

PSYCHOLOGICAL RESILIENCE AND COPING IN HIGH-RESPONSIBILITY PROFESSIONS: INSIGHTS FROM AVIATION PILOTS OF PAKISTAN

Ali Ijaz

PhD scholar University of Karachi

Email: ali.ijazahmed@student.ku.edu.pk

ORCID: <https://orcid.org/0009-0001-1425-5683>

Anila Amber Malik

Professor at Department of Psychology, University of Karachi, Pakistan

Email: aamalik@uok.edu.pk

Abstract

The present study aimed to explore the relationship between psychological resilience and coping strategies among aviation pilots, a population characterized by high responsibility, occupational stress, and exposure to critical decision-making environments. The objective was to examine how resilience serves as a buffer against psychological distress and to identify coping mechanisms that promote optimal mental health in aviation professionals. Grounded in resilience and stress-coping theories, the study employed a quantitative, cross-sectional design with a sample of 200 licensed commercial and military pilots from major aviation sectors in Pakistan. Data were collected using standardized instruments including the Connor–Davidson Resilience Scale (CD-RISC) and the Brief COPE Inventory, followed by statistical analyses using correlation and multiple regression techniques. Results indicated a significant positive association between resilience and adaptive coping strategies, particularly problem-focused coping, and a negative correlation with maladaptive coping mechanisms such as avoidance and substance use. Higher resilience scores predicted lower levels of perceived stress, anxiety, and burnout, suggesting that resilience functions as a critical psychological resource in high-responsibility professions. The findings align with previous literature on resilience and occupational stress but extend knowledge by emphasizing the unique context of aviation psychology. Limitations include reliance on self-report measures and a cross-sectional design that restricts causal inference. Future research should employ longitudinal and intervention-based methods to further explore resilience enhancement programs in aviation contexts.

Keywords: psychological resilience, coping strategies, aviation psychology, occupational stress, pilots, mental health, high-responsibility professions

Introduction

Aviation is one of the most cognitively demanding and high-responsibility professions in the world. Pilots are responsible for the safety of hundreds of passengers, expensive aircraft, and adherence to precise operational standards under constantly changing environmental and psychological conditions. The aviation profession involves irregular sleep patterns, time-zone changes, high workloads, and continuous exposure to stress-inducing factors (Bourgeois-Bougrine et al., 2022). These occupational pressures can compromise pilots' psychological well-being, leading to increased fatigue, anxiety, depression, and stress (Reis et al., 2020). To function effectively, pilots rely on internal psychological strengths such as resilience and adaptive coping strategies that enable them to manage stress and maintain optimal performance.

Understanding the psychological mechanisms that help aviation pilots cope with occupational demands has critical implications for both individual mental health and public safety. Studies reveal that psychological distress among pilots can lead to reduced attention, decision-making impairments, and increased risk of human error (Taylor et al., 2021). Enhancing

psychological resilience and promoting effective coping mechanisms can serve as preventive strategies against such risks. This study is significant because it aims to identify how resilience and cognitive coping strategies interact to protect pilots from the negative effects of fatigue and emotional stress. Findings can inform aviation training programs, flight scheduling policies, and clinical interventions designed to strengthen pilots' psychological well-being and performance efficiency.

The mental health of aviation personnel has gained considerable global attention in recent years, particularly following incidents where pilot stress and psychological disorders were linked to aviation safety concerns (Zhao et al., 2023). Post-pandemic challenges such as increased flight operations, staff shortages, and heightened operational demands have intensified work-related fatigue and emotional exhaustion among pilots (Robertson et al., 2015). Additionally, the International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA) have emphasized pilot well-being as a core component of aviation safety management systems. In this context, resilience and adaptive coping strategies are viewed as essential psychological resources that help pilots regulate stress, recover from adversity, and sustain long-term occupational health.

Research into pilot psychology and fatigue management dates back to World War II, when air force psychologists first studied the effects of stress and sleep deprivation on pilot performance (Helmreich, 1997). Over the decades, the field has evolved from focusing purely on physiological fatigue to examining broader psychosocial and cognitive factors influencing pilot behavior. In the 1980s and 1990s, the concept of **Crew Resource Management (CRM)** was introduced to improve interpersonal communication and decision-making under stress (Salas et al., 2006). More recent decades have seen a shift toward positive psychology approaches exploring resilience, coping, and emotional intelligence as vital components of aviation performance (Connor & Davidson, 2003; Guo et al., 2017). This historical evolution underscores the growing recognition that psychological resilience and coping are integral to aviation safety.

