Pilot Mental Health, Methodologies, and Findings: A Systematic Review

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INTRODUCTION: Pilots' mental health has received increased attention following Germanwings Flight 9525 in 2015, where the copilot intentionally crashed the aircraft into the French Alps, killing all on board. An investigation of this incident found that the pilot had a depressive disorder.

METHODS: This systematic review investigated peer reviewed studies of pilot mental health published since 1980. A total of 58 papers were identified.

RESULTS: Two main methodologies have been employed: questionnaires and database record searches. Anxiety, depression, and suicide were the most commonly investigated mental health conditions. There were almost an equal number of studies that found a higher prevalence of psychological symptoms in pilots as those that found a lower prevalence, relative to controls or the general population. Prevalence rates were higher in studies relying solely on questionnaires than in studies employing database record searches.

DISCUSSION: Prevalence estimates are closely associated with methodology, so it is difficult to determine the true rate. Factors that might account for low prevalence estimates include under-reporting of symptoms by pilots and a reluctance to diagnose on the part of health professionals. Factors that might account for high prevalence estimates include anonymous assessment, the use of questionnaires that do not align with clinical disorders, and inconsistent cut-off scores. It is recommended that future studies on prevalence use well-validated clinical measures, and that more research be conducted on the effects of particular disorders on job performance.

KEYWORDS: pilot mental health, aviation, psychological health, safety.

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Psychological/mental illness is believed to be a contributing factor in over 3% of all pilot incapacitations[48] and, as such, is a risk factor for aircraft accidents. In recent years, the number of studies examining pilot psychological health has appeared to increase, likely because of the Germanwings crash in 2015, where the copilot deliberately flew the aircraft into the French Alps, killing all on board. This information is vital to manage the mental health of pilots and hence aviation safety. However, it is currently unclear how consistent the results of these studies are, or how robust their assessment methods are. Accordingly, this systematic review aimed to investigate the methodologies and findings of studies that have investigated pilots' psychological health.

Mental Health

Mental health is often understood as the absence of psychological illness or disorder. Psychological health affects the way individuals think, feel, and act.[74] At a severe level, poor psychological health can be debilitating, significantly impairing performance. Even moderate symptoms may reduce wellbeing and lead to suboptimal attention, motivation, and performance.

Mental illnesses (i.e., psychological disorders) are clinically significant disturbances of mental health, defined by the presence of certain symptom clusters (i.e., syndromes/disorder), and the duration and significance of these symptoms.

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Psychological illnesses are diverse; the latest Diagnostic and Statistical Manual of Mental Disorders (DSM) lists 300 psychological disorders.[6] All psychological disorders are characterized by significant distress and/or impairments in normal daily functions. The DSM-5 recommends that a formal diagnosis should be made in accordance with specified diagnostic criteria on the basis of clinical interview and the judgement of a suitably trained professional (i.e., psychiatrist or psychologist).[6]

Mental Health of Pilots

Psychological health is vital for pilots who are responsible for the lives of their passengers. In the United States, between 1993 and 2003, at least one pilot per year used an aircraft to end their life, which accounted for 3.75% of all pilot incapacitations.[48] Pilots are extensively trained. They are also carefully selected, regularly assessed against standards, medically examined, and re-evaluated regularly.[10] However, pilot well-being and mental health does not undergo the same level of scrutiny or receive the same level of attention as their physical health and maintenance of flying skills.[20] This is despite the finding that psychiatric causes were the third largest cause of professional pilot unfitness, accounting for 10% of events that rendered a pilot at least temporarily unfit to operate an aircraft.[29] There is evidence that this rate of impairment has increased since the events of 9/11, which in the aftermath had dramatic effects on the occupational role of pilots.[11] Increased level of security, heightened level of threats, and increased restrictions such as procedures to enter/exit the flight deck have all added to the mental workload of pilots.[27] There is little acknowledgment of this shift in the role of a pilot and, as such, the secondary effects of this change may not have been thoroughly examined.

As pointed out by Butcher, pilots are a unique group who perform a very unique role.[16] They are often compared to first responders or upper-white collar professionals such as surgeons. However, neither of these comparisons fully encapsulates the demands on pilots. Cahill et al.[20] point out that pilots are often both shift-workers and remote-workers, two working types that are high risk for both physical and mental illnesses.[12,25] Further, the role of a pilot requires an emotional stability that few other jobs require.[16] The high pressure and relatively dangerous nature of their role places increased importance on the mental health of pilots and the factors that can adversely affect their mental health.

Pilot Psychological Assessment

In many parts of the world, pilots' mental health has come under increased scrutiny following the Germanwings incident. Part of this scrutiny involves an increased focus on the mental health assessment by the Designated Aviation Medical Examiner (DAME) at a pilot's annual medical evaluation. Although there is often a thorough mental health assessment during pilot selection, the primary focus regarding pilot mental health during annual medical evaluation appears to be on depression and suicidality, presumably in response to the Germanwings incident. Prior to the Germanwings incident, the Aerospace Medical Association (AsMA) working group advocated the use of an ultra-brief, four-item psychological screening measure for pilots, where the focus was on mood and suicidal thoughts.[1] Subsequently, the working group revised this recommendation and stated 'more attention' should be given to 'less serious' mental health conditions and stressors (e.g., grief, psychosocial stress, depression, anxiety, panic disorders, personality disorders, and substance use), as well as a comprehensive psychological evaluation, at least at the outset of a pilot's career and recurrently when there is a history of mental illness.[2]

Recent reviews have almost exclusively focused on Depressive Disorders and suicidality, either in reaction to the Germanwings incident, e.g., Pasha and Stokes,[59] or due to the belief that these "more severe" mental health disorders are more incompatible with flying than "less severe" mental health issues.[20,42,52,78] However, "less severe" psychological issues can still cause impairment and possibly at comparable levels of impairment to major depressive disorders (MDD) and suicidality.[10] Less severe mental disorders can also present a risk factor for the development of further and more severe disorders,[30] as well as create functional issues by way of "presenteeism," where a sick worker comes to work but performs suboptimally due to illness.[39] In fact, less severe and subclinical mental health issues are perhaps even more valuable to understand in terms of allowing early intervention.[30] This idea is supported by the AsMA[2] report which asserted that less serious mental health conditions and stressors are not only more common, but "show patterns that facilitate early detection, and have proven effective treatment strategies" (p. 505). As such, it is important to investigate the prevalence of all mental health conditions in pilots.

