remote-workers". However, in many ways, pilots represent a unique occupational group. Pilots are not subjected to the provisions of the European Time Working Directive (EU 2003). Working hours in a typical week can vary greatly from week to week and are regulated in accordance with several parameters, such as Duty Time and Block Time, as defined by the EASA (2019) and others (for example, Civil Aviation Authority (CAA) in the United Kingdom 2014). The overall intensity of the operation can also vary greatly, typically with busier summers and quieter periods during the winter.

The working routines of pilots vary according to the type of operations which they fly. Three types of operations can be distinguished—namely short, medium, and long ranges. These different types of options pose diverse wellbeing challenges. For example, pilots working long range are more likely to spend periods of time away from home—affecting the home/work interface and their ability to maintain social routines. Pilots operating short range tend to experience intense working days—potentially, involving three to four take-offs and landings. This type of operation, despite accruing relatively low Block Hours, involves high workload. In medium and long range, the Block Hours may be higher, with longer periods of rest/down time while on duty (i.e., cruise periods), and typically longer duty periods.

Pilots experience much disruption to their sleeping and eating patterns. Specific patterns may also vary according to the operations flown. For example, if flying short range, duty might involve a week of 'earlies' (i.e. starting at 5 am), followed by a week of 'lates' (finishing at 2 am), resulting in disruption of the circadian rhythm associated with sleeping and eating patterns. As reported by Wright et al. (2005), mental fatigue and sleepiness may rise to unacceptably high levels given relatively long duty periods that may coincide

with disruption of the circadian rhythm due to time zone shifts.

2.4 Pilot WRS

Pilots experience many physiological, psychological, and environmental stressors. Explorative interviews with pilots ($n = 103$) investigated the lived experience of pilots (Cahill et al. 2016). This research indicates that different sources of WRS affect the physical, social, and psychological health of pilots (Cahill et al. 2016). These include fatigue, working irregular hours, low levels of autonomy at work, and working in a confined space (Cahill et al. 2016). As reported by Hansen (2015), the top three sources of WRS for pilots include fatigue, working hours, and jet lag. Certain sleep/fatigue factors can be associated with specific dimensions of the job, including irregular sleep schedules, long duty days, night flying, and multiple time zone changes.

2.5 Pilot mental health

In a survey commissioned by the British Airline Pilots Association (BALPA), Steptoe and Bostock (2011) found an increased incidence of, and a positive correlation between, reported symptoms of anxiety and depression and fatigue, and work patterns amongst a sample of commercial pilots. Similarly, 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 systematic review of aircraft related suicide in the United States indicates that pilot suicides account for less than 1% of aircraft fatalities (Lewis et al. 2014). Following the Germanwings 9525 accident (2015), the issue of pilot suicide and detecting/managing mental health issues amongst pilots has been gaining increased attention. 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.

In a recent large-scale survey of airline pilots, 12.6% of respondents met the threshold for experiencing depression in the last fortnight (Wu et al. 2016). Similarly, 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 and Stokes 2018). As reported by Pasha and Stokes (2018), pilots experience several occupational stressors such as disrupted circadian rhythms and fatigue, which are recognised as being associated with the development of mood disorders.

2.6 Safety performance/measurement and lagging and leading safety indicators

The International Civil Aviation Organisation (ICAO) defines safety performance as 'a service provider's safety achievement as defined by its safety performance targets and safety performance indicators' (2013). A safety performance indicator is 'a data-based safety parameter used for monitoring and assessing performance' (ICAO 2013a, b). A safety performance target is 'the planned or intended objective for safety performance indicator(s) over a given period' (ICAO 2013a, b).

To measure safety, airlines need to measure (1) the results of their safety interventions as well as (2) whether they are being effective in terms of preventing incidents and accidents. Two common classifications for safety performance indicators (SPIs) are commonly used (Safety Management International Collaboration Group—SM-IMG 2013). These are lagging and leading indicators. Lagging indicators are measures of safety occurrences, in particular the negative outcomes that the organisation is aiming to prevent (Skybary 2019a). They measure the results of safety interventions (i.e., number of incident and accidents). A leading indicator is a measure preceding or indicating a future event used to drive and measure activities carried out to prevent and control injury—such as safety training and safety audits (Skybary 2019b). As such, leading indicators assess risk factors present in the workplace that will contribute to future incidents or accidents. This includes things that have the potential to become or contribute to a negative outcome in the future ('negative' indicators), and things that contribute to safety ('positive' indicators) (Skybary 2019c; SM-ICG 2013)).

2.7 Risk management and safety-II

Three risk management (RM) approaches are defined. Reactive RM approaches address the risks identified in an accident or incident after it has occurred. Proactive RM involves taking action before an accident happens. This typically requires the utilization of data to identify risks from past accidents or incidents. Predictive RM approaches take action based on potential risk as determined from normal operational data (i.e., not accident data) to reduce the risk of an accident that has not yet happened.

Safety (Safety-I) has traditionally focussed on the avoidance of bad events. That is, a reactive approach responding to what is going wrong and/or identified risks. Safety-II is a novel and complementary approach to Safety-I, highlighting the importance of utilizing both proactive and predictive approaches (Hollnagel 2014; Hollnagel et al. 2015). In addition, Safety-II emphasizes the importance of learning from normal operations, including when things go well. As stated by Hollnagel 'focusing on what goes right, rather than

on what goes wrong, changes the definition of safety from 'avoiding that something goes wrong' to 'ensuring that everything goes right' (2014). Importantly, 'Safety-II' is underpinned by open communication (briefings and debriefing), routine reporting and a just culture (Hollnagel 2014; Hollnagel et al. 2015).

2.8 European directives: workplace stress and risk assessment

The European Commission (EU) has introduced measures to ensure the safety and health of workers. The 1989 Council Directive (89/391) makes employers responsible for making sure that employees are not harmed by work, including through the effects of WRS (European Agency for Safety and Health in Work 2019). The Safety, Health and Welfare at Work Act (2005) requires employers to put in place systems of work which protect employees from hazards which could lead to mental or physical ill health. Risk assessment for stress involves the same basic principles and processes as for other workplace hazards. Risk pertaining to WRS must be addressed and managed using a risk assessment process, involving participation and consultation, and the application of the principles of prevention (European Agency for Safety and Health in Work 2019). The hazards must be identified, the risks assessed, and control measures identified, implemented, and evaluated. Furthermore, the European Pact for Mental Health and Well-being recognises the changing demands and increasing pressures in the workplace and encourages employers to implement additional, voluntary measures to promote mental wellbeing (European Pact for Mental Health and Well-being 2008).

3 Current interventions and pilot coping strategies

3.1 Aviation authorities and management of health and wellbeing

As recommended by ICAO in 'Annex 19; Safety Management' (2013), and mandated by the EASA (2019), airline Safety Management Systems (SMS) are designed to measure and manage safety risks. The objective of an SMS is to provide a structured management approach to control safety risks in operations (Skybrary 2019a, b, c, d).

In principle, an SMS addresses all risks. According to ICAO Doc 9859 (2013), an SMS may include both proactive and reactive methods and techniques (for example, occurrence reporting and investigation). As stated by European Agency for Safety and Health in Work (2019), their SMS rules 'are designed to embed the ICAO Annex 19 in a way as to ensure SMS compatibility with the existing management systems and to encourage an integrated management system'. The term 'Safety-II' is not used in ICAO's recommendations (2013). However, ICAO's 'Global Aviation Safety Plan' (2019a, b) refers to the future implementation of predictive risk management practices by 2027.

As defined by ICAO, an SMS includes four parts: (1) safety policy, (2) safety risk management, (3) safety promotion, and (4) quality assurance (2013). A safety risk management (SRM) is a formal process within the SMS composed of describing the system, identifying the hazards, assessing the risk, analysing the risk, and controlling the risk (ICAO 2013a, b). As indicated in Fig. 2, specific risks associated with hazards to flight conditions are systematically and formally defined, along with corresponding safety performance indicators and acceptable thresholds. Counter-measures/protections are identified, monitored, and assessed to ensure that that risks are adequately managed (and safety maintained).

Crew Resource Management (CRM) training is considered a key component of an airline's SMS (i.e., safety promotion). The aviation authorities mandate CRM/human factors training for pilots, which includes information about the practice of 'safety behaviours' and associated CRM theories (European Agency for Safety and Health in Work 2019). EASA have provided extensive guidance for CRM training. For example, EASA's document 'Crew Resource Management in Practice' (2017b). In addition, EASA have defined the Air Ops requirements for CRM Trainers (EASA 2012).

CRM training is informed by both CRM theory and 'Threat and error management' (TEM) theory. CRM theory 'focuses on the effective utilization of all resources including crew members, aircraft systems, supporting facilities,

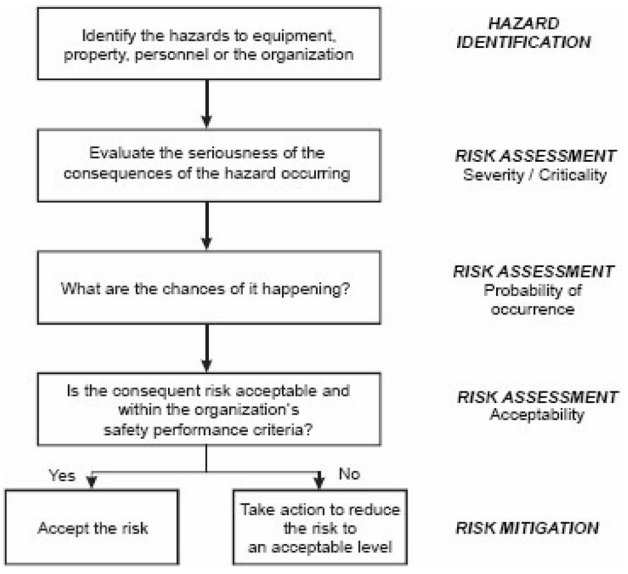

Fig. 2 Risk management process (ICAO Doc 9859—safety management manual)

and persons to achieve safe and efficient operations' (EASA 2017c). TEM theory is a subset of CRM theory which addressees the practice of thinking ahead to prevent and mitigate errors and operational threats, and manage Undesired Aircraft States (UAS), which can result from these (Helmreich et al. 1999; Cahill 2010). A cornerstone of TEM 'is the acceptance that threats and errors will occur and that they have to be identified and managed' (EASA 2017a). CRM training largely relates to certain bio-medical aspects of health (for example, the management of fatigue), the use of substances (for example, avoidance of alcohol and drugs), and certain socio-cognitive dimensions of performance (for example, crew teamwork and communication and compliance with procedures). In many ways, safety behaviour is conceived from an operational perspective (short term—while on duty) and not in relation to maintaining a healthy lifestyle (including work/life balance)—which has implications in relation to performance and safety. CRM training is discussed and evaluated in more detail below.