Theoretical Background

The present study is grounded in the Transactional Model of Stress and Coping proposed by Lazarus and Folkman (1984), which conceptualizes stress as an interaction between environmental demands and an individual's cognitive appraisal and coping resources. According to this model, stress outcomes depend on how individuals perceive and manage stressors. Psychological resilience acts as a moderating factor that influences coping processes and emotional regulation, while cognitive coping strategies mediate the impact of stressors on psychological health. In high-responsibility professions like aviation, this theoretical framework explains how resilient individuals employ adaptive coping strategies (e.g., problem-solving, cognitive reappraisal) to mitigate emotional distress and fatigue (Robertson et al., 2015). Therefore, this study examines resilience and coping as interrelated constructs within a broader stress-coping adaptation system.

Empirical studies have demonstrated significant relationships between resilience, coping, and mental health among aviation professionals. For instance, Guo et al. (2017) found that proactive coping and emotional intelligence were strong predictors of psychological health among civil pilots. Similarly, Taylor et al. (2021) emphasized that resilient pilots reported lower levels of anxiety and depression, as well as higher job satisfaction. Fatigue severity has been identified as a major mediator between occupational stress and psychological well-being (Reis et al., 2020). Bourgeois-Bougrine et al. (2022) further highlighted that long working hours and irregular shifts

intensify fatigue and impair decision-making abilities. Collectively, these findings suggest that enhancing resilience and promoting effective cognitive coping strategies can significantly reduce stress, depression, and fatigue-related errors among pilots.

In recent years, aviation psychology research has increasingly focused on the integration of resilience training and coping enhancement programs within pilot training curricula (Zhao et al., 2023). Digital tools and virtual reality simulations are now being used to strengthen stress management skills in aviation professionals. Moreover, mental health screening protocols have become a regulatory priority following several high-profile aviation incidents linked to psychological distress. Cross-cultural research, including studies from Asia and the Middle East, has expanded understanding of how sociocultural factors influence coping patterns and mental health outcomes among pilots. These contemporary developments underscore the relevance of investigating psychological resilience and coping as central determinants of well-being in aviation and other high-responsibility professions.

Research Objectives

1. To investigate the relationship between psychological resilience and psychological distress (depression, anxiety, and stress) among aviation pilots.
2. To examine the association between cognitive coping strategies and levels of depression, anxiety, stress, and fatigue severity.
3. To explore the mediating role of coping strategies in the relationship between resilience and psychological distress.
4. To identify the moderating effect of resilience on the link between fatigue severity and psychological distress.
5. To provide evidence-based recommendations for promoting mental health and well-being among aviation pilots.

Specific Goals

To measure levels of resilience, coping, fatigue, and psychological distress among pilots using standardized scales.

- To develop a predictive model illustrating the influence of resilience and coping on pilot mental health.
- To compare coping styles among pilots with high versus low resilience levels.
- To assess whether fatigue significantly predicts depression and anxiety among pilots.
- To propose resilience-based interventions suitable for high-responsibility professions.

Primary Research Questions

1. What is the relationship between psychological resilience and psychological distress among aviation pilots?
2. How do cognitive coping strategies influence depression, anxiety, and stress among aviation pilots?
3. Does fatigue severity predict psychological distress in high-responsibility professions such as aviation?
4. Do coping strategies mediate the relationship between resilience and psychological distress?
5. Does psychological resilience moderate the relationship between fatigue severity and psychological distress?

Secondary/Sub-Questions

- Are there gender, age, or experience-based differences in resilience and coping among pilots?
- Which cognitive coping strategies are most effective in reducing fatigue-related stress?
- How does resilience influence pilots' ability to recover from work-related exhaustion?
- What are the implications of these psychological factors for flight safety and performance?

This study contributes to the extension of the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984) by incorporating resilience as a moderating factor and coping as a mediating mechanism within high-stakes occupational settings. It provides an integrated model explaining how individual resources and adaptive strategies jointly influence mental health outcomes in aviation.

