Aerospace Medical Association Proposed Research Priorities for Mental Health and Safety in Aviation

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INTRODUCTION: Aviation safety sensitive personnel (SSP) function in highly complex environments. SSP mental health is thought to support safety, efficiency, and overall health. Research is needed to identify how to optimize and screen mental health across aviation SSP, but no consensus exists on the research priorities that need to be met.

METHODS: The Aerospace Medical Association established the Mental Health Research Subgroup within the Mental Health Working Group comprising 53 aviation and aerospace medicine professionals representing 9 countries. A five-round Delphi method was employed to generate research priorities.

RESULTS: Research priorities were identified under the following six topic areas: 1) Safety and Performance; 2) Mental Health Initiatives, Education, and Peer Support Programs; 3) Clinical Care, Pharmacology, and Return to Duty; 4) Epidemiology and Natural History; 5) Screening, Monitoring, and Emerging Technology; and 6) Special Considerations and Underrepresented Populations [Aerospace Medical Association Mental Health Research Subgroup Research Priorities Version 1.0 (current as of January 1, 2024)].

DISCUSSION: Research is needed to identify how to optimize and screen mental health across aviation SSP. This effort identified six key research priorities to achieve that aim.

KEYWORDS: mental wellness, aerospace medicine, psychiatry, occupational health, occupational mental health.

Hoffman WR, Tvaryanas A, Snyder Q, Spyropoulos BP, Garcia D, Schroeder D, Fahnenbruck G, Trottier K, Overbo S, Santilhano W, Brinks E, Ndoye A, Bongers H, O'Shaughnessy R, Miranda E; Aerospace Medical Association Mental Health Research Subgroup. *Aerospace Medical Association proposed research priorities for mental health and safety in aviation*. Aerosp Med Hum Perform. 2024; 95(11):845–850.

Aviation safety sensitive personnel (SSP)—defined by the International Civil Aviation Organization (ICAO) as persons who might endanger aviation safety if they perform their duties and functions improperly and includes, but is not limited to, technical air crew, cabin crew, aircraft maintenance personnel, air traffic controllers, and security screeners[1]—function in highly complex environments. SSP mental health is thought to not only impact their overall health, but also their performance and ultimately the safety of the aviation system.[2,3] That said, a range of mental health symptoms and conditions may be common in certain SSP populations[4] and recent incidents potentially related to mental health[5,6] speak to the opportunity to re-evaluate efforts to support SSP mental health and aviation safety. While recent reviews aim to summarize current knowledge related to mental health in aviation,[7] many knowledge gaps remain. These include: 1) the relationship between mental health symptoms, performance, and safety; 2) the optimal method(s) to screen for mental health related safety concerns; 3) the relationship between various stressors and mental health symptoms in SSP; 4) the effectiveness of mitigations to those stressors; and 5) the optimal approach to clinical mental healthcare for SSP.

Research is needed to address open clinical, safety, and performance questions related to mental health in aviation, but no consensus exists on research priorities to inform investigators.

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This manuscript was received for review in February 2024. It was accepted for publication in July 2024.

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DOI: https://doi.org/10.3357/AMHP.6442.2024

The benefits of identifying research priorities include helping to guide researchers on selecting relevant questions, encouraging the shared use of terms, and advocating for further investigation in this field. Additionally, identifying and prioritizing relevant priorities may also encourage stakeholder financial investment into research and encourage collaboration across institutions.

To meet this need, the objective of the current effort is to define research priorities related to aviation mental health that, when accomplished, aims to enable aviation stakeholders to optimize SSP mental health while effectively identifying and mitigating threats to safety. The scope includes all aviation SSP (including pilots, cabin crew, maintenance engineers and ground crew, and air traffic controllers) in all military and civilian environments (including all training settings) and in every member state of the ICAO. Interventions include the full scope of nonpharmacological and pharmacological, preventive, and therapeutic psychological and psychiatric care.