The public impression of a pilot's personality is that of a rational, robust, and resilient individual who possesses "the right stuff."[13] Bor et al.[10] and Jones et al.[40] assert that severe psychological disturbance for pilots is quite rare, relative to the general population. However, Butcher[16] has argued there is no reason to believe that rates of depression and/or bipolar disorder would differ in pilots from the normal population due to the biological and sociocultural causes for these disorders. It is possible, however, that airline and military pilots may have better mental health than the general population, given the level of screening they must undergo to obtain and maintain their qualifications.

With this backdrop, the aim of this systematic review was to identify studies that have assessed any of a broad range of psychological disorders, not limited to depression and suicidality. For this set of studies, we then summarized the psychological conditions investigated, the methodologies employed and their appropriateness (whether they are aligned with DSM/ICD symptomatology), any risk or protective factors identified, and key findings.

METHODS

Inclusion Criteria

The inclusion criteria for the systematic review were that studies: a) were peer-reviewed; b) published between January 1, 1980 and 1 December 2021; c) investigated pilot mental

health/illness; d) were available in full-text in English; and e) included any aviation pilot, including military pilots and flight instructors, but excluded helicopter pilots, trainees, students, or cadets. Case studies, books, conference papers, reviews, letters, and meta-analyses were excluded. Studies that looked at psychological symptoms without the purpose of assessing prevalence or categorizing pilots based on these symptoms were also excluded.

Search Procedure

The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework.[56] A search strategy was used to identify mental health factors in aviation pilots, including type of mental health disorder, suicide, risk factors, and coping strategies. This search extended that by Pasha and Stokes,[60] and Kenedi et al.,[42] by including more disorder/symptom terms (anxiety, stress, adjustment) as well as associated factors such as wellbeing and coping. Multiple search engine databases were used to maximize results that would meet the inclusion criteria. The initial search was performed using Scopus, followed by Embase, PubMed, and Psychinfo databases.

The following search string was used (adjusted for specific database as needed): Pilot AND (flight OR commercial OR airline OR aviation OR aircraft OR aerospace) AND (psychol* OR wellbeing OR coping OR stress* OR depress* OR "mental health" OR "mental disorder" OR mood OR anxiety OR anxious* OR suicide* OR panic OR adjustment OR worr*) (Scopus).

RESULTS

Fig. 1 outlines the studies identified at each stage of the present search, in accordance with PRISMA guidelines.[56] The initial search identified 3689 potential papers (after duplicates were removed) which were assessed by title and abstract where accessible. Of these, 3456 were excluded on this basis for being irrelevant to the review (e.g., focused on physical stress not psychological stress), and 233 papers were screened more closely by examining the full text articles. Of these, 47 were excluded due to being unavailable in English, and 58 met the full inclusion criteria. These papers were examined independently by two reviewers and the type of psychological concern (i.e., depression, anxiety) and method of assessment (i.e., questionnaire, interview) were identified.

Table A (Table A is available in the online issue and is also available at https://doi.org/10.3357/AMHP.6043sd.2022) presents the results of the systematic review, sorting the

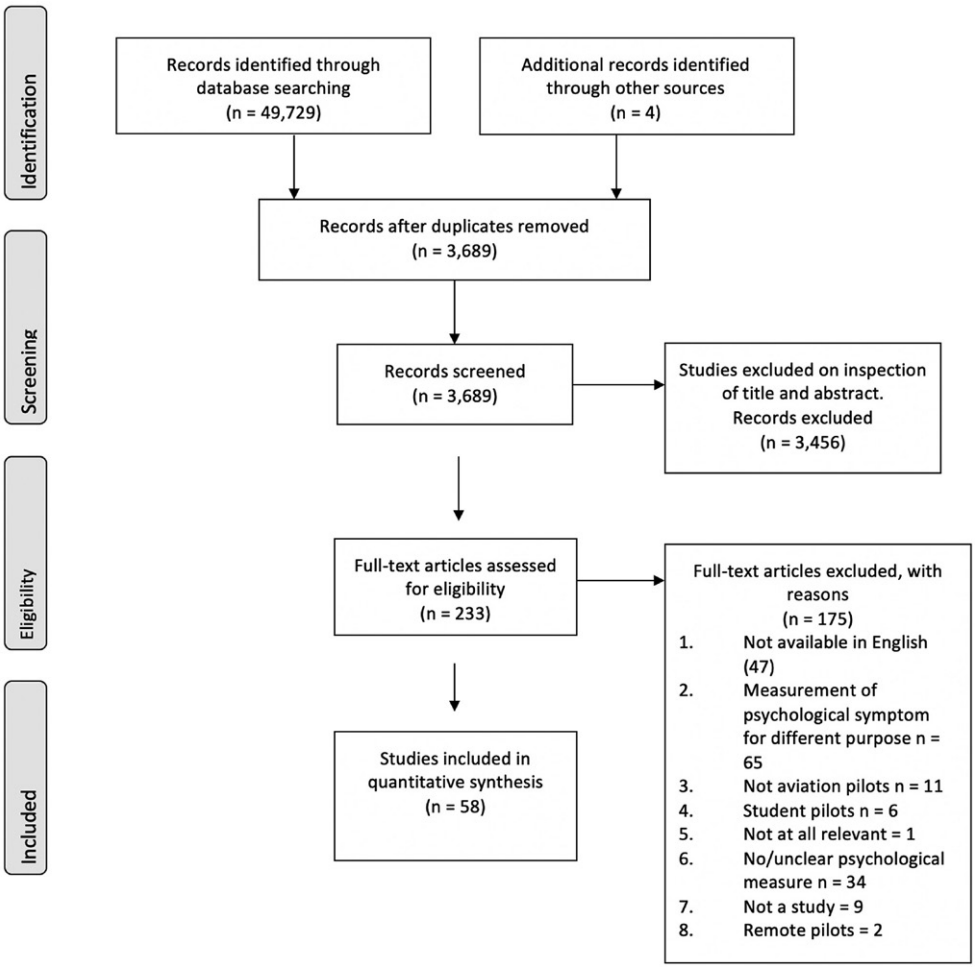

Fig. 1. Systematic review process undertaken.