Pilot health and fitness (including mental health) is assessed annually in accordance with mandatory rules regarding aeromedical assessment (Bor et al. 2017). There are very clear guidelines concerning the impact of a psychiatric disorder on pilots (Dickens 2016). All regulatory bodies distinguish between conditions that mean mandatory exclusion from flying and those that allow a pilot to fly under controlled conditions (Dickens 2016).

EASA has recently introduced new rules on pilot mental fitness, following the Germanwings tragedy in 2015 (European Agency for Safety and Health in Work 2019). These rules pertain to 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 will be required to demonstrate compliance with these rules by 2021.

In relation to psychological assessment, EASA's current focus is MH issues. Current AMC and GM does not focus on the promotion of wellbeing more generally and specifically, the promotion of positive MH. Furthermore, the focus of assessment is at the recruitment and training stage. Crucially, a pilot's wellbeing and mental state may change over time. Accordingly, such an assessment would need to provide an insight into potential future wellbeing and MH risk. EASA has also recommended that any proposed assessment 'should not be considered or conducted as a clinical psychological evaluation' (European Agency for Safety and Health in Work 2019). This raises questions about the potential for bias in the assessment processes (i.e., not using clinically validated and/or standardised assessment instruments). Evidently, Pilots would need to understand and trust the assessor and the assessment process. Furthermore, to be effective, the evaluation would need to be of benefit to pilots (and not just their employers). Potentially, a self-management assessment model, which includes the assessment of wellbeing along with common mental health disorders (i.e., anxiety and depression), might complement such an approach.

3.2 Airline interventions (wellbeing and MH)

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. Licences and flying privileges can be suspended if serious health problems (including MH issues) are detected. Given that their licence is at stake, pilots are likely to under report MH issues. Furthermore, pilots are not likely to approach aeromedical examiners for help.

Currently, sources of WRS and wellbeing factors (spanning the three pillars of wellbeing) are not properly defined within existing airline safety management systems. As such, it is difficult to assess whether a particular safety event (for example, over-speed in landing) follows from an error linked to a wellbeing problem (which, in turn, can be attributed to a source of WRS), or a training deficit. Furthermore, there is no risk assessment in relation to WRS and wellbeing issues.

Presently, the primary focus of airline wellbeing interventions is in relation to the management of crew fatigue and alertness. The 'Fatigue Management Guide for Airline Operators' specified by the International Air Transport Association (IATA), the International Civil Aviation Organisation (ICAO), and the International Federation of Airline Pilots Associations (IFALPA) (2015) describe a science-based and operationally oriented fatigue management processes. Fatigue Risk Management Systems (FRMS) have been advanced by a number of airlines including EasyJet and Singapore Airlines (Skybrary 2019a, b, c, d). Typically, airline FRMS provide outputs to crew pairing/rostering and flight scheduling systems to ensure that risks pertaining to fatigue are managed from an operational perspective.

Operational reporting is a key component of any SMS (Cahill 2010). Currently, specific wellbeing/WRS reporting systems are not used at an airline level. However, nothing prevents pilots from reporting wellbeing/WRS issues using the existing SMS reporting system (i.e., voluntary and mandatory safety reporting tools). Anecdotally, it is known that pilots do not report wellbeing issues (including MH), using existing safety reporting systems. In terms of organisational structure, pilots can report issues to their head of flight operations and/or chief pilot. However, this is rarely done.

Airline CRM training addresses the socio-cognitive dimensions of task performance (for example, teamwork, briefing, and decision-making) and crew management of threats, to avoid errors and/or unacceptable aircraft states as outlined in the TEM model (Helmreich al. 1999). Typically, airlines classify threats in relation to high-level taxonomies

such as crew, aircraft, and the environment (Cahill 2010; Cahill et al. 2011). As highlighted by Cahill et al. (2011, 2013), the crew state is conceived in relation to fatigue, situation awareness, and crew competency (i.e., training level and flight experience). Critically, the TEM model does not comprehensively address the crew state as conceived from a biopsychosocial perspective.

As part of CRM training, safety behaviours such as the performance of crew briefings and checklists at different flight phases (as mandated by EASA) are introduced. The impact of fatigue on alertness is also addressed. Stress management is also part of the CRM syllabus as defined by EASA (2017a, 2019). As such, airlines must include general stress management training as part of their CRM syllabus. Specific stress management modules have been successfully implemented and positive outcomes realized (Moriarty 2015). However, the guidance material does not explicitly mention WRS, techniques for managing WRS/wellbeing issues, and stress coping behaviours while on and off duty. This includes issues related to the biological pillar (i.e., food and exercise), the psychological pillar (i.e., mood/emotional states and MH awareness), and the social pillar (i.e., including both crew relations and the crew member's broader social relationships). As reported by Joseph (2016), coping strategies relate to crew interaction styles and are of relevance to CRM. Specifically, coping is linked to how social and cognitive challenges in the aviation environment are handled and pertain to situational awareness and decision-making (Fornette et al. 2012). It should be noted that EASA's document 'Crew Resource Management in Practice' (2017c) refers to concepts of 'resilience' and the recent 'resilience training' implemented by Luzair (EASA 2017a). However, there is no actual guidance pertaining to the implementation of such resilience and stress coping training. Evidently, there is nothing preventing airlines from elaborating on EASA's guidance material.

Following from CRM and 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 (linking to TEM constructs) 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). Such issues are understood by pilots to have a bearing on safety and should be raised in crew briefings (Cahil 2010; Cahill et al. 2011, 2013). It could be argued that WRS is already addressed as part of pre-flight briefings. That is, it is formalised in the duty/responsibility of pilots to refuse to fly when he or she feels unfit to fly. Anecdotally, it is known that often fail to 'call in sick' given operational pressures. Furthermore, stigma in relation to MH can impact on a pilot's willingness to declare themselves as suffering. In this regard, new electronic checklist/briefing solutions predicated on CRM/TEM concepts have been advanced to enhance crew briefings at the pre-flight stage (Cahill 2010; Cahill et al. 2011). Potentially, these tools might be extended to include briefing around WRS and wellbeing, and specifically risk assessment pertaining to WRS and its impact on wellbeing, performance, and safety.

Ideally, a good crew composition mitigates the effects of individual crew state weaknesses (for example, fatigue and experience, etc.). Specific airline crew pairing and rostering systems vary in sophistication. Advanced systems consider crew factors such as fatigue (i.e., taking data from airline Fatigue Risk Management Systems), operational experience (i.e., routes flown), training/competency, and reported crew inter-personal problems.

Many airlines provide crews with their roster information (for example, a PDF file of their duty schedule). This can be used by pilots to support self-management of sleep/fatigue (i.e., to anticipate busy times/fatigue and take rest). In an attempt to enable pilots to better manage the home/work interface, some airlines have developed bidding systems, which allows pilots to select specific days off (i.e., leave for family events and holidays).

In addition, some airlines provide psychological support using a peer-support service (Atherton 2019). As reported by Atherton (2019), peer-support services have been operated by American Airlines, British Airways, Lufthansa, KLM, and Qantas for many years. Peer-support programmes can take many forms (Gibbs 2016). However, all require certain fundamental features such as confidentiality and mutual respect (Dickens 2016). Specifically, the peer employee assistance programme implemented by Delta (2015) has been positively received by the Aerospace Medical Association Working Group on Pilot Mental Health (2016).

3.3 Pilot coping strategies and wellbeing/MH interventions

Currently, pilots adopt their own coping mechanisms, relying on themselves as opposed to their employers. As reported by Sloan and Cooper (1986), overall mental ill health amongst pilots has a very close association with lack of autonomy at work, fatigue, the inability to relax, and insufficient social support. Bennett (2006) highlights the importance of social support obtained from fellow pilots, reporting that team members' mutual support, camaraderie, and cohesion enhance their resilience to internal pressures (for example, busy rosters), and external pressures (for example, adverse weather, technical faults, delays, and unruly passengers). Evidence also suggests that support from family/spouse is of use (Karlins et al. 1989). A recent study by Avis et al. (2019) indicates that partner support was key in managing the demands of shift work. Pilots suffering marital distress

are less able to concentrate effectively on their piloting duties and responsibilities (Raschmann et al. 1991). On the other hand, anti-social work practices have the potential to undermine the positive social support provided by romantic/spousal relationships.

In the military sphere, interventions include critical incident stress debriefing, stress inoculation training, and stress management techniques Joseph (2016). Furthermore, cognitive behaviour therapy has been applied in the management of fear of flying (Dobie and May 1994).

3.4 Pilot advisory groups

Many pilot unions have Pilot advisory groups (PAG). These provide a confidential service that pilots can use to talk about problems and obtain support. However, there is no published evidence as to the effectiveness of such groups.