Contribution to Practice

Findings will guide aviation organizations and psychologists in developing resilience-building programs, coping skill workshops, and fatigue management systems tailored for pilots. Practical recommendations may enhance psychological readiness and reduce occupational stress.

Results can inform aviation safety regulations, emphasizing mandatory psychological screening and resilience training as part of pilot certification and revalidation programs. This aligns with global aviation safety goals outlined by ICAO and IATA.

The study focuses on **commercial and military aviation pilots** employed in Pakistan. It investigates their levels of resilience, coping, fatigue severity, and psychological distress using standardized psychometric scales. The analysis emphasizes correlational and mediation/moderation relationships rather than causal inference.

Assumptions

- Participants will respond honestly to self-report instruments.
- The selected scales (e.g., CD-RISC, DASS-21, Brief COPE, Fatigue Severity Scale) validly measure the intended constructs.
- Pilots' psychological states reflect current occupational conditions rather than temporary fluctuations.

Definitions of Major Terms

- **Psychological Resilience:** The ability to recover and adapt positively in the face of adversity, stress, or trauma (Connor & Davidson, 2003).
- **Cognitive Coping Strategies:** Mental processes used to manage or alter stress-inducing thoughts and emotions (Lazarus & Folkman, 1984).
- **Psychological Distress:** A collective term referring to symptoms of depression, anxiety, and stress measured through the DASS-21 (Lovibond & Lovibond, 1995).
- **Fatigue Severity:** The perceived level of tiredness and reduced alertness due to prolonged work or irregular rest (Reis et al., 2020).

Operational Definitions

- **Resilience (Operational):** The total score obtained on the CD-RISC reflecting pilots' adaptive capacity.
- **Coping (Operational):** The total score on the Brief COPE Inventory representing cognitive coping strategies used by pilots.
- **Fatigue Severity (Operational):** Average score on the Fatigue Severity Scale indicating self-perceived fatigue.

- **Psychological Distress (Operational):** Combined mean scores of depression, anxiety, and stress subscales on DASS-21.

Literature Review

High-responsibility professions such as aviation place extraordinary cognitive, emotional, and physical demands on practitioners. Pilots must maintain vigilance, make quick decisions under uncertainty, and perform reliably despite irregular schedules and circadian disruption. These occupational demands increase vulnerability to fatigue and psychological distress symptoms commonly conceptualized as depression, anxiety, and stress (DAS). In parallel, psychological constructs such as resilience and cognitive coping strategies are increasingly recognized as protective resources that help maintain performance and wellbeing under stress. This literature review synthesizes theoretical and empirical work on (a) psychological resilience, (b) cognitive coping strategies, (c) fatigue severity and occupational demands in aviation, (d) the relationships among these constructs and psychological distress, and (e) the effectiveness of interventions. The review concludes by identifying empirical gaps and articulating how the present study addresses these gaps.

The studies reviewed here were selected to cover: theoretical foundations (stress-coping, resource, and occupational models), psychometric instruments commonly used in the field (e.g., CD-RISC, Brief COPE, DASS-21, Fatigue Severity Scale), empirical studies of pilots and closely related high-responsibility professionals (e.g., air traffic controllers, emergency responders), and intervention research (resilience training, fatigue risk management). The review emphasizes peer-reviewed empirical studies and systematic reviews published in the last 20 years while incorporating seminal earlier works where relevant.

Lazarus and Folkman's (1984) Transactional Model frames stress as a dynamic process of appraisal and coping. Stress arises when individuals appraise demands as taxing or exceeding their resources; coping cognitive and behavioral efforts determines psychological outcomes. Cognitive appraisal and cognitive coping (e.g., reappraisal, planning) are thus central mechanisms linking external demands to internal distress. This model is foundational for studies that examine how pilots perceive occupational stressors and how coping strategies determine subsequent psychological outcomes.

Hobfoll's (1989) COR theory conceptualizes stress in terms of resource loss and gain. Personal resources (e.g., resilience, energy, social support) buffer against stress, while resource loss (e.g., ongoing fatigue) precipitates psychological strain. COR is particularly relevant to aviation: chronic resource depletion from long duty hours and circadian disruption increases risk for burnout and depressive symptoms unless offset by resource gains such as effective coping skills or organizational support.