Table I. Method of Assessment, Psychological Ailment Under Investigation, and Author of Research.

MEASUREMENT TOOL	PSYCHOLOGICAL AILMENT UNDER INVESTIGATION	AUTHOR/S
QUESTIONNAIRE		
Patient Health Questionnaire (PHQ)-Full scale	Mental Health issues broadly	Zamorski et al.[80]
Patient Health Questionnaire-9 (PHQ-9)	Depression	Guo et al.[37]
	Depression	Cahill et al.[19]
	Depression and suicidal thinking	Cahill et al.[20]
	Depression and suicidal thinking	Wu et al[78]
Patient Health Questionnaire-8 (PHQ-8)	Depression	Venus & Holtforth[72]
General Health Questionnaire 12 (GHQ-12)	Psychological distress	Alaminos-Torres et al.[4]
PTSD Checklist Civilian (PCL-C)	PTSD	Zamorski et al.[80]
Self-Reporting Questionnaire (SRQ-20)	Common mental disorders	Feijo et al.[30]
		Venus & Holtforth[72]
Minnesota Multiphasic Personality Inventory second revised edition (MMPI-2)	Overall psychopathology	Butcher[16]
	Overall psychopathology	Butcher et al.[18]
	Personality	Georgemiller et al.[34]
	Overall psychopathology	Flynn et al.[33]
Eysenck Personality Questionnaire	Personality factors	Girodo[36]
Health Opinion Survey	Somatic symptoms	Girodo[36]
Symptom Checklist 90	General psychological symptoms	Girodo[36]
	Stress symptoms	Sung et al.[68] (Korean version)
	Overall wellbeing	Widyahening[76]
Generalized Anxiety Disorder (GAD-7)	Anxiety	Li et al.[49]
	Anxiety	Guo et al.[37]
	Anxiety	Venus & Holtforth[72]
Maslach Burnout Inventory	Burnout	Li et al.[49]
Mindfulness Attention Awareness Scale	Mindfulness	Li et al.[49]
Impact of Events Scale – Revised (IES-R)	PTSD and stress-related symptoms	Eckblad[28]
Crown-Crisp Experiential Index	Stress and Coping	Cooper & Sloan[26]
Mood Adjective Checklist	Mood	Cooper & Sloan[26]
Competition State Anxiety Inventory-2	Anxiety	Hidalgo-Munoz et al.[38]
Hospital Anxiety and Depression Scale (HADS)	Anxiety and depression	Johansson & Melin[39]
	Anxiety and depression	Ross[64]
	Anxiety and depression	Aljurf et al.[5]
Bespoke/ random questions presented in survey format	Anxiety and depression	O'Hagan et al.[57]
	Anxiety and depression	Sykes et al.[69]
	Depression	Loewenthal et al.[51]
		Wetzler et al.[75]
Becks Inventories	Anxiety and Depression	Ross[64]
	Depression	Parsa & Kapadia[59]
The Zung Depression Scale	Depression	Cetinguc[24]
The Spielberger State-Trait Personality Inventory	Anxiety	Cetinguc[24]
The Trait Meta Mood Scale for Emotional Intelligence	Emotional intelligence	Guo et al.[37]
The Proactive Coping Scale	Coping	Guo et al.[37]
Oldenburg Burnout Scale/ Modified Instrument	Burnout	Cahill et al.[19]
	Burnout	Cahill et al.[20]
Work Related Stress Questionnaire	Work-related stress	Cahill et al.[19]
Life Events and Difficulties Schedule	Stress	Loewenthal et al.[51]
Symptoms of Stress Scale	Depression	Little et al.[50]
The Fighter Pilot Work Stress Scale	Stress	Sung et al.[68]
The Cognitive Flexibility Inventory	Stress	Sung et al.[68]
Airline Pilots Sources of Stress	Work-related stress	Widyahening[76]
Home Stress Checklist	Home-related stress	Widyahening[76]
The Cornell Health Questionnaire	General mental health	Xiao-Yong et al.[79]
Standardized Multifactor Personality Study (SMPS)	Personality	Krapivnitskaya[43]
Portrait Choice Task	Personality	Krapivnitskaya[43]
The Shiffman Jarvik Tobacco Withdrawal Questionnaire	Nicotine Withdrawal	Giannakoulas et al.[35]
The Profile of Mood States (POMS)	Nicotine Withdrawal symptoms	Giannakoulas et al.[35]
History of Psychiatric Diagnoses (C-DIS)	Personality. General mental illness	Flynn et al.[33]
DATABASE		
Aeromedical Epidemiological Data Repository	SSRI use and related diagnoses	Kelley et al.[41]
Defense Medical Surveillance System	Any mental health issues	Otto & Webber[58]
MORS as well as CAA records	Incapacitation and impairments rates and associated causes	Evans & Radcliffe[29]

(*Continued*)

Table I. (*Continued*)