METHODS

The Aerospace Medical Association (AsMA) Executive Committee established the Mental Health Research Subgroup (MHRSg) under the broader Mental Health Working Group on March 3, 2023. The objective of this subgroup was to accomplish a knowledge gap analysis and formulate research priorities. Solicitation for MHRSg members began with the Mental Health Working Group followed by snowball recruitment to create the final subgroup membership. Individuals with experience and interest in aviation SSP mental health were specifically sought to participate. MHRSg membership included 53 individuals with a broad range of backgrounds and work experience, including aviation psychiatry, aviation psychology, aerospace medicine research, civil aviation regulation, neuropsychology, aerospace academia and flight instruction, aircrew, military and civilian aviation, primary care and aerospace medicine physicians, and peer support program leaders. Working group medical and mental health professionals included 15 physicians, 2 aviation psychiatrists (one a Federal Aviation Administration Human Intervention Motivation Study Aviation Medical Examiner), 2 master's degree-level clinical aviation psychologists, and 3 Ph.D.-level clinical aviation psychologists. Members represented nine countries including the United States, Australia, Norway, Finland, England, Switzerland, Germany, South Africa, and Iceland in both military and civilian aviation settings.

The MHRSg used the Delphi method[8] to generate consensus aviation SSP mental health research priorities.[8] The MHRSg consulted with two qualitative researchers within the working group experienced in the Delphi method prior to starting the effort. Five rounds of electronic surveys were distributed to members between April and October 2023. Google Forms was used as the survey platform and links were distributed via email. Instructions for each round included the scope and objectives of the effort. One in-person meeting occurred on May 24, 2023, at the AsMA Annual Scientific Meeting in New Orleans, LA, United States.

Round one took place in April 2023, where opinions about the scope and objectives were collected. The scope and objectives were subsequently finalized at the in-person meeting in May 2023. Subsequently, attendees of the in-person meeting were divided into five groups. Each group was asked to independently generate a list of research categories (i.e., research themes) and an associated definition under which knowledge priorities would be included. The founders of the MHRSg then aggregated these five lists into a single list including six categories using a consensus-based approach. Round two took place in June 2023, where feedback on the six research categories, the definitions, and prioritization (using a voting method to rank the categories in priority order) was collected. Round three asked members to propose research priorities (i.e., research topics) for each research category.

To generate the preliminary list of research priorities for each category, six groups consisting of one to four volunteers were designated. Each group was assigned a specific research category based on their experience, academic qualifications, and interest. Knowledge priorities for each category obtained during the second round of Delphi were provided to the respective group. The groups then: 1) consolidated their list into 5–10 priorities statements; 2) condensed questions when able; 3) defined terms; 4) reviewed the relevant literature to ensure no similar studies had already been published; and 5) reviewed their priorities with an additional expert in the field. A MHRSg leader then met with all six teams individually to provide guidance and ensure efforts were mirrored between groups. There was no specification on what constituted a comprehensive literature search or expert review. The final list of research priorities was submitted electronically in the fourth round in August 2023.

The submissions from round four were reviewed and edited by the MHRSg. This included: 1) ensuring use of uniform terminology, 2) reallocating priorities into appropriate categories, 3) clarifying priority statements, 4) removing redundant priorities, and 5) formatting the document. This task was completed independently by two of the leading researchers of the MHRSg and then a final document was generated using a consensus approach. Disagreements were resolved through the guidance of other subgroup members. The document was then reviewed by an oversight team of three experts. Feedback from round five was incorporated in the document. The final document was reviewed by the chair of the AsMA Mental Health Working Group prior to submission. The process is summarized in **Fig. 1**.

A list of terms requiring definition was identified. A member of the MHRSg conducted a literature review on relevant terms and generated the final list of definitions. When possible, definitions from the ICAO[9] list of definitions were used or were otherwise referenced. The list of definitions is included in **Appendix A** (available at https://doi.org/10.3357/amhp.6442sd.2024).