4 Opportunities: new tools/technologies

4.1 Health apps

Smartphone ownership continues to increase and there has been considerable growth in relation to the development of mHealth Apps and Mhapps for the general population. Currently, the app markets provide people with an ever-increasing number of applications, about 40,000 of which are related to healthcare, namely "health and fitness" apps or mHealth Apps (Boulos et al. 2014). Furthermore, smartphone apps for mental health (Mhapps) represent a compelling new delivery mode for self-guided psychological interventions in prevention and stepped care (Bakker et al. 2016). Self-guided interventions are part of a stepped care approach, which prioritises "high intensity" psychological interventions (e.g., psychotherapy and psychoactive medications) for those with the greatest distress and clinical need, and "low intensity interventions" for those who may not require one-on-one clinician support (van Straten et al. 2015).

4.2 Self-management for pilots

As part of a joint safety initiative, Boeing and Jeppesen have advanced a new digital tool supporting pilot management of alertness and fatigue (Jeppesen 2018). Built on the Boeing Alertness Model (Ingre et al. 2014), 'CrewAlert' is the first iOS application designed specifically to help airlines and their crews manage alertness and fatigue (Jeppesen 2018). The app provides risk assessment information to pilots in relation to current and future fatigue and alertness levels. As part of this, the pilot reports on their own sleep and the app deduces expected alertness levels over time. This information can be used by the pilot in relation to their own coping strategies/self-management of fatigue/sleep, so that predicted fatigue/alertness risks are appropriately managed. Pilots can use the tool (1) as part of an integrated approach (i.e., sharing of data between pilot and airline) and/or (2) independent of their airline. If the airline has procured the tool, the pilot's roster is automatically prepopulated. If not, the pilot can manually add this information (i.e., synch from a PDF file). The pilot can select to share anonymous information about their sleep and fatigue/alertness levels—so that the airline can have a real picture of crew fatigue and potential operational/safety impact. In principle, this information informs flight planning and crew rostering activities. However, there is little information available about the airline process for this and the associated wellbeing and operational/safety impacts. Furthermore, the main focus of 'CrewAlert' is on the management of pilot fatigue and alertness (i.e., factors associated with the biological pillar of wellbeing). Pilot wellbeing spans the three pillars of wellbeing—that is, their physical, psychological, and social health. Critically, there is a relationship both (1) between different factors within each of these pillars and (2) across these pillars. Potentially, this tool might be extended to include data collection, monitoring, and risk assessment in relation to the three pillars of wellbeing and the complex relationship between different wellbeing factors. Such developments might link to broader health and wellness interventions (including pilot mental wellbeing) at both a (1) pilot self-management level and (2) an airline level.

4.3 Machine learning and artificial intelligence

Airlines are now making use of statistical modelling techniques and new machine learning and artificial intelligence technologies to make predictions about flight safety. Specifically, machine learning techniques have been used to inform risk assessment and prediction in relation to unstable approaches (Baranzini 2018; Baranzini and Zanin 2015). This follows the integration and analysis of operational data (Baranzini 2018; Baranzini and Zanin 2015). Potentially, equivalent approaches might inform risk assessment around crew state/wellbeing and the allied impact on performance/flight safety.

4.4 Organisational tools to enable assessment of mental health and stress coping

Tools such as MindQ™ and MindFull online enable mental wellbeing assessment for organisations wanting to monitor and support their staff's mental health at work (Symbiotics 2019). These tools provide organisations and employees with insights relating to the employees existing mental health and their risk for developing a mental health condition.

Critically, these tools are designed for use at the recruitment and selection stage and to support ongoing monitoring of employee mental health. These tools have been adapted to the aviation context. However, little information is available about specific implementation strategies and barriers at an airline level. In principle, these tools might form part of a confidential employee assistance programme (EAP). However, this requires much trust and commitment on behalf of the employee. Given that a pilot's licence depends on the assessment of MH, pilots may not be willing to volunteer this information. Potentially, such tools might be adapted from a pilot self-management perspective.

5 Research methodology

5.1 Overview and research design

Two sequential phases of field research were undertaken with commercial pilots. This research built on prior exploratory interviews with pilots ($N=103$), investigating the lived experience of pilots and associated sources of WRS (Cullen et al. 2017).

Three workshops were undertaken with 33 commercial pilots (workshop 1: $N=12$, workshop 2: $N=10$, workshop 3: $N=11$). The workshop methodology integrated participatory evaluation (Bødker and Burr 2002) and stakeholder evaluation approaches (Cousins et al. 2013). The workshops were undertaken between March and May 2018.

This was followed by a cross-sectional descriptive study. An anonymous web-based survey was completed by commercial pilots between November 2018 and February 2019. Participants were invited to participate in a web-based online survey which examines the effects of work-related stress (WRS) on pilot wellbeing, and the associated impact on both pilot performance and flight safety. The survey also investigated pilot coping methods, and pilot perception of the airline role in relation to managing WRS and wellbeing issues.

The survey incorporated several standardised 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 (OLBI 8) (Demerouti et al. 2003), and the Oldenburg Burnout (Modified Instrument) (Demerouti et al. 2018). Furthermore, the survey design draws upon prior research undertaken by the authors pertaining to a biopsychosocial model of 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 (Cullen et al. 2017, 2018a, b, c).

In relation to the workshops, the pilots were recruited through network and word of mouth. In the case of the survey, pilots were recruited using social media platforms such as LinkedIn and Twitter. In both cases, ethics approval was granted by the School of Psychology, Trinity College Dublin (TCD).

5.2 Pilot workshops

Specifically, the workshops had three objectives:

- To validate prior research relating to the impact of the job/WRS on pilot wellbeing.
- To map the relationship between WRS, pilot wellbeing, pilot performance, and flight safety.
- To validate preliminary workshop findings related to the relationship between WRS, pilot wellbeing, pilot performance, and flight safety.

Participants were provided with a short presentation pertaining to the biopsychosocial model of pilot lived experience, the preliminary safety case, and associated worked examples. In workshop 1, participants were invited to review both the model, the safety case, and associated worked examples. This was followed by a group discussion concerning the relationship between WRS, pilot wellbeing, pilot performance, and flight safety. In workshop 2 and 3, the findings of workshop 1 were presented to participants. This included six scenarios pertaining to the impact of WRS on wellbeing, performance, and flight safety. Participants were invited to review/validate the six scenarios. Following this, there was a general discussion about the relationship between WRS, pilot wellbeing, pilot performance, and flight safety. All participants were invited to complete a homework exercise after the workshop. All participants were debriefed, at the end of each workshop. The debriefing included information about follow-up supports and confidentiality.

5.3 Anonymous survey

Survey objectives include the following: to (1) measure routine suffering amongst pilots, (2) understand pilots experience of WRS/wellbeing issues, (3) understand pilot attitudes to reporting wellbeing issues (including mental health), (4) understand the relationship between work-related stress, pilot wellbeing, pilot performance, and safety, (5) understand how pilots adapt to WRS and wellbeing issues, (6) identify pilot coping/self-management techniques, and (7) examine pilots perceptions regarding the role of their employers/airlines in terms of managing WRS/wellbeing issues.

First, pilots received background information about the study. They complete the electronic consent. Following this, they complete questions for each of the nine sections (part 2

Table 1 Age brackets

< 25	25–35	36–45	46–55	56–65
4.2%	33.5%	27.8%	23.0%	10.0%

to part 10), as indicated above. Following this, there was a debriefing—includes contact information for relevant support groups and Pilot Support Groups.

6 Workshop and survey results

6.1 Summary

Overall, 33 commercial pilots (spanning three airlines) attended the workshops. Workshop participants had on average 9178 h of flying experience and included 20 Captains and 13 First Officers. Of the 33 participants, 7 were female and 26 were male. 8 participants had part time work contracts, while 25 were working full time. In terms of flight operations, this included 4 short range, 7 long range, and 22 mid-range pilots.

325 respondents completed the online survey (62% rate). 70% completed the PHQ. Overall, survey respondents can be described as male (83.9%), full time (91%), married (57.88%), and based in home country (82.33%). Table 1 below provides a summary of respondent ages. Table 2 provides a summary of respondent time working as a commercial pilot.

The integrated findings of two strands of research are outlined in relation to several topics as indicated in Table 3.

6.2 Awareness of wellbeing problems

Workshop participants reported a significant stigma in terms of talking about wellbeing problems (including MH). Furthermore, feedback indicates that pilots often normalise the problems that they are experiencing, and many may not even realize that they have problems (including MH problems). In terms of MH, participants stated that the prevailing culture (i.e., machoism and stigma associated with mental health issues) presents significant challenges. As reported by participants, this contributes to a situation where there is a lack of awareness/openness about MH issues. As such, MH issues are not being identified and addressed.

These findings were validated in the survey. Over 80% of participants agreed that there are low levels of speaking out and/or reporting mental health among Pilots (46.46% of participants strongly agreed, while 38.89% agreed). The majority of participants indicated that they would talk to a partner/spouse (78.89%) about an MH issue, closely followed by a friend (56.28%). Only 24.6% indicated that they would talk to a close-friend colleague. 14.07% indicated that they would speak to a peer-support group. A very small number (2.51%) indicated that they would speak with their line manager.

6.3 Prevalence of wellbeing and MH problems

All workshop participants reported wellbeing problems spanning physical and social pillars. Participants disclosed that they periodically experience stress and WRS. Workshop participants did not report specific MH problems, but noted that others were experiencing MH difficulties.

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
8.5%	12.6%	17.1%	15.7%	14.7%	7.2%	12.0%	12.3%

Table 3 Research themes and findings

#	Theme/topic	Workshops	Survey
1	Awareness of wellbeing problems (including MH) and talking about wellbeing problems	X-detail	X-detail
2	Prevalence of wellbeing problems (including MH)	X	X-detail
3	Reporting MH problems in work	X	X-detail
4	Experience of WRS and ability to cope	X	X-detail
5	Sources of WRS	X-detail	X-detail
6	WRS and impact on wellbeing, performance, and safety	X-detail	X-detail
7	Pilot coping mechanisms	x	X-detail
8	Engagement	x	X-detail
9	Airline role in relation to management of wellbeing problems	x	X
10	Perception of current airline role/activity in relation to management of wellbeing problems	X-detail	X-detail

Just under half of the survey, respondents (48.7%) reported that they had spoken to somebody about an MH issue which they were experiencing or had experienced. 42.5% of respondents indicated that they have a close-friend pilot colleagues who has experienced MH issues. 12.8% of participants meet the threshold for Clinical Depression. 7.9%, had suicidal thoughts in the previous 2 weeks.