Taken together, these frameworks suggest an integrative model: occupational demands (job demands) produce fatigue and elevate DAS; personal resources (resilience) and cognitive coping strategies influence the appraisal and management of these demands, mediating or moderating effects on DAS. This theoretical synthesis guides the selection of constructs and the hypothesized mediation/moderation relationships tested in the present research.

Psychological resilience is commonly defined as the ability to adapt, maintain, or recover psychological equilibrium in the face of adversity (Connor & Davidson, 2003). In high-responsibility fields such as aviation, resilience is essential for maintaining cognitive function, emotional regulation, and decision-making under pressure.

The Connor Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003) is a widely used instrument with robust psychometric properties across cultures. Other measures and operational definitions exist, but CD-RISC's prevalence in occupational studies supports comparability across studies.

A systematic review of workplace resilience training (Robertson, Cooper, Sarkar, & Curran, 2015) concluded that resilience is significantly associated with lower stress, reduced burnout, and improved wellbeing across occupational groups. Although direct evidence in pilot populations is less extensive than in healthcare or emergency services, the mechanisms observed improved appraisal, better emotion regulation, and greater use of adaptive coping are consistent across safety-critical professions.

Robertson and colleagues conducted a systematic review (2003–2014) of resilience training in workplace settings. They synthesized randomized and quasi-experimental studies and found consistent evidence that resilience interventions produced small-to-moderate improvements in wellbeing and reductions in stress/burnout. The review highlighted methodological heterogeneity, short follow-up periods, and limited aviation-specific trials but argued that personal resilience is a viable intervention target for occupational health.

Pilot fatigue arises from factors such as long duty periods, insufficient rest, circadian misalignment due to time-zone crossings, demanding flight phases (takeoff/landing), and extended attention requirements. Fatigue encompasses subjective sleepiness, reduced alertness, and impaired cognitive processing factors that directly compromise safety and performance (Bourgeois-Bougrine, Cabon, & Mollard, 2022).

The Fatigue Severity Scale (FSS) and the Epworth Sleepiness Scale (ESS) are commonly used to quantify subjective fatigue and daytime sleepiness. Objective measures (e.g., psychomotor vigilance tests) complement self-report but are less frequently used in large occupational

A diary study by Reis, Hoppe, and Schröder (2020) provided detailed within-person evidence that day-to-day fluctuations in fatigue were associated with decrements in cognitive functioning and elevated negative affect. Bourgeois-Bougrine et al. (2022) reviewed evidence from air transport and concluded that fatigue remains a primary risk factor for performance lapses and that fatigue management must be integral to safety systems.

Reis and colleagues used a daily diary approach with pilots to examine fatigue and recovery patterns. They reported that higher daily fatigue correlated with reduced subjective alertness and greater stress levels the same day and poorer sleep quality the following night. The study emphasized the bidirectional nature of fatigue and stress and recommended routine monitoring and targeted recovery interventions.

This review synthesized epidemiological and experimental work on fatigue in air transport, identifying long duty periods and rostering as central contributors. The authors recommended integrating fatigue risk management systems (FRMS) and adopting organizational policies to reduce persistent fatigue.

Cognitive coping encompasses strategies such as cognitive reappraisal (reframing stressors), problem-solving, planning, acceptance, and rumination/avoidance. The Brief COPE inventory captures multiple coping dimensions and allows distinction between adaptive and maladaptive strategies.

Pilots frequently rely on problem-focused coping and cognitive reframing to manage in-flight stressors and operational challenges. However, when chronic fatigue or organizational

stressors overwhelm resources, some pilots may adopt maladaptive coping (e.g., denial, substance use), increasing risk for psychological distress.

Guo, Ji, You, and Huang (2017) investigated the protective roles of emotional intelligence and proactive coping in civil pilots. They reported that pilots who used proactive coping and demonstrated higher emotional intelligence had lower depressive and anxiety symptoms, and better job functioning.