MEASUREMENT TOOL	PSYCHOLOGICAL AILMENT UNDER INVESTIGATION	AUTHOR/S
archive of the Aeromedical Section of the Norwegian Civil Aviation Authority	Medical disqualifications and related causes	Arva & Wagstaff[7]
The USAF military personnel database as well as USAF inpatient database	Psychiatric hospitalisations and associated mental health issues and return to flying outcome	Flynn et al.[33]
Central Medical Board of the Canadian Forces	Groundings and flight restrictions and associated mental health issues	van Leusden et al.[71]
The Individual Flight Activity Reporting System (IFARS)	Hospitalisations and associated diagnoses	Burr & Hoiberg[15]
USAF School of Aerospace Medicine's Aeromedical Consultation Service (ACS)	Suicide	Patterson et al.[61]
Psychiatric files from the Centro de Instruccion de Medicina Aerospacial	Anxiety-phobia	Medialdea & Tejada[55]
Aeromedical Electronic Resource Office (AERO)	Any psychological disorder Long term disability and related causes	Britt et al.[14] Band et al.[8]
Difficult Case Management Database (DCM)	Antidepressant use and associated psychological conditions	Ross et al.[65]
The Civil Aerospace Medical Institute (CAMI)	Fatal incidences and associated SSRI and psychological conditions SSRI use and depression	Sen et al.[67] Akin & Chaturvedi[3]
National Transportation Safety Bureau (NTSB)	Fatal incidences and associated SSRI and psychological conditions	Sen et al.[67]
	PTSD	Laukkala et al.[47]
	SSRI use and depression	Akin & Chaturvedi[3]
	Suicide	Laukkala et al.[45]
	Suicide	Vuorio et al.[73]
	Suicide	Politano & Walton[62]
	Suicide	Lewis et al.[48]
	Suicide	Bills et al.[9]
	Suicide	Ungs[70]
	ADHD	Laukkala et al.[46]
National Centre for Health Statistics (NCHS)	Suicide	Ungs[70]
Aeromedical Information Management Wavier Tracking System (AIMWTS)	Anxiety - Panic Depression - MDD	Marsh et al.[53] Lollis et al.[52]
Toxicology	Medications and medical histories of pilots involves in accidents	Canfield[21]
INTERVIEW		
40 min semistructured interview (along with questionnaires)	Mental health issues broadly	Zamorski et al.[80]
Clinical Diagnostics Interview (along with questionnaires)	Anxiety and depression	Ross[64]
Millon Clinical Multiaxial Inventory (along with MMPI-2)	Decision making, and alcohol use	Georgemiller et al.[34]
Inquiry by DAME	Depression	Castelo-Branco et al.[23]

58 papers based on the psychological condition under investigation, while **Table I** sorts the 58 papers based on methodology employed. In Table A, details such as authors, aim of the study, psychological condition under investigation, sample size, method of psychological measure and findings are presented. In addition, and in line with the aim of this systematic review, this table contains an evaluation of each study based on how comprehensively the study investigated pilot mental health across three criteria: 1) Focus on two or more Mental Health (MH) conditions; 2) Appropriate assessment method (aligned with recognized clinical syndromes such as those represented in DSM/ICD systems); and 3) Examination of context (i.e., risk or protective factors).

As shown in Table A (Table A is available in the online issue and is also available at https://doi.org/10.3357/AMHP.6043sd.2022), 18 papers looked broadly at mental health, aiming to identify any number of issues (though mostly through database searches for historical diagnoses rather than through independent assessment). An additional 13 studies looked at 2 or more mental health issues. Depression and suicide, in isolation and/or together, were the most commonly investigated psychological concerns. Pilot suicide was investigated in seven papers. Depression was the primary psychological focus for six papers, investigated along with anxiety in eight papers, and identified among eight broader studies. Depression and pilot suicide were investigated together in an additional two papers. Additionally, five papers assessed anxiety/specific anxiety disorders, seven assessed other psychological issues (i.e., Post-Traumatic Stress Disorder - PTSD, Attention Deficit Hyperactivity Disorder - ADHD, personality), and five assessed 'overall' mental health in a nonspecific way.

As can be seen in Table I, questionnaires were the preferred method of data collection, with 29 out of 32 studies using them as the sole method. Three studies used a combination of questionnaires and interviews, while 25 studies solely used database searches. The National Transportation Safety Board's (NTSB)

aviation accident database was the most commonly used database (10 studies), followed by The Civil Aerospace Medical Institute (CAMI) toxicology database (2 studies) and the Aeromedical Electronic Resource Office (AERO) database (2 studies). Sample size ranged across the studies from 10 pilots to 17,722 aviation personnel.

There were 33 studies that identified risk and/or protective factors associated with their findings of pilot mental health. For example, Feijo[30] identified that work-related stressors were associated with increased mental health symptoms and found that the effect of these stressors was somewhat buffered by exercise. Work-related stressors were identified as associated factors in 10 studies. Other risk factors identified included age, gender, fatigue, burnout, marital status, psychiatric history, and life stressors (such as physical health condition, relationship breakdown). Lifestyle factors like sleep, diet, and exercise are well known to contribute to better mental health outcomes[31] and have been identified as intentional coping strategies used by pilots.[19,30,75] Other protective factors have included relationships, proactive coping, and mindfulness.

As can be seen in the evaluation column of Table A (Table A is available in the online issue and is also available at https://doi.org/10.3357/AMHP.6043sd.2022), most studies (N = 32) addressed two of the evaluation criteria. There were 12 studies that met all of the evaluation criteria. These studies assessed two or more mental health (MH) conditions, with well used, validated questionnaires which aligned to DSM or ICD criteria, or searched databases using DSM/ICD search terms, as well as attempted to put these conditions in context by exploring associated risk or protective factors. Three of the studies meeting all evaluation criteria found an increase in mental health conditions. However, two of the studies studied pilots in specific circumstances, that is pilots involved in labor disputes or having returned from combat, affecting the extent to which their findings may generalize to a typical pilot population. The remaining study used the PHQ-9 to examine depression and suicidality. As will be discussed, the PHQ-9 is a questionnaire which is associated with high prevalence findings in a number of studies.

Table A (Table A is available in the online issue; it is also available at https://doi.org/10.3357/AMHP.6043sd.2022) also outlines the prevalence rate of psychological issues identified in each study. As can be seen in this table, prevalence rate was investigated in more than half of the studies (36 from 58 studies). A lower prevalence rate was identified in the pilot samples compared to the general or comparable population in approximately 80% of studies. **Fig. 2** and **Fig. 3** display the reported prevalence for the most commonly investigated issues, namely anxiety and depression, in relation to the World Health Organization's (WHO) published prevalence rates for the general population.[77] Only those papers that explicitly stated prevalence rates are included in these figures. As can be seen in Fig. 2, with anxiety, six studies found a higher prevalence rate, while nine found a lower prevalence rate compared to the WHO's reported prevalence rate. As can be seen in Fig. 3, with depression, an equal number of studies found a higher and lower prevalence rate compared to the WHO's reported prevalence rate.