6.4 Reporting MH issues in work

Overall, workshop participants indicated a considerable level of stigma in relation to reporting mental health issues at work. In terms of MH, it was agreed that pilots may be reluctant to stand down or disclose mental health problems, given real concerns over the potential impact of this on their job (i.e., fears of losing their licence and/or possible impact on future career progression).

Survey feedback is consistent with these findings. 77.6% indicated that if they had a mental health issue, they would not disclose it to their employer. Only 8.08% had reported "unfit for flight" due to a mental health issue. 16.67% indicated that they previously reported "unfit for flight" due to a mental health issue, but provided a different reason. 56.92% reported that if they were "unfit for flight" due to a mental health issue, they would provide a different reason. When asked about their reasons for this, the vast majority of respondents (71.69%) indicated 'fear of loss of licence and loss of long-term earnings'. Other reasons included 'fear of stigmatisation by employer' (57.83%) and 'potential negative impact on career progression' (54.22%). On a more positive note, over 75% agreed that they would look for help (with 45.45% agreeing and 29.8% strongly agreeing). Nearly 97% of participants agreed with the statement 'Promoting mental health awareness (recognising problems in one's self or others) is important from a safety perspective' (70.56% strongly agreed and 26.9% agreed).

6.5 Experience of WRS and ability to cope

Workshop feedback indicates that individual differences in relation to pilot coping ability must be considered. As reported by participants, Pilots are coping all the time. As stated by one participant, 'pilots are managing stress, adapting to the job and its challenges, and not having safety events/accidents'. As stated by participants, 'some pilots cope better than others'. Specifically, 'they have developed strategies to cope with the challenges they face'. It was noted that the general estimation amongst pilots is that '70% cope well, while 30% find adapting more difficult'. However, participants agreed that 'pilots show up to work and tick all the boxes'. Furthermore, 'things don't give until the very end'. As observed by participants, the fact that pilots are coping, presents its own risk. Critically, this masks the suffering that is experienced by pilots, and gives the impression that safety risks are being managed.

Nearly 50% of participants (48.9%) indicated that they find the job stressful 'now and again', while 24.44% indicated that the job is 'frequently stressful'. Pilots were asked to rate their ability to cope with WRS. The majority (over 83%) agreed that they tolerate the pressures of their work very well (68.57% agreed, while 14.76 strongly agreed). However, over 75% of participants agreed that they feel worn out and weary after work (50.95% agreed, while 24.29% strongly agreed). Survey data suggest that Pilots are adapting and coping. Over half of respondents agreed to the statement 'Pilots are suffering, but they are also adapting and coping' (48.1% agreed, while 8.7% strongly agreed).

6.6 Sources of WRS

It was agreed that both work and personal stressors either (1) acting on their own and/or (2) acting together, put pilots in a situation where they are at increased risk of developing an MH issue, and/or worsening a pre-existing MH issue. Participants highlighted the potential impact of personal stressors which can be intensified/made worse by certain features of the job (for example, time away from home and inability to contact family while in work).

Participants provided feedback as to sources of WRS and the potential impact on pilot wellbeing. Participants indicated that the key sources of WRS include the following:

1. Fatigue, potentially leading to burnout.
2. Unnatural workspace (5 miles up in the sky).
3. Sleep disruption.
4. Lack of breaks.
5. Time away from home.
6. Close confines of cockpit.
7. Social isolation.
8. Having different goals and values to management.
9. Lack of management engagement with pilots.
10. Lack of support from flight operations and management.
11. Imposed sedentary nature of job.

Survey data indicate a similar trend. Respondents reported the top 3 most common sources of WRS (indicated in order) as working irregular hours (72.07%), working ant social hours (59.46%), and the divergence of values between management and pilots (54.95%).

6.7 WRS and impact on wellbeing, performance, and safety

Participants indicated that aspects of the job present a potential threat to flight safety, given the ensuring impairments

to task performance In terms of specific impacts on performance, workshop participants highlighted issues around impact on cognition, workload management, teamwork, and communication. Specifically, participants referred to the following:

- Potential reduction in situation awareness.
- Impaired decision-making.
- Inability to focus on the current task.
- Difficulties managing multiple tasks/workload.
- Task omissions.
- Reduction in quality of error identification and management behaviour.
- Poor quality communications with fellow pilot.
- Withdrawal of pilot (not communicating).

Overall, six impact scenarios were identified (see Table 4 below). Of these, participants suggested that the primary focus of wellbeing interventions might be on addressing routine suffering (Scenarios 1 and 2), the prevention of Scenario 3 (i.e., pilot not coping on the day—impacting on flight safety), and Scenario 5 (i.e. pilot suffering which ends in harm to the person).

Survey data substantiate this picture. Overall, the data indicate that sources of WRS have a negative impact on pilot wellbeing. As indicated in Fig. 3, sleep difficulties (79.8%) 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 (73.74%) and then digestive symptoms (55.05%). Other impacts include social isolation (41.92%), marital/family discord (36.87%), respiratory symptoms (33.84%), and psychological distress (31.82%).

Just over 75% of participants agreed to the statement 'My partner/spouse/friends think that my job has a negative impact on my social/family life' (48.13% agreed, while 27.10% strongly agreed). Although psychological distress was ranked the lowest in terms of wellbeing impact, the vast majority of respondents indicated that the environment in which Pilots work can contribute to the onset of or worsen an existing a mental health issue (58.88% participants agreed, while 28.5% strongly agreed).

Survey feedback also indicates that sources of WRS impact on performance and flight safety. Over 78% of participants agreed to the statement that 'certain sources of Work-Related Stress (WRS) have an impact on my performance (58.50% agreed, while 20% strongly agreed). Furthermore, just under 75% of respondents agreed to the statement 'Certain sources of WRS have an impact on my performance and by implication, have the potential to impact on flight safety agree' (52.02% of respondents agreed, while 22.73% strongly agreed). Respondents were invited to identify specific performance impacts in relation to different sources of WRS. 83.33% of respondents reported 'working within the close confines of the cockpit' as the having the strongest impact, specifically, in relation to distraction and inability to focus on current task. Working irregular hours (76.8%) and working long duties (76.53%) were rated as having most impact on decision-making. Nearly 60% of respondents agreed to the statement that they are 'mostly coping well and that periodically, they may make a mistake, but they will identify their own mistake and correct their actions, thus ensuring that a safety event does not occur' (51.24% agreed, with 8.46% strongly agreeing). Equally, nearly 70% of respondents agreed to the statement 'if something were to give on the day, and I were to make a mistake, it is most likely that my fellow pilot would detect this and take a corrective action, thus ensuring that a safety event would not occur' (57.21% agreed, while 11.94 strongly agreed).

6.8 Coping mechanisms

Overall, workshop participants indicated that pilots attempt to self-manage with some using sleep diaries and adopting exercise routines. All participants alluded to the benefits of talking with colleagues and/or friends and family.

In terms of survey data, pilots were asked to select from list of common methods of coping with (1) non-WRS (stress outside work) and (2) WRS (stress inside work). 61.64% reported adopting coping strategies for non-WRS, while 55.30% reported using coping strategies for WRS. In relation to coping strategies for non-WRS, 30.48% reported using positive diet each day. Only 1.23% used relaxation devices/tools on a daily basis. At a weekly level, respondents reported using sleep and fatigue (53.65%), exercise (52.88%) positive diet (48.13%), and relaxation (14.11%). In relation to daily activities to manage WRS, the strongest focus appears to be on sleep and rest (29.28%), diet (26.47%), and exercise (13.61%). In terms of activities performed several times a week, respondents reported exercise (49.74%), positive diet (45.88%), and sleep/rest (45.30%). 22.56% of respondents reported talking with colleagues, while 21.5% reported talking with family and friends. The data analysis indicates that pilots do not use relaxation methods as frequently as others (2.84% every day, 11.35% a few times a week, and 7.80% once a week). In addition, it indicates that pilot use of professional supports is infrequent (1.54% several times a week; 0.77% once a week).

6.9 Engagement

Overall, it seems that pilot engagement is quite low. All workshop participants reported low level of engagement with airline management.