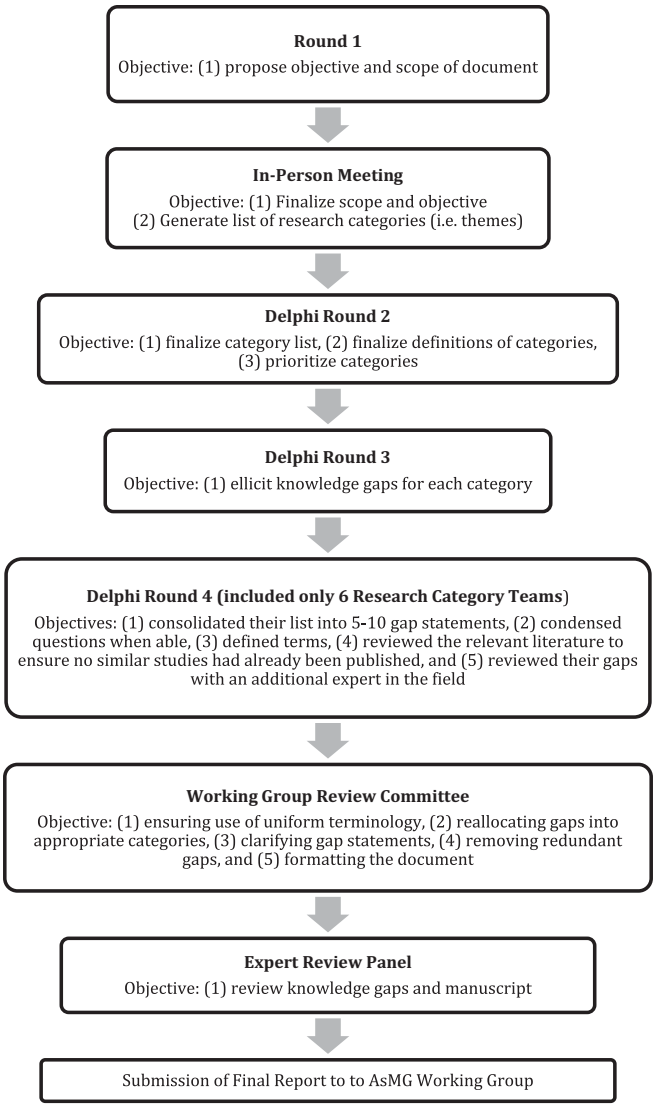

Fig. 1. Process for compiling and reviewing the report.

RESULTS

The methods described above produced the AsMA MHRSg Research Priorities Version 1.0 (current as of January 1, 2024), which are presented below. **Table I** shows the collection dates and number of responses for each round. Six teams were established to oversee each of the six research categories. **Table II** lists the six research categories, the number and background of the team members, and the number of group members who voted the category as being among the three most important.

Table I. Survey Collections.

ROUND	COLLECTION DATES	NO. OF SURVEY RESPONSES
1	May 2–12, 2023	14
In-person meeting (AsMA Annual Scientific Meeting in New Orleans, LA)	May 24, 2023	43 attendees
2	June 2–20, 2023	21
3	July 8–24, 2023	16
4	July 29–October 2, 2023	6 (group responses)

Safety and Performance

These are the relationships between mental health, performance, and safety in SSP and threats to safety and performance associated with various mental health states and operational stressors.

1. Characterize and/or quantify performance of SSP who report mental health symptoms and/or fulfill the diagnostic criteria for a clinical mental health condition, including generalized anxiety disorder and major depressive disorder.
2. Identify and/or quantify threats to safety associated with various mental health states in SSP in all operational environments.
   A. Identify unique threats to safety associated with various mental health states in single-pilot operational environments.
3. Identify and/or quantify defenses used to mitigate hazards to safety associated with various mental health states in SSP in all operational environments.
   A. Identify and quantify defenses used to mitigate the hazards associated with various mental health states in SSP in single-pilot operational environments.
4. Identify and/or quantify the effects of mental health states on performance in SSP in all operational environments.