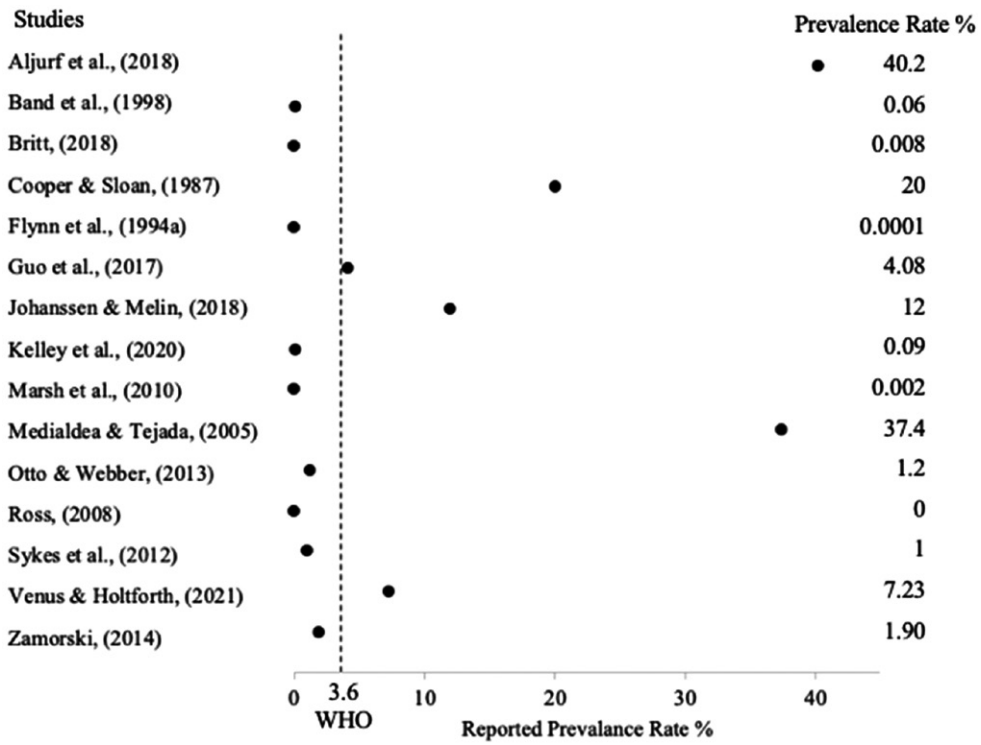

Fig. 2. Reported prevalence rate for "anxiety" from studies appearing in this systematic review compared to the WHO's published prevalence rates for the general population.

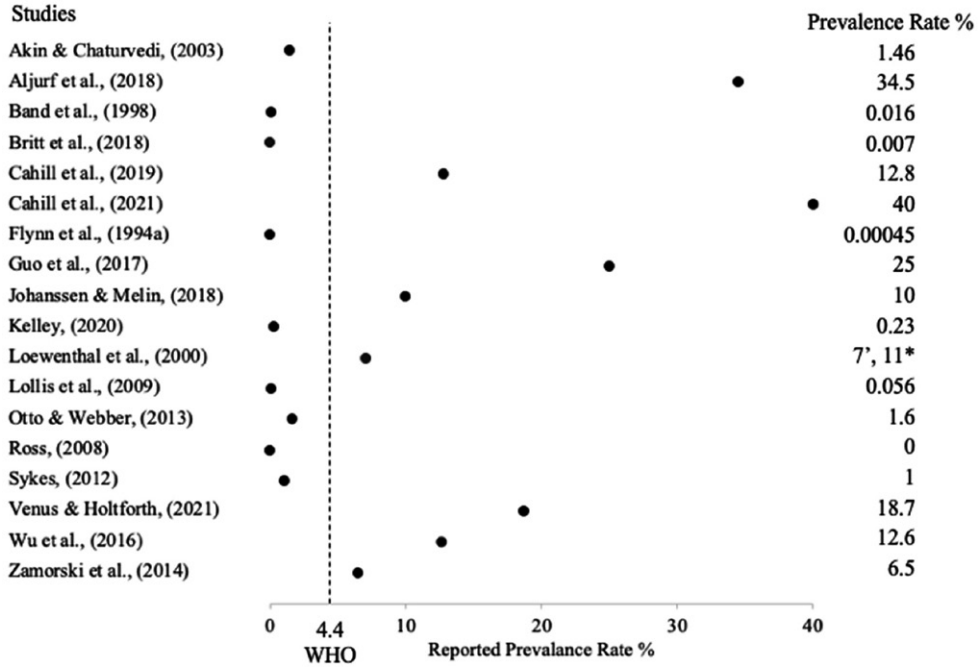

Fig. 3. Reported prevalence rate for "depression" from studies appearing in this systematic review compared to the WHO's published prevalence rates for the general population. * = Involved in incident; ' = not involved in incident.

DISCUSSION

This systematic review examined the methodologies and findings of studies concerning pilots' mental health. The review revealed five key findings: 1) The methodologies employed predominately fall into one of two categories, namely questionnaires or database record searches; 2) Depression, anxiety and suicide were the most commonly investigated mental health conditions or symptoms; 3) The prevalence rate of mental health symptoms was higher among studies relying solely on questionnaires than among studies employing database record searches; 4) There are diverse findings relating to the prevalence of mental health symptoms experienced by pilots (both civilian and military) compared to the general population; and 5) The prevalence of symptoms, as opposed to the extent to which they impaired flying performance, was often the main focus of the research.

Methodology

As can be seen in Table I, questionnaires were the preferred method. A total of 32 studies employed questionnaires, 29 using them as the sole method of data collection. There were 3 studies that used both questionnaires and interviews, while 25 studies solely used database searches. From the 38 different questionnaires employed, the PHQ-9 (Patient Health Questionnaire-9) and the MMPI-2 (Minnesota Multiphasic Personality Inventory second revised version) were the most commonly used questionnaires (both used in four studies and revealed largely consistent results, five including Venus & Holtforth,[72] who used the PHQ-8). The HADS (Hospital Anxiety and Depression Scale), GAD-7 (Generalized Anxiety Disorder 7-item) and the SCL-90 (Symptom Checklist 90) were used in three studies, while the SRQ-20 featured in two studies. The remainder of the questionnaires were only featured in one study.