In terms of survey data, just over 20% of participants agreed with the statement 'my employer and I share the

Table 4 Impact scenarios

#	High-level scenario	Work-related stress (WRS)	Wellbeing impact	Impact on pilot performance	Frequency	Safety outcome
1	Pilots mostly coping well	Any pillar—e.g., fatigue and social isolation	Minor impact	Minor—sometimes degraded—small errors and omissions	Frequent	None—pilot self corrects own actions
2	Pilots mostly coping well, but impacts on physical health (e.g., gastrointestinal and musculoskeletal issues)	Mostly biological pillar	Minor impact—suffering in daily life	Minor—sometimes degraded—small errors and omissions	Frequent	None—pilot self corrects own actions
3	Pilots experiencing difficulties but mostly coping—however, something gives on the day—potential for event but fellow pilot acts as a barrier	Complex combination of personal and work factors and operational situation on the day	Significant impact	Loss of attention—Impact on situational awareness, decision-making and teamwork	Infrequent	Near-miss—Potential for incident/accident, if not picked up by other pilot
4	Pilots mostly coping, but long-term impacts	Any pillar—e.g., fatigue and social isolation	Long-term impact on health—develop illness when on annual leave on upon retirement	N/A	N/A	N/A
5	Pilots not coping—impact on wellbeing	Complex combination of personal and work factors	Significant impact—suffering in daily life—stop working—potential for serious MH issues, including self-harm and/or suicide	N/A	N/A	N/A
6	Extreme cases—murder–suicide	Potentially pre-existing MH issue	Major impact	Major impact	Extremely rare	N/A

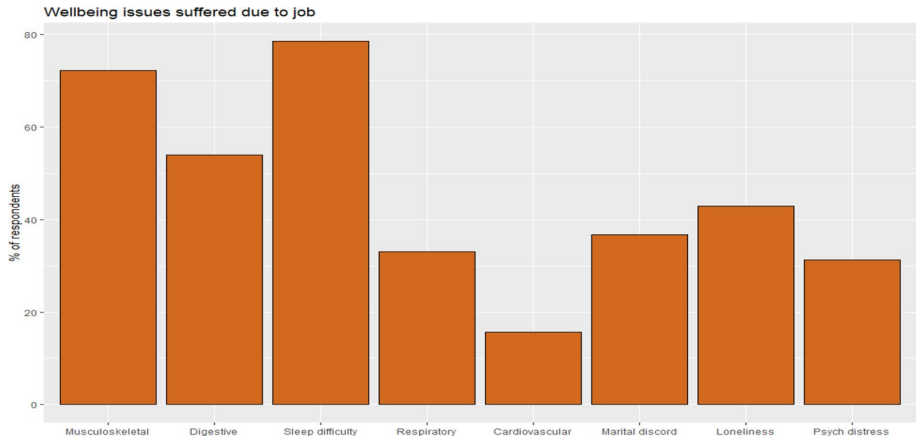

Fig. 3 Wellbeing issues suffered due to the job

same set of values', (19.14% agreed, while 1.91% strongly agreed). Over 76% of participants rated the level of engagement between themselves and their employer as poor (38.10% rated it as very poor, while 38.57% rated it as poor).

6.10 Airline role and current perception of airline management of wellbeing/WRS issues

The workshops did not investigate existing airline approaches in much detail. However, all participants indicated that the airlines should have a role in relation to managing issues pertaining to WRS and the ensuing impact on pilot wellbeing, performance, and safety. Furthermore, all participants noted that existing airline SMS systems do not address issues pertaining to sources of WRS and impacts on wellbeing, performance and safety. All participants indicated that this needs to be addressed from a safety perspective.

Nearly 99% of survey respondents indicated that ensuring and maintaining positive mental health for pilots should be a key priority for all airlines (82.74% strongly agreed, while 16.24 agreed). However, it appears that this is not being taken seriously at an airline level. Just under 20% of respondents agreed with the statement 'Ensuring and maintaining positive mental health for pilots is a key priority for my airline' (10.15% agreed, while 8.12% strongly agreed). 97% of participants agreed that the process for supporting positive mental health and managing mental health problems in Pilots should be clearly defined at an airline level (63.27% strongly agreed, while 34.18% participants agreed). However, survey data indicate that airline operational and safety processes fall short of this. A very small number (11%) agreed that this process is clearly defined at their airline (8.67% agreed, while 2.55% strongly agreed). Furthermore, a small number of respondents (8%) agreed with the statement 'The Safety Management practices at my airline adequately address issues concerning the support and management of Pilot mental health and wellbeing' (7.11% agreed, and 0.51% strongly agreed).

7 Proposed interventions: airlines and pilots

7.1 Introduction

Airlines and pilots need the right tools to safeguard the wellbeing and mental fitness of pilots, and ensure flight safety. Following the analysis of workshop and survey data, a preliminary set of requirements for interventions at (1) an airline and (2) pilot self-management level have been identified. The interventions focus on (1) the promotion of positive mental health, (2) the prevention of WRS/wellbeing problems, and (3) the management of wellbeing/MH problems. As such, prevention, predictive risk assessment, and proactive risk assessment approaches underscore many of the interventions. This links to Safety-II concepts, safety performance evaluation processes pertaining to the evaluation of 'leading indicators', and specific processes pertaining to predictive risk assessment as defined in ICAO's recent 'Global Aviation Safety Plan' (2019).

Overall, the proposed interventions go further than the IR and GM provided by European Agency for Safety and Health in Work (2019), in relation to the management of mental health issues in pilots. This is discussed in more detail in a later section.

In line with occupational health and safety approaches to stress management, the interventions focus on three levels:

1. Primary: prevention (entire workforce)—promoting and educating on WRS and wellbeing, preventing or minimising the occurrence of stress and promoting stress coping.
2. Secondary: protection/management (entire workforce—including those who are suffering)—interventions targeted at different stages in the lifecycle of being an employee (i.e., recruitment, training, on the job mentoring, on the job performance feedback, etc.) and management of WRS & associated impacts on person.

3. Tertiary: rehabilitation (pilots who are suffering—including those who may need expert help)—managing existing suffering, rehabilitating symptoms of existing stress-related problems or diseases to minimise potential harm. This also involves referring pilots to specialist support services.

Furthermore, the proposed interventions map to the Stepped Care model (NICE 2011), albeit they are adapted to take into account the occupational context (i.e., pilot specific adaptations) and the complex relationship between different sources of WRS and the associated impact on the three pillars of wellbeing (i.e., physical, social, and psychological).

In relation to mental wellbeing and mental health, the interventions attempt to promote positive mental health and mental wellbeing in the workplace, while also addressing suffering and mental ill health.

Overall, the proposed interventions address the impact scenarios as identified in the workshops and validated in the anonymous survey. Accordingly, the proposed interventions span all aspects of health and are not limited to MH. The proposed interventions target routine suffering and its impact on wellbeing (scenarios 1, 2, and 4), as well as wellbeing issues that impact on performance/safety (scenario 3). Evidently, there is a requirement for specific interventions pertaining to mental health (scenario 5 and 6). In line with workshop feedback, there is less of focus on extreme cases/consequences (scenario 6).

The proposed interventions have their conceptual underpinnings in concepts of self-efficacy, awareness, acceptance, and behaviour change. Our recommendations span the socio-technical perspective (i.e., people, process, technology, culture, training, and environment). Smart technology is core feature of many of these recommendations. However, the interventions are not all technology-based. Finally, in some cases, there is a link between certain interventions for (1) airlines and (2) pilots—specifically, in relation to those interventions that are technology-based and involve reporting and/or data sharing.

7.2 Airline approaches

Arguably, risks pertaining to crew WRS/wellbeing and their impact on pilot performance and flight safety might be more adequately managed at an airline level. Overall, field research results indicate that airlines need to actively manage these risks and adopt a systemic approach to assessing and maintaining the health and wellbeing of pilots both 'on the line' and at an earlier stage (i.e., recruitment and training). In accordance with safety management system approaches, specific wellbeing issues and associated performance/safety risks need to be identified, prioritised, measured, and managed.

Airlines need to address the occupational barriers to supporting all the aspects of pilot wellbeing (i.e., stigma, long hours, and working anti-social hours). As part of an organised approach, airlines might collaborate with health promotion researchers, human factors psychologists, and clinical psychologists, to see how existing approaches might be tailored to the occupational context (this is specifically relevant in relation to wellness support interventions and specific MH interventions).

Table 5 provides a summary of specific recommendations/interventions. Each intervention is associated with an issue, and an impact scenario. Furthermore, a summary indication (i.e. yes/no) of the potential implications of these recommendations in relation to changes to existing the implementing rules (IR), acceptable means of compliance (AMC), and guidance material (GM) as documented by European Agency for Safety and Health in Work (2019) is also provided.

7.3 New digital tools for pilots

Table 6 below provides a summary of the proposed requirements for new digital tools to enable pilot self-management of WRS and wellbeing. The specific solutions are defined in relation to existing problems and the six impact scenarios. Overall, this includes functionality to support WRS and wellness awareness, risk assessment in relation to WRS and impact on wellbeing/performance/safety, personality profiling and stress coping methods, reporting wellness issues, coping skills, and resilience building and monitoring and self-assessment of wellbeing. Specific functionality is targeted at the management of specific sources of WRS such as fatigue/sleep difficulties (Scenario 1) and operational risk assessment at a pre-flight stage (Scenario 3). Furthermore, a set of tools to support the promotion of positive mental health for pilots, personality profiling and MH risk assessment, the management of MH problems such as depression and mood disorders (Scenario 5 and 6), and the management of crisis situations (scenario 5 and 6) is also defined. As indicated in Table 2, some of the proposed functionality links to potential airline interventions.

Primarily, we are focusing on tools for pilots—which directly support safety behaviour. Other relevant stakeholders (i.e., family member, PAG, clinician, and aeromedical examiner) might have access to this information and/or analysis outputs, pending permission from the user/pilot. Furthermore, additional reporting tools (i.e., observer reporting) might be advanced for family members and others. Data collected by 'observer reports' might be considered in terms of wellness assessments/intelligence (i.e., facilitate inclusion of observation reports/beyond self-report to mitigate reporting biases), and/or assessed by a clinician, if required (for example, in relation to scenarios 5 and 6).