Table II. Delphi Round 4 Team Members.

CATEGORY	NO. OF TEAM MEMBERS	BACKGROUND OF TEAM MEMBERS	RESPONDENTS WHO RANKED CATEGORY AS TOP THREE MOST IMPORTANT (%)*
Safety and performance	1	Aerospace researcher, clinical psychologist, pilot peer support leader, airline pilot	18/21 (85.7%)
Mental health initiatives, education, and peer support programs	4	Airline pilots, pilot peer support leaders, pilot union aeromedical committee members	18/21 (85.7%)
Clinical care, pharmacology and return to duty	1	Aviation psychiatrist	12/21 (57.1%)
Epidemiology and natural history	2	Aerospace safety researcher, airline pilot, university student	8/21 (38.1%)
Screening, monitoring, and emerging technologies	1	Airline pilot, graduate-level psychology student	6/21 (28.6%)
Special considerations and underrepresented populations	3	Aviation university counseling center director, aerospace psychologist, airline pilot	1/21 (4.8%)

*Number of responders to Delphi Round 2 who selected the associated category as being among the top three most important of all listed categories.

5. Identify and/or quantify the relationship between operational stressors and mental health states in SSP in all operational environments.
6. Characterize and/or quantify the relationship between mental health states in SSP and perception of and adherence to safety protocols.

Mental Health Initiatives, Education, and Peer Support Programs

This is evidence-informed best practices aimed at optimizing and maintaining aircrew mental health; for instructing and assessing mental health practices; and for aircrew peer support programs and employee mental healthcare programs.

1. Define the factors in peer support programs that result in optimal mental health states in SSP.
2. Define the factors in mental health education and promotion programs that result in optimal mental health states in SSP.
3. Define the optimal selection, training, evaluative, and oversight factors in peer support programs using mental health state, performance, and/or safety outcomes.
4. Evaluate the extent to which organizations have used: 1) mental health education and promotion, and 2) peer support programs and quantify the return on investment using a financial measure.
5. Characterize and/or quantify the relationship between use of mental health education and promotion programs and mental health states in SSP.
6. Characterize and/or quantify the relationship between use of mental health education and promotion programs and mental health states in other safety sensitive industries to identify factors unique to SSP.
7. Characterize the relationship between the application of a salutogenic approach in aviation and mental health, performance, and/or safety.
8. Characterize and/or quantify the attributes of a psychosocially safe work environment for SSP using a financial, safety, and/or performance measure.
9. Identify the legal and ethical hazards associated with data collection in peer support programs for SSP.

Clinical Care, Pharmacology, and Return to Duty

These are evidence-informed best practices for clinical treatment of aircrew mental health conditions including the full scope of nonpharmacological and pharmacological, preventive, and therapeutic psychological and psychiatric care, and for return to duty. Another aim was to clarify the aeromedical risk profile of psychotropic medications in all aircrew populations.

1. Characterize and/or quantify the engagement and compliance with clinical treatment in SSP.
2. Characterize and/or quantify performance decrement related to medication side effects in pilots and air traffic controllers using performance and/or safety measures.
3. Define the optimal method(s) to identify operationally relevant medication side-effects in SSP.
4. Characterize the relationship between the clinical severity of mental health condition(s) in SSP and the circumstances surrounding reporting.
5. Compare approved medications, certification standards, and monitoring protocols related to mental health between regulatory jurisdictions using safety and/or performance measures.
6. Characterize and/or quantify the relationship between mental health symptomatology and performance as it relates to aeromedical certification.
7. Define and/or quantify the acceptable level of clinical remission from a mental health diagnosis to permit return to duty in SSP using safety and/or performance measures.
8. Define and/or quantify the effectiveness of various forms of psychological and psychiatric care in SSP using safety and/or performance measures.

Epidemiology and Natural History

This is a characterization and natural history of the mental health states in SSP throughout their operational lifespans and the prevalence, incidence, and history of mental health conditions in SSP throughout their lifespan.