The main database employed was the National Transportation Safety Board's (NTSB) aviation accident database, which was used in 10 studies. The Civil Aerospace Medical Institute (CAMI) toxicology database and the Aeromedical Electronic Resource Office (AERO) databases were both used by two studies. No other studies utilized the same database.

Data contained in the databases differed fundamentally from the data collected using questionnaires. Questionnaires were employed to identify symptoms associated with mental health conditions, whereas the databases contained either information about toxicology results, psychiatric history, reasons for hospitalization (using International Classification of Diseases - ICD (8 through to 10) codes) and/or the grounding of the pilots. Of the 25 database studies, 9 were concerned with military pilots. Of the four studies that used interviews, three employed a semistructured or structured clinical interview.

The three data collection methods all have their own benefits and limitations. Questionnaires can be beneficial due to their anonymity, and ease of administration. For pilots, anonymity is important due to the threat of loss of license (i.e., "loss of medical"), which may otherwise create reluctance to report mental health symptoms. However, and depending on their construct, questionnaires may fail to capture the full breadth of the symptoms intended. Questionnaires are also subject to manipulation, where respondents may minimize the existence of symptoms (i.e., impression management/under-reporting).

Researchers can also manipulate the reporting of results from the questionnaire, through altering the cut-off score. Interviews, on the other hand, provide the opportunity to clarify the existence and significance of potential symptoms. They are, however, not immune from problems associated with other self-report methods (i.e., impression management) and present some of their own such as administrator/clinician biases, transference, and the reluctance for clinicians to make a potentially career-ending diagnosis of a pilot.

Disorders Investigated

From the studies that targeted specific mental health conditions or symptoms (i.e., outside of database searches), depression, anxiety, and suicide were the most commonly investigated. Specifically, depression was the focus of six studies, anxiety was the focus of five, while both depression and anxiety were the focus of eight studies. Depression along with suicide were the focus of two studies, and suicide alone was the focus of seven studies. This narrow focus neglects the importance of other mental health symptoms that are known to impair pilots' flying performance, as discussed below.

As identified in the database searches, which were not limited to the focus of a specific disorder, mental health conditions such as panic disorder (i.e., DSM5[6] Anxiety disorder), PTSD (i.e., DSM5 Trauma and Stress Related disorder), and Obsessive Compulsive Disorders - OCD (i.e., DSM5 Obsessive Compulsive and Related disorders) were identified. Yet, symptoms of these disorders extend beyond questionnaires' assessment of anxiety symptoms, which typically focus on core physiological and subjective symptoms of anxiety (see HADS and Beck Anxiety Inventory).

Adjustment disorder was identified in a number of studies. Adjustment disorder has been a contentious label in the context of aviation, with the suggestion that it is given over other diagnoses such as Major Depressive Disorder (MDD) due to its acceptance by regulators.[10] Indeed, Ross[64] reported that 25.16% of pilots who were taking SSRI (Selective Serotonin Reuptake Inhibitors) medication had been given an associated diagnosis of adjustment disorder. This finding could be indicative of health professionals choosing a more "accepted" diagnosis and would also be in line with the related suggestion that professionals may "carry" pilots due to reluctance to harm their careers.[52] Adjustment disorder, being time-limited and often requiring little intervention, is understandably considered "less serious" in some terms. However, for it to reach the diagnostic threshold, symptoms must at the very least be functionally impairing or significantly distressing and represent a departure from "normal" human experience and functioning. Furthermore, the broad range of symptomatology can include severe symptoms, and adjustment disorders have also been reported to be reasonably represented in the cases of suicides.[22]

The change in regulatory acceptance of SSRIs for pilots demonstrates an understanding that depression and anxiety are not wholly incompatible with flying and have effective treatment options. Additionally, MDD is generally understood to be an acute disturbance, the symptoms of which can wax and wane, and improve with psychological and/or psychopharmacological treatment. While Flynn et al.[32] reported that depressive disorders were the second most common cause of psychiatric hospitalization, they further found that 70% of pilots hospitalized for these disorders were subsequently cleared for return to flying duties, emphasizing the successful management of even severe depressive presentations. Awareness and confidence in the management of these conditions is key, as they are more common, more easily recognizable, and early intervention lends itself to more effective treatment.[1,32] Conversely, there is greater risk associated with "hiding" these symptoms, including a possible worsening of psychological states and associated impairment. This is similar to adjustment disorders where early identification may facilitate better treatment outcomes. Hence, it is important to screen for risk factors to facilitate early detection, rather than waiting for symptoms to manifest into more impairing conditions.

Psychotic disorders, on the other hand, are deemed to be more severe, and highly disabling and incompatible with a pilot's role. They are also incredibly rare[1] and difficult to predict, making efforts to pre-empt and prevent these conditions unproductive. When present, however, detection is common, with present touch points such as selection, routine examination, and occupational observations being effective.

It is important to note, mental health issues do not appear nor exist in a vacuum. Mental health issues are generally understood to arise from the interaction between individual vulnerability and precipitant stressors, and to be buffered by protective and/or coping factors. However, few studies in the present review investigated these factors, and those that did tended to have a narrow focus on specific stressors and/or coping strategies, rather than a broader exploration of the factors at play. Hence, expanding not only the disorder investigated, but also the context within which mental health issues develop and how they are managed, has the potential to improve our understanding of pilots' mental health and conditions that result in mental health problems.

Methodology and Prevalence

Prevalence rate was investigated in 36 of the 58 studies. In just under 80% of these studies, a lower prevalence rate of mental health symptoms was found with pilots than the general or comparable population. However, there were notable differences in the prevalence rate based on methodology. The use of questionnaires, either with or without a clinical interview, was the only methodology to reveal a prevalence rate higher than the general or comparable population. This occurred in 8 out of the 20 studies in which questionnaires were used in isolation, and in one of the studies in which a questionnaire was used in conjunction with a clinical interview, although in this study the sample was military pilots who had just returned from combat (post deployment screening[79]). In no study involving a database search (13 investigated prevalence) was the prevalence rate of mental health symptoms found to be higher with pilots than the general or comparable population. In the seven studies involving questionnaires where a higher prevalence rate was

found, three studies employed the same questionnaire, the PHQ-9 (four including Venus and Holtforth,[72] who used the PHQ-8). The remaining four studies all used different questionnaires.