Table 5 Proposed airline interventions: on the line

#	Category	Issue/problem	Recommendation/potential airline intervention	Impact scenario	Recommendations and regulatory change		
					IR	AMC	GM
1	SMS design and risk assessment	Airlines not gathering information about WRS/wellbeing issues and associated impact on performance and safety Wellbeing/MH threats not identified in existing Safety Management System	Define new safety performance indicators in relation to management of staff WRS and wellbeing/MH Gather data around WRS/wellbeing threats and include in risk assessment process—see below on reporting	All	Yes	Yes	Yes
		Existing SMS does not include specific processes for risk assessment in relation to WRS and impact on wellbeing, performance and safety	Advancement of new processes and tools to support risk assessment in relation to WRS Applying biopsychosocial framework Integrated into SMS and reporting in relation to WRS—see below	All	Yes	Yes	Yes
2	SMS and reporting	Reporting No dedicated reporting process for wellbeing issues	Modification of existing anonymous reporting systems to capture data about WRS/wellbeing and impact on performance/safety Reporting information might be linked to other operational/safety information so that the impact of sources of WRS in relation to (1) wellbeing, (2) performance and (3) safety is better understood. This should link to ongoing hazard/risk identification and the identification of control measures—and associated measurement of outcomes at different levels	All	Yes	Yes	Yes
			Introduction of dedicated anonymous reporting systems—which would feed into SMS (risk identification) and crew rostering systems.	All	No	No	Yes
			Airlines action their own wellbeing surveys—assess prevalence of problem, identify sources of WRS and impacts, elicit feedback on practical solutions	All	No	No	Yes
3	SMS and fatigue risk management systems (FRMS)	FRMS not linked to other biopsychosocial dimensions of wellbeing FRMS not standardised—variance in quality levels	Extension of fatigue risk management systems to other biopsychosocial dimensions of wellbeing so that fatigue understood in context of relationship to other factors (i.e. diet, hydration, exercise)	All	No	No	Yes
4	SMS and airline wellbeing/MH functions	Lack of dedicated role/function within airline to ensure the co-ordination and management of wellbeing/MH support/training programmes, safety promotion and interventions, management of risk pertaining to WRS, wellbeing/MH etc.	Require new wellbeing role/function formalised within SMS	All	Yes	Yes	Yes

Table 5 (continued)

#	Category	Issue/problem	Recommendation/potential airline intervention	Impact scenario	Recommendations and regulatory change		
					IR	AMC	GM
5	WRS/wellbeing/MH: Stigma, awareness and culture	Pilots have normalised wellbeing problems and not aware that might be suffering—hence not taking early action to mitigate potential adverse consequences	Training—(1) general wellness awareness and (2) promoting awareness of wellbeing/MH problems amongst pilots and normalising this issue	Scenarios 1, 5 and 6	Yes	Yes	Yes
		Pilots not aware of WRS and associated impact on wellbeing, performance and safety	Training—promoting awareness of WRS and impact on wellbeing, performance and safety	Scenarios 1, 5 and 6	Yes	Yes	Yes
		Pilots not talking to line managers about wellbeing problems—attributed to lack of trust and fear about losing job or limited career progression Pilot engagement low—this can be attributed to a divergence in values between pilots and airline management (third highest source of WRS)	Need to engage pilots—work with pilots on practical solutions that fit operation type and culture	Scenarios 3, 4, 5, and 6	No	No	Yes
		Pilots denying, concealing or ignoring psychological health issues (including both self-denial and denial to others) This can be attributed to Pilot culture (machoism) Stigma about MH Airline culture—current perceived punitive culture presents a clear threat to reporting wellness and MH problems Leadership and lack of understanding/awareness In relation to both pilot culture and airline/organisational culture, MH issues for pilots need to be destigmatized. Pilots need to be encouraged to put their hands up if they are experiencing difficulties. Critically, pilots will not do this if they believe the outcome will be punitive (i.e. loss of licence, impact on career progression)	Development of a supportive and positive work environment and culture in which the safety and welfare of all employees is a priority	Scenarios 1, 5, and 6	No	No	Yes
			Development of a Peer Assistance Network—see below		No	No	No
			Access to specialist confidential online supports via Mhapps paid for by airline		No	No	Yes
			Training airline leadership re MH and culture initiatives addressing stigma		No	No	Yes
6	Process design	No formal process for briefing around wellbeing issues	New pre-flight briefing process—incorporate wellbeing briefing	Scenario 3	No	No	Yes
			New checklists/tools to support briefing around wellbeing/MH Checklists/tools might be developed to support pilots to identify MH risks. This might build on prior research in relation to the application of TEM concepts to the specification of an intelligent flight plan, supporting pre-flight planning and briefing (Cahill et al. 2011)		No	No	Yes
		Processes for managing wellbeing/MH issues that arise during flight operations (i.e. if co-pilot suffering and expected or demonstrated impact on performance/safety) not well defined	Airlines need to develop clear processes for pilots in terms of managing wellbeing/MH issues that arise during flight operations (i.e. if co-pilot suffering and expected or demonstrated impact on performance/safety)		No	No	Yes
		Lack of flexibility in work/life interface	Improved rostering/bidding processes and systems	Scenarios 1, 2, 3, 4 and 5	No	No	Yes

Table 5 (continued)

#	Category	Issue/problem	Recommendation/potential airline intervention	Impact scenario	Recommendations and regulatory change		
					IR	AMC	GM
7	Training	CRM training does not sufficiently address sources of WRS and its impact	Training should focus on the less serious and more common physical and mental health issues and conditions that can arise as a result of WRS (i.e. link to the job)	Scenarios 1 and 3	No	No	Yes
		TEM Training does not provide suitable guidance in terms of risk identifying behaviour—WRS and impacts on wellbeing/MH, performance and safety	Include training in risk identifying behaviour—as part of TEM	All	No	No	Yes
		Insufficient emphasis on the pilot as an agent of change and as having the ability to self-manage their own health and positively contribute to changes in quality of life and wellbeing	Encourage pilots to take responsibility for their own health, giving them information on safety, health and welfare and their own health and wellbeing—see below on training and self-management tools	All	No	No	Yes
		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). Current training does not focus on the promotion of self-management techniques Lack of support/training in terms of coping strategies	Increase pilot's ability to cope Pilots need to be trained in terms of (a) self-managing wellbeing issues and (b) risk identifying in relation to their own wellbeing/MH (i.e. detecting potential for problem/problem in self and managing this) *Require* Educational strategies to promote learning about personal health and coping with stress (finding coping strategies that suit person given occupational demands) Specific wellness training—meditation, mindfulness Maintaining work-family balance, and dealing with complex professional practice situations that eventually affect health and work performance	All	No	No	Yes
		Currently, no training/supports provided to pilots to learn about their own personality style and ability to cope with stress Increased self-awareness and understanding of oneself can be an effective preventive aid in curbing the consequences of mental health decline	Use personality tests to promote awareness and educate pilots on personality type, ability to manage stress and potential for MH problems Also, educate on coping methods that make sense for personality type In relation to psychometrics/personality awareness and assessment, the outcome should not be disclosed to the employer, but process enabled by employer to support employee awareness/coping See what RAES recommending around Big 5 tests	All—but specifically 5 and 6 (MH)	No	No	Yes

Table 5 (continued)

#	Category	Issue/problem	Recommendation/potential airline intervention	Impact scenario	Recommendations and regulatory change		
					IR	AMC	GM
8	Peer support and assistance	Insufficient and inadequate support for pilots: Experiencing general and less serious MH/wellbeing issues Experiencing decline in wellbeing/psychological health Experiencing wellbeing/MH problems—requiring referral to specialist supports services where appropriate	Require peer employee assistance programme Require peer assistance network—provision of confidential counselling and advice for all	All	No	No	No
		Confidential Peer Assistance Programmes not standardised and/or widely implemented	Require peer employee assistance programme Require peer assistance network—provision of confidential counselling and advice for all	All	No	No	No
		Support networks help, but often there is a reluctance to seek help/support within airline	Provide access to specialist confidential online supports using online and/or Mhapps paid for by airline	All—and specifically 5 and 6	No	No	Yes
		Lack of support for crisis situations	Require 24 h/7 day crisis support to deal with emergency situations and ensure immediate referral to clinical services and specialist help	Scenarios 5 and 6	No	No	Yes
9	Airline wellbeing/MH services/programmes	Across the industry, there is limited evidence of dedicated wellness programmes within airline—focussing on preventing onset of problems Such programmes are not the standard—but rather the exception	Airline should implement a service focussing on preventing the onset of wellbeing problems This might include an array of employee wellness activities to assist pilots with learning how to recognize and cope with stress in a healthy way Development of wellness management services—yoga, meditations, groups to talk The above would require adaptation given the working schedule of pilots and fact that often work away from home	Scenarios 1, 2, 4 and 5	No	No	Yes
10	mHealth and MH apps	Airlines not looking at external tools/resources (for example, mHealth and MH apps)—in relation to (1) safety promotion and (2) how they might integrate to these, to promote better self-management for pilots	Encourage use of mHealth and MH apps—to support self-management and self-assessment in relation to own wellbeing/MH	Scenarios 1 and 3	No	No	Yes
			Advance own rostering functionality so can link to apps Advance tech, so that outputs of rostering can be easily integrated into mHealth and MH apps—specifically in relation to sleep and activity	Scenarios 1, 2, 3, 4 and 5	No	No	Yes
14	Assessment	Currently, assessment is only carried out at the recruitment stage—and not while flying the line Pilots can develop MH problems at any stage in their career	Define a new wellbeing/MH assessment process for pilots while flying the line	All—but specifically 5 and 6 (MH)	Yes	Yes	Yes
		The aeromedical assessment of pilots should give more attention to the less serious and more common mental health issues and conditions	Aeromedical examination should address routine wellbeing/MH assessment – Methods should be utilized to build rapport and trust with the pilot in a nonthreatening environment	All—but specifically 5 and 6 (MH)	No	No	Yes

Table 5 (continued)

#	Category	Issue/problem	Recommendation/potential airline intervention	Impact scenario	Recommendations and regulatory change		
					IR	AMC	GM
15	Food and self-catering for pilots	Research demonstrates that simple coping strategies such as attention to diet and meals is useful—yet existing regulations prohibit pilots to self cater and bring own food	Work with Authorities/Regulator on other practical solutions—pilots bringing own meals	All but specifically 1 and 4	Yes	Yes	Yes

In relation to the proposed applications, this might involve the use of mobile phones (i.e., phone apps) and other digital devices. Furthermore, the proposed technology might be integrated with other digital devices used by the pilot—for example, Fitbit or other wearables, to enable the automatic capturing of information (for example, in relation to sleep and exercise).

8 Discussion

8.1 Mapping complex/wicked problems and role of aviation authority

Airlines and pilots need the right tools to safeguard the wellbeing and mental fitness of pilots. Those seeking to introduce solutions addressing wellbeing/MH problems (for example, pilots, airlines, and aviation authority) are also part of it. Stakeholders will have differing perspectives. These perspectives influence how they think about the problem and the solution. Thus, we need to engage all stakeholders to find the best possible solution for all.