1. Define the incidence and prevalence of clinical mental health conditions in SSP over their operational lifespans.
2. Characterize the natural history of clinical mental health conditions in SSP over their operational lifespans.
3. Define and/or quantify operational, occupational, and demographic factors that influence mental health states in SSP.
   A. Characterize and quantify the relationship between operational stressors and mental health states in SSP using performance and/or safety measures.
   B. Define and validate tools to measure operational stressors in SSP.
4. Characterize and validate interventions to mitigate operational stressors in SSP.
5. Define and/or quantify operational, occupational, and demographic factors that influence mental health states in other safety critical professions to identify risk factors unique to aviation SSP.
6. Characterize and/or validate the effectiveness of existing channels in aviation to report factors that negatively influence mental health states in SSP.
7. Characterize and/or quantify the factors that influence mental healthcare seeking behaviors and health information disclosure in SSPs.
8. Characterize the relationship between a history of a mental health condition and seeking/securing a career as an SSP.

Screening, Monitoring, and Emerging Technologies

This defined screening and monitoring for mental states in SSP and the role of emerging technology, including artificial intelligence, biometric data collections tools, and real-time monitoring devices on screening and monitoring mental states in SSP.

1. Define the sensitivity and specificity of the following methods to screen for hazardous mental health states in SSP using performance and/or safety measures.
   A. Online questionnaires
   B. Periodic medical evaluations
   C. Flight simulator and other operational surrogate evaluations
   D. Neuropsychological testing
   E. Emerging artificial intelligence tools
   F. Biometric data collections tools
2. Define the sensitivity and specificity of the following in monitoring for hazardous mental health states and determining return to duty in SSP using performance and/or safety measures.
   A. Online questionnaires
   B. Periodic medical evaluations
   C. Flight simulator and other operational surrogate evaluations
   D. Neuropsychological testing
   E. Emerging artificial intelligence tools
   F. Biometric data collections tools
3. Define and/or quantify the relationship between the usage of various methods for screening and monitoring mental health states in SSP as it relates to safety.
4. Identify the legal and ethical hazards associated with the usage of various methods to screen and monitor mental health states in SSP.

Special Considerations and Underrepresented Populations

These are factors unique to select populations that have the potential to influence SSP mental health, including (but not limited to) factors related to traditionally underrepresented persons or groups in aviation, reproductive topics, military operations, and resources available for mental health.

1. Define strategies and standards to generate and implement culturally sensitive mental health education and promotion programs, peer support programs, and mental health policies at all levels.
2. Define and/or quantify factors that influence access to and usage of: 1) mental health education and promotion programs, 2) peer support programs, and/or 3) mental health clinical care in all SSP.
3. Define and/or quantify factors that influence mental health states in historically underrepresented SSP.
4. Define strategies and standards to conduct aviation mental health research that is inclusive of historically underrepresented SSP.
5. Define and/or quantify factors that influence mental health states in SSP related to reproductive topics.
6. Define and/or quantify factors that influence mental health states in SSP related to military operations.
7. Define and/or quantify factors that influence mental health states in SSP related to resources available for mental health in different geographic, regulatory, and operational environments.
8. Define and/or quantify factors that influence mental health states in SSP related to flight training environments.

DISCUSSION

This study employed the Delphi method to generate a consensus list of aviation SSP mental health research priorities. Members believed investigating these priorities would help aviation stakeholders optimize SSP mental health states, understand the role of various metal health states on performance, and also identify and mitigate safety threats. This effort is not intended to be exhaustive or serve as a statement of the current state of knowledge. Other publications like those available thorough the European Union Aviation Safety Agency MESAFE project should serve this function.[7] Instead, this effort aims to guide researchers in selecting research topics, encourage use of shared terminology, and facilitate advocacy for investing in research on this topic based on the opinions of a range of subject matter experts. This document should be seen as part of an ongoing and evolving discussion.