These findings highlight the link between methodology and prevalence rate and suggest that the type of questionnaire, in addition to the actual condition or symptom, influences the observed prevalence rate. While questionnaires are a useful tool in the diagnostic process, they are not without their limitations. Questionnaires designed for psychological screening or diagnostic assessment should be closely aligned with known mental health disorders. In the case of the PHQ-9, despite being aligned with the symptoms of Major Depressive Disorder (MDD), it fails to determine the pervasiveness and the variability of symptoms, the extent to which these symptoms are better accounted for by another medical or mental health condition, or whether the symptoms are considered appropriate for circumstance. While this criticism is applicable to the use of the PHQ-9 more broadly, it is particularly problematic when used to compare against known prevalence rates derived from formal diagnoses (rather than comparing scores between a pilot and a control group). Indeed, and as with all questionnaires used for mental health assessment (as opposed to screening), they are best used in conjunction with a clinical interview, where the clinician can rule out physical or other psychological causes that may account for the symptoms or conditions.[44] Another limitation relates to the cut-off score, as this can affect interpretation and comparison.[30] In the case of the four studies that used the PHQ-9, only three studies stated the cut-off score (all used ≥ 10) for depression.

The questionnaire method can also vary, with some aligning to diagnostic criteria (e.g., PHQ-9 and MDD in the DSM), and others less connected to diagnostic premises (POMS, Portrait Choice Task). Some questionnaires are also considered more sophisticated than others, largely based on their ability to provide a comprehensive profile such as the Minnesota Multiphasic Personality Inventory (MMPI).[10] All of the above described instruments have been used in studies in this review to assess depressive symptoms; however clearly comparisons of these findings are significantly limited due to the heterogeneity of the measures.

Diverse Findings

As highlighted in Table A, there are diverse findings relating to the prevalence of psychological symptoms experienced by pilots (both civilian and military) compared to the general population. The World Health Organization (WHO) provides data about the prevalence rate of certain psychological conditions, two of which featured prominently in pilot mental health studies, namely anxiety and depression.[77] As can be seen in Fig. 2 and Fig. 3, six and nine studies, respectively, found a higher prevalence rate for anxiety and depression compared to the WHO's reported prevalence rate. Conversely, there were nine studies for each condition that found a lower prevalence rate compared to the WHO's reported prevalence rate.

As articulated previously, there are a number of factors that could account for the findings of specific studies, one of which relates to the data collection method. While the psychological properties of the questionnaires may be responsible for some of these differences, there are other factors that may account for these differences. For example, questionnaires can offer the respondent anonymity, which in the aviation context, renowned for underreporting, has the potential to elicit a less guarded response.[16] In contrast, clinical interviews are more likely to be influenced by factors relating to both the respondent and the clinician, such as impression management on behalf of the respondent, and biases or competence of the clinician. The results may have also been influenced by the type of pilot who volunteered for the studies involving questionnaires. In contrast, it would appear that none of the clinical interviews and databases that contained their findings were voluntary in nature, thus possibly accounting for the differences. Questionnaires also generally measure symptoms rather than established diagnoses, whereas the opposite is true of databases.[57]

Another factor that may affect the prevalence rate is the profession the pilot is employed in. It is of note that 18 studies focused on military aviators (2 of these used mixed samples of pilots[28,55]). Military aviators may comprise a unique group within aviation, due to the specialized training and environmental stressors they face (e.g., combat-related stressors). Even within this unique group, variability has been found due to factors such as mission activities and base location,[59] making comparisons difficult with commercial pilot operations.[14] Of the 18 studies on military pilots, 50% utilized databases. All of these database-based studies reported prevalence rates found for mental health issues were lower than that of the general population, with the exception of two studies whose sample population were not comparable. The remainder of the studies utilized questionnaires, including one study which used both questionnaires and interview. Only two studies found higher prevalence rates of mental health issues in their samples (three were not comparable), including the study administering questionnaires and interview; however, as mentioned with regard to this study earlier in this paper, the sampled group of military pilots had just returned from combat (post deployment screening[79]).

Symptoms and Flight Performance

The effect of mental health symptoms on flying performance was investigated in 13 studies. However, most studies noted the impact from a management perspective, such as grounding of pilots, as opposed to its effect on a pilot's flight performance. These studies were all database studies. For example, six studies noted psychiatric causes that resulted in the pilot becoming unfit (i.e., grounded) for flying duties.[7,8,14,29,32,71] One study examined the link between antidepressant medication usage and incident and accident involvement. SSRI usage was not associated with higher incident or accident involvement.[65]

The studies that were able to identify in some detail the impairment caused by mental health symptoms were all questionnaire-based studies. For example, Johansson and Melin[39] used the HADS, along with a single question about presenteeism to determine the link between anxiety, depression,

presenteeism, and errors committed in the cockpit. No link was found between anxiety or depression (HADS score ≥ 8) and errors; however, number of self-reported errors was higher among pilots reporting presenteeism than pilots who did not report presenteeism. Loewenthal et al.[51] found a relationship between self-reported flying incidents and stress (weak 0.019), as well as distress (moderate 0.041) using the Life Events and Difficulties Schedule (LEDS). However, no differences were found between nonincident and incident pilots based on depressed mood, loss of concentration or suicidal thoughts. Wu et al.[78] linked depression symptoms as determined by a score on the PHQ-9 above 10 with problems in one of three areas of functioning: at work, taking care of things, or getting along with people. A link between the two was noted by 1.5% of males and 0.4% of females. Hidalgo-Munoz et al.[38] assessed the interacting effects of personality traits and anxiety during a simulator task where speed and heading was recorded to measure performance. They found that the presence of a social stressor increased anxiety, moderated by neuroticism, though no performance effects were found. Giannakoulas et al.[35] examined the effect of nicotine withdrawal on three cognitive tasks: mental arithmetic, visual vigilance, and image free-recall. Nicotine withdrawal affected pilots' mental arithmetic and image free-recall, not visual vigilance. Pilots also reported they had experienced the following effects during flight (with percentage of pilots who experienced the symptoms in parentheses): fatigue (25%), difficulty concentrating (20%), vigilance decrement (20%), increased reaction time (10%), and impairment of judgment (5%). Aljurf et al.[5] found pilots who had a high HADS depression score (≥ 8) were at a high risk of obstructive sleep apnea.