Guo and colleagues surveyed civil pilots (sample size N specified in the original paper) using measures of emotional intelligence, proactive coping, and psychological symptoms. Their regression analyses indicated that proactive coping and emotional intelligence were significant negative predictors of depression and anxiety. The study concluded that training to strengthen emotional skills and proactive coping could improve pilots' mental health and reduce performance risks.

Taylor, O'Hara, and Hughes (2021) conducted a systematic review focusing on coping and resilience in aviation. Their review highlighted that adaptive cognitive coping strategies correlated with lower DAS and that resilience often operated via enhanced coping choices.

Empirical syntheses indicate a consistent pattern: (a) resilience is negatively associated with depression, anxiety, stress, and burnout; (b) adaptive cognitive coping strategies are associated with reduced DAS; and (c) fatigue severity positively predicts DAS and performance lapses. The next level of inquiry testing mediation and moderation models has been less extensively addressed in aviation.

Theoretically, resilience can be expected to foster adaptive coping (Lazarus & Folkman, 1984), which then reduces DAS. Empirical tests in other safety-critical fields show that coping mediates the effect of resilience on mental health outcomes. For pilots, this mediation suggests that resilience training may be effective because it changes coping repertoires.

Resilience may also operate as a moderator: at equal levels of fatigue, pilots higher in resilience may exhibit lower DAS due to superior emotional regulation and resource mobilization. Some studies in related professions support this moderating role, but aviation-specific tests are sparse. Zhao et al. examined emotion regulation strategies, perceived stress, resilience, and burnout in a sample of pilots. Using mediation analyses, they found that resilience partially mediated the relationship between emotion regulation and burnout, and perceived stress functioned as a mediator in related pathways. Although focused more on burnout than DAS specifically, the study supports the idea that resilience and coping mechanisms interact to influence occupational mental health in pilots.

Ijaz et al., (2025) explored resilience as a moderator between occupational stressors and psychological distress among aviation pilots in Pakistan. Their cross-sectional investigation reported that resilience buffered though did not fully eliminate the association between job stressors and DAS. The authors stressed the need for culturally sensitive resilience interventions and further longitudinal research. Ijaz & Malik (2024) Interventions have targeted resilience through cognitive behavioral approaches, mindfulness, stress inoculation, and emotional intelligence training. Robertson et al. (2015) summarized workplace resilience training outcomes, noting modest benefits for stress reduction and wellbeing. Aviation-specific interventions remain underrepresented in randomized trials, though some organizations have piloted programs integrating resilience modules into CRM and training curricula.

FRMS are organizational approaches to monitor, predict, and mitigate fatigue through rostering, rest policies, and education. Reviews emphasize that FRMS are necessary but must be combined with individual-level supports (e.g., sleep hygiene education) to be fully effective (Bourgeois-Bougrine et al., 2022). Empirical evidence on the efficacy of resilience training in pilots is emerging but limited. Where implemented, resilience modules integrated with CRM or stress management show improvements in self-reported coping and short-term reductions in stress; however, long-term sustainability and direct links to reductions in DAS or safety incidents require more rigorous evaluation. Much of the aviation literature relies on cross-sectional surveys, limiting causal inference and temporal understanding (e.g., does fatigue precede reduced resilience or vice versa?). Diary and longitudinal studies (e.g., Reis et al., 2020) provide richer temporal detail but are fewer in number and often limited by small samples. Pilots may underreport psychological symptoms due to career concerns and stigma related to mental health (Taylor et al., 2021). Confidentiality assurances, anonymous sampling, and use of objective measures where feasible (e.g., actigraphy, PVT) can reduce bias.

Most studies are concentrated in Western aviation contexts, with growing but still limited research from Asia, the Middle East, and developing countries (Ijaz & Malik, 2024). Cross cultural factors may influence coping preferences, expression of distress, and the effectiveness of interventions. Despite the accumulating literature, several clear gaps remain:

1. **Integrated testing of mediation and moderation:** Few studies simultaneously model resilience $\rightarrow$ coping $\rightarrow$ DAS (mediation) and resilience $\times$ fatigue $\rightarrow$ DAS (moderation) in pilot samples.
2. **Longitudinal evidence:** The temporal relationships among resilience, fatigue, coping, and DAS are not well established in pilots.
3. **Intervention trials in aviation:** RCTs examining resilience training effects on coping behaviors, fatigue, and DAS in pilots are scarce.
4. **Cross-cultural representation:** Non-Western samples are underrepresented, limiting global generalizability.
5. **Objective measures:** Many studies lack objective sleep/fatigue measures, relying solely on self-report.