While there are many possible research questions, this effort identified priorities that were felt by the working group to be of greatest relevance to aviation stakeholders facing complex questions related to SSP mental health. These include questions about safety and performance, mental health and peer support programs, clinical care and certification, epidemiology, and natural history. These topics should be explored in the context of evolving technology and in a way that is inclusive of traditionally underrepresented populations. Outcome measures were intentionally selected in hopes of increasing the likelihood that the broader objectives of this effort are accomplished. For example, priorities about peer support programs suggested a financial outcome measure to better understand the return on investment for such programs. More broadly, it is critical that these topics be investigated in a way that will not result in unintended harm to aviation SSP. For this reason, a broader discussion about how to conduct research related to mental health in aviation is necessary. This discussion should be continuous and include aviation SSP, operators, regulators, researchers, and ethicists to ensure the aeromedical system of the future focuses on meeting the unique mental healthcare needs of SSP while optimizing safety. An additional consideration is the difference between the science related to various interventions related to mental health and the policy and practice of those interventions. For example, investigating the sensitivity of a mental health screening tool in airline pilots requires different research methods than investigating the optimal application or use of such a tool. These types of questions should be investigated separately and with due consideration of culture, access, and practice. Lastly, the depth and complexity of mental health in aviation must be acknowledged. While the current effort primarily focuses on factors on the level of the individual SSP, the cumulative systems-level implications are complicated by policy, culture, practice, and access. The scoping of research projects, the selection of outcomes, and the interpretation of results should be considered within this context.

Any conclusions drawn from this study should be within the context of the limitations. It is significant to note that all the group members were volunteers, and the results may therefore

reflect the opinions of their varied degrees of participation. Furthermore, the results are limited by the volunteers' experience and expertise. There were no formal criteria for membership beyond interest in the topic and meeting a broad definition for experience with aviation SSP mental health. Each round of Delphi included survey responses from fewer than half of the group members, which may have resulted in response bias toward those who participated the most. Further, nonpilot SSP had limited representation within this working group, including ground crew, air traffic controllers, flight attendants, and other professionals. This could have resulted in priorities preferentially focused on pilots. These points were partially mitigated by seeking external subject matter expert opinions and guidance from members of ICAO and the AsMA Mental Health Working Groups. Additionally, while representation from nine ICAO countries could be viewed as a strength, the generalizability of the results to all ICAO nations is limited for many reasons. Further efforts should focus on encouraging the participation of the 193 ICAO nations. The authors acknowledge that identified priorities are broad and lack individual research questions, making it difficult to determine if and how a priority might be fully addressed. Further, priorities are prioritized by large categories, limiting the ability to determine the priority of individual research questions. Future iterations should: 1) focus on definitions of terms, 2) conduct a systematic gap analysis, 3) prioritize gaps, and 4) make the focus of gap statements into research questions. As it relates to methods, there was no formal process to guide teams on how to conduct a literature review and no dedicated oversight or quality check of reviews. The listed knowledge priorities are also broad, making it difficult to fully review all literature potentially relevant to any one priority. Consequently, there may be previous studies that address some priorities listed in this document, so this document should not be seen as a current state of knowledge. There were no experts on the Delphi method within the subgroup. While external consultation and guidance from previously published work were used, group leaders employed this method to the best of their knowledge and ability. Additionally, the questions, science, and practice of mental health in aviation is rapidly evolving and these research priorities and definitions pertain to the state of the science at the time of writing. Therefore, future updates or iterations will be necessary to keep this document up to date.

ACKNOWLEDGMENTS

We would like to thank the 53 members of the AsMA Mental Health Research Working Subgroup who volunteered their time and expertise in this effort. We'd also like to specifically thank Mr. Jeffrey Sventek, who provided critical support and guidance. This project would not have been possible without Elijah Miranda, who assisted with administration and coordination.

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Financial Disclosure Statement: Sky Overbo is employed by the College of Aerospace at the University of North Dakota, which may benefit from the outcome of research in this area. However, his participation in this research is not funded by the school. The other authors have no competing interests to declare.

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