Pilots may argue that the airlines are not doing enough. On the other hand, airlines can reasonably argue that they are following the regulatory requirements (i.e. duties) as laid out by the aviation authority. It is worth noting that airline safety improvements follow from new regulatory guidance and requirements. As such, the implementation of improved safety practices pertaining to WRS and wellbeing (i.e., tool recommendations emerging in this research) will largely depend on the recommendations from the authorities and potential modifications/changes to these. This is discussed in more detail below.

8.2 Research recommendations and impact for rule-making, acceptable means of compliance, and guidance material

As stated previously, 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. The interventions address awareness, prevention, routine suffering, and mental ill health—following from Safety-II concepts, safety evaluation metrics including 'leading indicators', and proactive and risk assessment approaches.

At an airline level, some recommendations from this research (for example, in relation to training and culture) can be addressed within the current regulatory framework and associated rule-making (European Agency for Safety and Health in Work 2019). As indicated in Table 5 (see earlier section), such recommendations might be considered in

Table 6 Overall functions and features (pilot self-management tools)

#	Issue/problem	Proposed tool function/feature	Scenario	Airline link
1	Pilots have normalised wellbeing problems and not aware that might be suffering—hence not taking early action to mitigate potential adverse consequences Pilots not aware of WRS/wellbeing risks Pilots no clear benchmark to compare their own 'WRS/wellbeing level' and associated risk	Wellness assessment and establishment of targets/goals Pilot enter profile info and obtain preliminary wellness assessment Capture existing norms for person Assessment against general norms Assessment against pilot norms (at airline—pilots flying similar range) Directed towards goal setting and behaviour change—recommend areas/factors to focus attention on Recommended approach/strategies Goal setting and behaviour change targets Link to other monitoring functionality (see below)	Scenarios 1, 2 and 4	If share sleep data can compare against other pilots at your airline
2	Requirement to support self-management of wellbeing—currently limited supports provided Existing industry apps focus on subset of biopsychosocial (i.e. fatigue/alertness)	Prompting ongoing self-monitoring of behaviour and routine wellness assessment and managing any potential decline in their psychological wellbeing (all and scenario 5 and 6) Feedback on lifestyle/data entered—some automatically generated (phone captures physical and sleep activity, roster data etc.)? Daily/weekly monitoring of key parameters Sleep management Activity and exercise Social activity Nutrition and diet Mood Potential inclusion of reporting feedback from others—to avoid bias—require permission from pilot (for example, spouse enters data on mood or other factor) Rewards and feedback Tools—screening/link to emergency help (Scenario 6) Option to share with airline—use 'anonymous' data about crew to inform assessment of risks (link to SMS) and wellness programmes	Scenarios 1, 2, and 4 Scenario 6	Potential to share anonymised data with airline SMS
3	Lack of awareness/education in terms of how WRS impacts on wellbeing and associated coping methods	Educates pilot on wellness—relationship between different wellness factors—for example, mood, sleep and level of socialisation Education on WRS awareness Educate on healthy lifestyle habits and coping strategies	Scenarios 1, 2 and 4	Corresponding programmes at airline—similar content
4	Pilots denying, concealing or ignoring psychological health issues (including both self-denial and denial to others) Requirement to support education in terms of MH awareness and coping mechanisms	Education—MH awareness, how to manage MH problems, supports available Personality tests and risk factors for MH	Scenarios 5 and 6	Corresponding programmes at airline—similar content
5	Requirement to support pilots in terms of risk assessment for WRS Requirement to support pilots in terms of identifying wellbeing risks that might impact on the operation and by implication safety	Pre-flight risk assessment (self-assessment) in relation to WRS and impacts on wellbeing/performance/safety	Scenario 3	Link to information from roster—assessment of fatigue
6	Requirement to support pilots in terms of sharing information about potential wellbeing risks, as part of a pre-flight briefing	Pre-flight briefing tool incorporated in pre-flight briefing checklist	Scenario 3	Link to briefing checklist

Table 6 (continued)

#	Issue/problem	Proposed tool function/feature	Scenario	Airline link
7	Requirement to obtain picture about operational reality—gather information about current wellbeing status of pilots—level of WRS, sources of WRS, wellbeing impacts, performance/safety impacts Lack of reporting about WRS and impact on wellbeing, operational performance and safety	Reporting forms—send de-identified information to airline so obtain picture of operational reality Wellbeing report includes information about issue/source of WRS, wellbeing impact, performance/safety impact including near-misses and safety events) Gathering of data (pending pilot consent) from any sleep/duty logs—to inform operational picture	All scenarios	Link to Airline SMS
8	Psychometric testing/assessment in recruitment and training not meet on the line demands—need insights for pilot as career progresses/wellbeing changes over time Need to support self-management of wellbeing including MH	Support personal insights re personality type, ability to manage stress and potential for MH problems Requirement to educate on coping methods that make sense for personality type	All scenarios	Link to airline psychometric testing
9	Support networks help, but reluctance to seek help/support within airline	Sharing of norms, info and tips across pilot groups/forums Tools to support sharing info/tips with other pilots Tools to enable a social support/network Online groups Calendar of events (sign-in and arrange online/offline meet-ups)	Scenarios 1, 2, and 4	
10	Personality tests—not linked to stress coping	Get feedback about self/awareness (all scenarios) Risk factors for stress (personality types) Recommendations on coping methods/responses—linked to personality type (all scenarios)		
11	Sleep is a key source of WRS—require tools to support sleep/fatigue management—in line with quantified self-approach Potentially pilots use many of the existing apps for sleep/fatigue management—but not linked to biopsychosocial Requirement to extend Jeppesen app to include diverse sources of WRS—linking to biopsychosocial	Fatigue/Sleep component Initial demonstration of tools—enhance sleep functionality—to integrate airline rostering info with sleep diaries Potential integrate with Jeppesen app Extend Jeppesen to include biopsychosocial Diet Hydration Physical exercise Social activity Relaxation Mood	Scenario 1	Yes—link to roster information
12	No specific tools targeted at management of MH problems for pilots—specifically in relation to mood disorders	Mood management (MH component)—customize existing moodapps for pilots Specific functionality linked to the Mental Health First Aid model Application of CBT and ACT therapies?	Scenario 5	

relation to a future elaboration process pertaining to safety promotion material and guidelines. However, the current OPS rules, AMCs, and GMs are insufficient to accommodate all of the recommendations from this research. Certain recommendations require rule-making (amending rules, AMCs or GMs) and/or modifications to the existing rules (European Agency for Safety and Health in Work 2019). This pertains to interventions to address.

- The promotion of wellbeing more generally.
- The promotion of positive mental health.
- Certain practical issues (such as diet and the ability of pilot's to bring their own food) that have an impact on wellbeing and MH.
- Specific SMS safety/risk evaluation and safety promotion processes and tools.
- New organisational roles for managing above and providing support above and beyond confidential peer support.
- 'On the line' assessment processes and supports.

Ideally, additional stakeholder evaluation research might be actioned and/or undertaken by EASA. This might follow the processes used in the initial stakeholder evaluation/consultation process. Stakeholder engagement could include IATA, the ERAA. and other industry organisations [for example, the European Society of Aerospace Medicine (ESAM), the European Association of Aviation Psychologists (EAAP), and the European Cockpit Association (ECA)], along with researchers gathering evidence pertaining to these issues.

The existing IR does not address interventions at the pilot self-management level (i.e., taking into account the work/life interface). It is not likely that EASA can mandate/regulate for the use of new self-management tools by pilots. However, these might be considered as 'best practice' and taken into account in terms of EASA's GM pertaining to safety promotion and CRM training.

8.3 Safety evaluation and safety performance indicators

This research indicates that existing safety performance indicators (SPI) require further elaboration in relation to factors/measures pertaining to WRS and wellbeing. Existing SPI do not measure all aspects of wellbeing that contribute to safe performance and flight safety. Given these deficits, it could be argued that existing SPI result in a false/incomplete picture in relation to (1) understanding routine performance (i.e., pilots' adapting/safety is maintained), (2) understanding why accidents happen, and (3) making flight safety estimates. To this end, we would argue that key vulnerabilities exist in the current approach to risk/safety management (i.e., proactive techniques are not considering wellbeing dimensions linked to WRS). As indicated in this research, if we use a different evaluation metric (for example, consider metrics and SPI linked to wellbeing and WRS), we might conclude that we are far from "Ultra-Safe" and that a significant number of safety risks (i.e., wellbeing/MH) are not being managed. Moreover, we are missing important outcomes linked to pilot suffering and wellbeing (see scenarios 2, 4, and 5).

Crucially, this research indicates that pilots are coping with significant challenges/sources of WRS (scenario 1). If WRS leads to a potential error (scenario 3), this is typically identified and managed by the co-pilot. The fact that pilots are adapting/coping and working effectively as part of a team is important. However, it should not be used to underestimate or mask safety issues or wellbeing impact (scenarios 2, 4, and 5).

8.4 Data, risk management, and decision-making/leadership

As stated in the EU report on The European Aviation Safety Programme (EASP), 'safety management needs to continuously adapt to changes in the aviation market, technological evolution, and the emergence of new safety hazards' (2015). The greatest hazards are those that we are not aware of, or those that we naïvely believe do not apply to us. The collection of data enables us to not only look at past accidents and incidents, but to also see what is happening in routine operations. This allows us to identify hazards and see what and where the current risk trends are, and to identify potential or new risks. Potentially, the above tools and specifically, (1) crew reports: collecting data about sources of WRS which have the potential to impact on pilot wellbeing and potentially performance/safety, and (2) crew wellness information: anonymous data about crew wellbeing levels via digital self-management tools provide an opportunity for airlines to advance a better understanding and assessment of wellbeing risks. However, this is only one part of the process. Airline management must be committed to acting on this information and making real changes that yield benefits in relation to staff wellbeing and operational safety. As defined, there are two keys to being successful at being predictive in a reactive world—(1) to have the data to verify the risk exists and show that it is worth addressing, and (2) to have the support of the decision-makers to address the risk without having an accident to react to (Skybary 2019d).