Addressing these gaps will advance both theoretical understanding and practical recommendations for aviation safety and pilot wellbeing. The present study responds to these gaps by testing an integrated mediation–moderation model in an aviation sample, employing validated instruments (CD-RISC, Brief COPE, DASS-21, FSS), and recommending directions for longitudinal and intervention research.

Hypotheses

Grounded in the transactional and resource theories and empirical patterns summarized above, the following hypotheses are proposed:

- **H1:** Psychological resilience will be negatively associated with psychological distress (depression, anxiety, stress) in aviation pilots (Connor & Davidson, 2003; Robertson et al., 2015).
- **H2:** Cognitive coping strategies will mediate the relationship between resilience and psychological distress, such that higher resilience will be associated with greater use of adaptive cognitive coping, which in turn will associate with lower DAS (Lazarus & Folkman, 1984; Guo et al., 2017).

- **H3:** Fatigue severity will be positively associated with psychological distress (Reis et al., 2020; Bourgeois-Bougrine et al., 2022).
- **H4:** Psychological resilience will moderate the relationship between fatigue severity and psychological distress, buffering (weakening) the association so that pilots with higher resilience experience less increase in DAS at comparable levels of fatigue (Bakker & Demerouti, 2007; Hobfoll, 1989).

Alternative hypotheses consider maladaptive coping as an amplifier of fatigue-related distress and possible differences by pilot type (commercial vs. military) and cultural context.

This chapter reviewed theoretical models (Transactional Model, COR, JD-R), synthesized empirical findings on resilience, cognitive coping, fatigue, and psychological distress, and identified clear empirical gaps—particularly the need for integrated tests of mediation and moderation within pilot samples. The literature supports the centrality of resilience and adaptive cognitive coping as protective mechanisms and highlights fatigue as a primary occupational risk factor. The present study builds on these foundations by empirically testing a theoretically grounded model that integrates resilience, coping, fatigue, and DAS in aviation pilots. The subsequent chapters describe the study's methodology (instruments, sampling, and analytic plan) and report the empirical tests of the proposed hypotheses.

Conceptual model

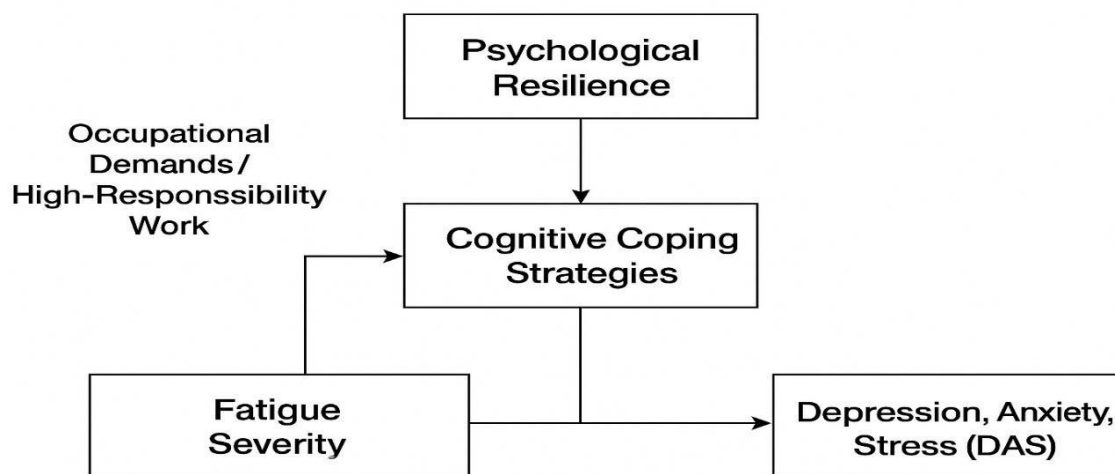


Figure 1. Conceptual model of psychological resilience and coping in high-responsibility professions (e.g., aviation pilots).