Summary of Findings

In summary, the systematic review revealed that studies examining pilot mental health outside of database searches largely had a narrow focus, typically focusing on general depression and anxiety symptoms, and suicide. Studies examining the findings from clinical interviews or hospitalizations through database searches revealed specific psychological conditions such as panic disorder, PTSD, and OCD as being common. The results also revealed that observed prevalence rate of mental health symptoms was closely tied to methodology, where questionnaires, and in particular the PHQ-9, consistently revealed higher prevalence rates than other methods. The findings also highlight possible reasons for these differences, such as anonymity, use of different cut-off scores, and validity of questionnaire as possible reasons for the differing findings. Lastly, most studies implicitly assume there is a direct link between symptoms and pilot flying ability. However, few studies sought to investigate this assumption, and if they did it was through self-report measures as opposed to examining its effect at a behavioral or cognitive level.

Applied Implications

From an applied perspective, and notwithstanding the suggestion above that questionnaires should not be used in isolation for diagnostic purposes, clinical practice should consider a comprehensive assessment of potential pilot mental health conditions across the span of a pilot's career. Furthermore, a clearer assessment during examination of the extent to which any mental health symptoms cause flight impairment is warranted, rather than to presume the presence of mental health symptoms necessarily cause flying impairment. In addition, a concerted effort is required by both aviation governing bodies and airlines to build trust among pilots to overcome the widespread underreporting of psychological symptoms by pilots.[54] Central to its success is having a system that supports pilots, as opposed to one that is punitive in nature. This involves clearly articulating and promoting the benefit of reporting, protecting pilots that report from reprisal at both a regulatory and organizational level, ensuring adequate treatment is available, and importantly providing a clear path to potentially continue flying or an alternate meaningful role (e.g., simulator instructor).

Limitations

While this review was comprehensive, it is not without its limitations. The most obvious relates to scope and terms of the systematic review. It is possible that the search strategy may have failed to capture all papers, despite using a range of specific and broad terms as well as multiple databases. Furthermore, only papers printed in English were included in the review. This study did not include studies on rotary wing pilots. While rotary wing pilots are indeed pilots and are subject to mental health issues, the type of operation, risks (i.e., number of passengers on board, engines, weather), as well as the operational demands vary. Therefore, it is difficult to compare study findings alongside fixed wing pilot studies. In terms of content, it was difficult to compare prevalence rates of mental disorder in different samples when the disorder was not clearly defined or was assessed in different ways (e.g., medical records, questionnaire, structured interviews).[63] This was further exacerbated by the diversity in symptom definition. In addition, not all studies had a control group or normative data to compare against.

Future Research

The study of pilot mental health has seen increased interest since the Germanwings incident in 2015. This was observed in this review with more than a 2.5-fold increase in studies on pilot mental health published since 2015, compared to a comparable period prior to 2015 (8 studies published 1999–2014, 21 studies published 2016–2021). Nevertheless, the areas for future research are plentiful. Pilot mental health is of utmost importance to airlines, passengers, and to pilots themselves. Understanding the breadth of symptoms that pilots may experience is important. Hence, future research should focus on employing more comprehensive methods, making sure to include anxiety disorders, OCD, stress-related disorders, and substance use issues. To achieve this aim, studies should consider supplementing questionnaires with a clinical interview. While questionnaires are commonly used to investigate mental health in other populations, the fact that pilots are renowned for being reluctant to endorse mental health symptoms is a compelling

argument that a questionnaire-based methodology in isolation is less than an ideal choice for assessing psychological experiences of pilots. Further, questionnaires and interview used in combination increase not only the chance of detecting symptoms, but our ability to understand comorbidity. Future research should also investigate in greater detail risk factors (e.g., financial stress, marital problems, etc.) and their relationship with disorders. In a similar vein, protective factors such as coping strategies, exercise, diet, and music should be investigated to understand how they contribute to a pilot's overall psychological health.

Research should also be directed toward understanding the link between symptoms and pilots' flight performance. Understanding if and how mental health issues impair performance through biological measurements and observations in flight simulators would be valuable, though not without its challenges. The complexity of this issue extends beyond the physiological, behavioral, and cognitive effects, and includes reasons for withholding information (either underreporting or failing to report). Obtaining such information at present is becoming increasingly difficult due to the positive effect of fewer incidents and accidents, as aviation becomes safer. Therefore, some aviation organizations are placing reliance on pilots to provide safety related information to further enhance safety.[54] Understanding the barriers to reporting mental health symptoms is an important step in breaking down these barriers.

Conclusion

Two important conclusions can be drawn from this systematic review. The first is that the prevalence rate of a psychological disorder among pilots is closely associated with the methodology. Moreover, questionnaires, either with or without a clinical interview, were the only methodology to reveal a prevalence rate higher than the general or comparable population. The second is the lack of clarity surrounding the link between common mental health conditions, as investigated in the majority of papers, and a pilot's flying ability. To some extent the strength of these conclusions needs to be tempered by the limited studies that investigated prevalence rate and impairment in flying ability. They also need to be tempered by the lack of clarity associated with the factors that may explain these differences. For example, questionnaires may provide a more accurate picture in some situations due to their anonymity, and with pilots this is important due to the threat of "loss of license." This, however, is highly contingent on many factors, such as how well the questionnaire is designed and accurately measures symptoms, whether the threshold (i.e., cut-off) is appropriate to define the condition, symptom, or syndrome, and whether the questionnaire is being used by the respondent for other purposes (e.g., to attract the attention of management). Hence, future research should scrutinize the efficacy of questionnaires in measuring pilots' mental health and consider alternative approaches such as supplementing a questionnaire for diagnostic purposes with a clinical interview. Future research should also focus on employing objective methods to investigate the link between symptoms and flight performance to better understand the effect of mental health on pilots' ability to safely operate an aircraft, as well as understanding the barriers to reporting mental health conditions.

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