8.5 Proposed interventions and learning from coping mechanisms

As indicated in this research, not all pilots are suffering. This research presents a picture of pilots that are coping and adopting strategies to enable them to cope with various

work stressors. Fatigue and sleep management is a key strategy, along with diet, exercise, and talking with others (colleagues and family). These strategies enable some pilots to cope in a work environment that is detrimental for others. If this relationship is better understood, then lessons might be learned in terms of identifying strategies that enable pilots to increase their resilience to WRS/wellbeing challenges (including MH). Furthermore, these coping strategies might underscore interventions at different levels—and specifically, in relation to new digital tools enabling self-assessment and self-management of WRS for pilots.

8.6 Safety behaviours

This research calls for new definitions in relation to safety behaviour for pilots. Arguably, we should conceptualize the management of WRS and its impact on wellbeing, performance and safety as a core safety behaviour. This concerns managing WRS and wellbeing at different times—including (1) recruitment, (2) training, (3) while flying the line, and (4) while off duty. This follows from concept of behaviour-based safety.

8.7 Research limitations

The results of this study should be interpreted/considered with potential limitations in mind. In relation to both the workshops and survey, the sample size is small. This limits the statistical power of the study. Workshop participants may have had difficulties self-reporting (i.e., issues pertaining to trust and disclosing sensitive/personal information in a group setting).

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. Furthermore, survey data are cross section in nature. The results can only be used to evaluate the sample for the time-period during which these data were collected. Thus, no cause-and-effect relationship can be drawn from the findings.

Additional research (for example, one-to-one interviews with pilots) is required to unpack specific WRS issues and wellbeing factors as emerged in both the workshop and survey feedback.

This research reflects the perspective of one stakeholder group (namely pilots). This research 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 rule-making and the implementation of solutions at an airline level.

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

8.8 Next steps

The next steps involve further analysis of the first wave of this survey (November 2018–February 2019). A second wave of survey data (spanning period from March to July 2019) will also be evaluated. In addition, we are planning a second version of the survey to capture more detailed information about the positive impacts of the job, specific sources of WRS, and impact and coping strategies (specifically, in relation to diet, sleep, physical activity, social activity, and social support mechanisms).

We would also like to further validate our impact scenarios with different stakeholders. Specifically, we would like to obtain some measure of the frequency of these scenarios and their impact.

Furthermore, interviews will be undertaken with pilots to investigate specific sources of WRS, existing coping strategies, and to evaluate the proposed tools both at an airline and pilot self-management level. In relation to the proposed self-management tools, we plan to prototype a subset of this functionality. Following this, we will evaluate the prototypes using co-design techniques.

In relation to specific airline solutions, we plan to undertake broader stakeholder evaluation-based research to validate the proposed solutions in terms of existing SMS processes and tools, and to advance a road map for their implementation at an airline level.

We also hope to undertake research with other operational personnel in the aviation system (i.e., cabin crew, ATC, maintenance engineers, ground operations, airport emergency services, and so forth).

Finally, we would like to use this research as an evidence basis to engage with EASA and other interested parties/working groups addressing the regulatory framework for managing pilot mental health along with the promotion of positive mental health and more broadly, pilot wellbeing.

9 Conclusions

If the wellbeing of pilots is being negatively affected by the nature of their work (and specifically, stressors in the work environment), this needs to be identified and measured, and the associated risks managed accordingly.

In general, pilots try to normalise/adapt to the job and manage wellbeing issues. However, there is much variation

in relation to coping ability, with some pilots coping better than others. As indicated in this research, this variation needs to be considered in relation to (1) modelling performance/safety impact, and (2) addressing wellbeing interventions at different levels (i.e., airline level and pilot self-management level).

Addressing issues pertaining to pilot health and wellbeing and sources of WRS is a problem whose solution requires a great number of people to change their mindsets and behaviour and to collectively identify solutions of which they all are a part. It is impossible to remove all stress from the work life of pilots. The effectiveness of pilots coping techniques affects their health and wellbeing. Therefore, it is important for pilots (and their employers/airlines) to find healthy ways for pilots to cope with work-related stress and wellbeing/MH issues. As indicated in this research, there is much to learn from existing coping mechanisms adopted by pilots.

The proposed interventions/recommendations attempt to promote positive mental health and mental wellbeing in the workplace, while also addressing suffering and mental ill health. Critically, the proposed interventions are conceptualized in relation to the six scenarios advanced in this research. As such, they span all aspects of health and are not limited to MH. The proposed interventions target routine suffering and its impact on wellbeing (scenarios 1, 2, and 4), as well as wellbeing issues that impact on performance/safety (scenario 3). Evidently, there is a requirement for specific interventions pertaining to mental health (scenarios 5 and 6).

Recommendations are proposed both for airlines and at a pilot self-management level. The proposed interventions are designed to promote wellbeing and prevent or minimise the occurrence of stress. Furthermore, they are designed to help pilots manage or cope better with stress and the impact on wellbeing, performance, and safety. It is hoped that in the short term, some airlines may consider implementing some of these solutions (voluntary measures) to promote mental wellbeing. The specific solutions require further elaboration using stakeholder evaluation methods (including feedback from the authorities).

Airlines and pilots need the right tools to safeguard the wellbeing and mental fitness of pilots, and ensure flight safety. Some of recommendations arising in this research relating to airline interventions can be addressed within the current regulatory framework, while others will require additional IR and/or modifications to existing IR, AMC, and GM. The existing regulations do not address the pilot self-management level.

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Appendix 1: biopsychosocial model of wellbeing

See Fig. 4.

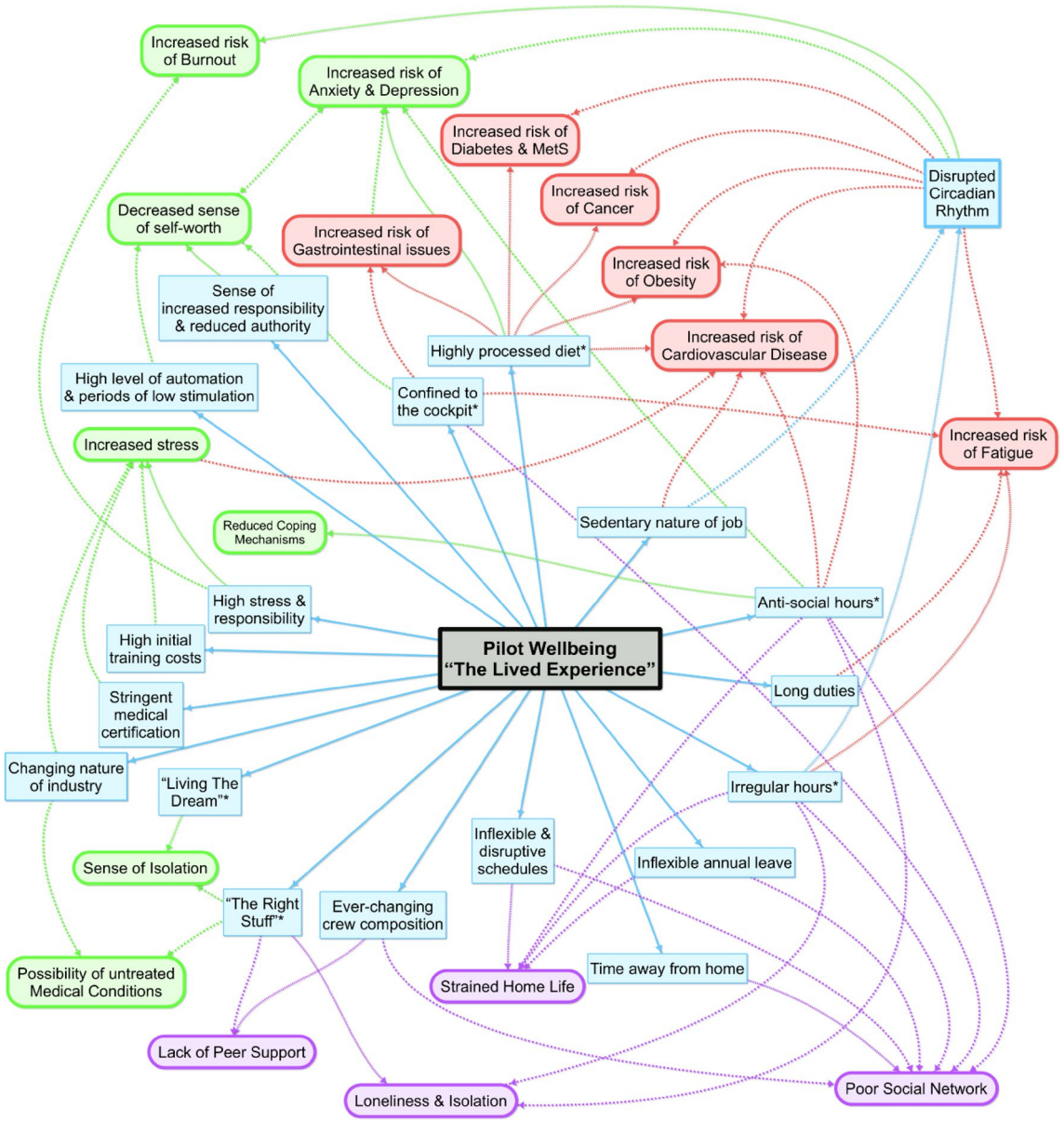

Fig. 4 Biopsychosocial model of wellbeing (workshop feedback)

Appendix 2: sources of WRS

See Fig. 5.

Fig. 5 Sources of WRS (workshop feedback)

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