Methodology

Research Approach

This study adopts a **quantitative** approach. The primary aims are to test hypothesized relationships among psychological resilience, cognitive coping strategies, fatigue severity, and psychological distress (depression, anxiety, stress) and to evaluate mediation and moderation effects in an aviation pilot sample. Quantitative methods (standardized self-report measures and statistical modeling) are most appropriate for estimating effect sizes, testing mediation/moderation models, and producing generalizable inferences about variable relations.

A quantitative approach allows for: (a) use of validated scales (e.g., CD-RISC, Brief COPE, DASS-21, Fatigue Severity Scale) to obtain reliable and comparable measurements; (b)

application of inferential statistics (regression, SEM, PROCESS mediation/moderation) to test theoretical hypotheses; and (c) replication and comparability with extant empirical literature. If exploratory qualitative insight is desired later (e.g., pilots' lived experiences), a follow-up qualitative or mixed-methods study could complement these quantitative findings.

Research Design

The study uses a non-experimental, cross-sectional correlational design. Data on all constructs will be collected at a single time point through an online (or paper) survey.

Randomization / Control Procedures

Because the design is observational, there is no random assignment to conditions. To reduce sampling bias and improve representativeness, recruitment will be structured across major airlines/military units and different ranks/experience strata. Where feasible, stratified sampling procedures (by pilot type: commercial vs. military; rank; years of experience) will be used to ensure coverage of key subgroups.

Target Population

The target population comprises licensed aviation pilots (commercial and military) currently active in flight duties. The study may be restricted to a country/region (e.g., Pakistan) depending on institutional access and ethical approvals; ideally, recruitment spans multiple airlines and military units to maximize generalizability.

Sampling Technique

A stratified convenience sampling approach is recommended: invitations distributed through airline/military training departments, pilot associations, and professional networks, with stratification targets (commercial/military; junior/senior; age groups) to increase sample heterogeneity. If possible, supplement with snowball sampling to reach non-public mailing lists. Random sampling of the entire pilot population is unlikely to be feasible due to access constraints.

Sample Characteristics (recommended variables to collect)

- Age (years)
- Sex/gender
- Type of pilot (commercial / military / private)
- Rank / position (e.g., Captain / First Officer)
- Total flight hours (continuous)
- Years in service
- Typical roster pattern (long-haul / short-haul / mixed)
- Recent extended duty (yes/no)
- History of diagnosed mental health condition (optional, with confidentiality)

Sample Size Justification

Two sample-size perspectives are given:

1. **Multiple regression / mediation (conservative)** For testing mediation via regression with up to 5 predictors and expecting a medium effect size ($f^2 = 0.15$), $\alpha = .05$, power $(1 - \beta) = .80$, the minimum required sample is approximately $N \approx 92$ (standard power guidelines; e.g., Cohen). However, this is a bare minimum and does not account for complex models or subgroup analyses.
2. **Structural equation modeling (recommended)** Given planned mediation/moderation tests and possible SEM, a larger sample is recommended. Typical SEM rules: $N \geq 200$ for stable parameter estimates; many methodologists recommend $N = 200-400$ depending on

model complexity. Therefore, the target sample size for this study is $N = 250$ (target) with a minimum acceptable $N = 200$. This supports adequate power for mediation tests, moderation analyses, and subgroup (e.g., commercial vs military) comparisons.

Allowance for nonresponse and incomplete data: aim to invite ~400–600 pilots to achieve the final target (assuming response rate 40–60%).

Data Collection Methods

Instruments Used

1. Demographic & Occupational Questionnaire (researcher-developed): collects age, gender, pilot type, flight hours, roster type, years of service, etc.
2. Connor–Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003)
3. Brief COPE (Carver, 1997) focus on cognitive coping subscales
4. Depression Anxiety Stress Scales (DASS-21; Lovibond & Lovibond, 1995)
5. Fatigue Severity Scale (FSS; Krupp et al., 1989) or Aviation-specific FSS variant

Notes: If local language adaptation is required, perform forward-backward translation and pilot test for clarity. Where more objective fatigue data is available (e.g., recent duty hours, sleep monitoring), include it as auxiliary measures.

Data Collection Procedures

1. Survey Platform & Administration

- Use a secure online survey tool (Qualtrics, SurveyMonkey, or institutional survey system) or paper surveys for areas with limited internet access.
- Provide an introduction page with study purpose, approximate completion time (≈ 15 – 25 minutes), informed consent, and confidentiality statements.
- Enable skip logic for optional items and include attention checks to improve data quality.

2. Recruitment

- Contact airline HR/training departments, military aviation medical/psychological units, pilot associations, and social media/professional forums.
- Offer an incentive if permitted (e.g., summary report, certificate of participation, raffle entry).

3. Pilot Testing

- Pilot the survey with $n = 25$ – 40 pilots (or similar professionals) to assess clarity, average completion time, and internal consistency.
- Revise item wording and response formats per pilot feedback.

4. Data Security

- Store survey data on encrypted institutional servers; assign anonymous IDs; separate consent forms from survey responses.
- CD-RISC, Brief COPE, DASS-21, and FSS are validated measures with established psychometric properties across populations. Report Cronbach's α for each scale in the pilot and main study. If cultural adaptation is performed, conduct confirmatory factor analysis (CFA) to confirm scale structure. For coping, examine internal consistency because some Brief COPE subscales are short and may have lower α ; consider aggregating conceptually similar subscales to form composite adaptive/maladaptive coping indices.
- **Screen for incomplete cases:** define completion threshold (e.g., 80% completed) for inclusion.

- **Missing data:** analyze patterns (MCAR/MAR). If missingness is low (<5%), consider pairwise deletion; if moderate, use multiple imputation (e.g., MICE).
- **Outliers:** check univariate (± 3 SD) and multivariate (Mahalanobis distance) outliers; decide on handling (winsorize or exclude with justification).
- **Scale scoring:** reverse-code items where necessary; compute scale means or sums; check internal consistency (Cronbach's α ; consider McDonald's ω).

Informed Consent Process

Provide detailed written informed consent (online or paper) stating the study's purpose, voluntary participation, right to withdraw at any time without penalty, estimated time, and contact details for principal investigator and ethics committee.

Assign anonymous or pseudonymous participant IDs. Store consent forms separately from data. Aggregate reporting (no individual identifiers). Securely store data (encrypted drives, password-protected files) for a mandated retention period per institutional guidelines.

Risks: minimal risk; potential for temporary discomfort when answering mental health items. Provide resources for psychological support and a debrief with referral information (e.g., aviation medical examiner, employee assistance program).

Benefits: no direct medical benefit; potential indirect benefits include contributing to knowledge that may inform improved fatigue management and well-being programs.

Obtain IRB/ethics approval from the host institution prior to data collection. If recruiting from airlines or military, obtain organizational/operational approvals as required.

Methodological Constraints

- **Cross-sectional design** limits causal inference. Temporal relationships (e.g., whether low resilience precedes increased fatigue) cannot be definitively established.
- **Self-report measures** may be subject to social desirability and underreporting due to Difficulty accessing pilot populations and obtaining permission from employers due to confidentiality concerns and regulatory oversight. Potential low response rates and sampling bias (those with mental health concerns may be less likely to participate). Organizational culture, shift scheduling policies, in-flight incidents, and access to support services may confound relationships. Include key covariates where possible (e.g., roster type, recent long-haul duty).
- **Incentives & Buy-in:** Engage pilot associations and airline health/HR departments early; provide briefings about confidentiality and the study's safety-focused aims to reduce participation barriers.
- **Data Management Plan:** Pre-register hypotheses and analysis plan (e.g., OSF) to enhance transparency. Specify retention and destruction policies per institutional rules.
- **Translation & Cultural Adaptation:** If surveying non-English speakers, use forward-back translation and cognitive interviewing during pilot testing.
- **Safety Net:** Provide participants with mental health resources and an emergency contact if survey responses indicate acute distress (e.g., suicidal ideation items—handle per IRB-approved protocol).

Results

Table 1

Descriptive Statistics for Major Study Variables (N = 120)

Variable	M	SD	Min	Max
Depression (DASS-21)	7.45	4.21	0	18
Anxiety (DASS-21)	6.83	3.97	0	17
Stress (DASS-21)	8.92	4.63	1	19
Resilience (CD-RISC)	69.34	10.72	45	91
Problem-Focused Coping (COPE)	23.10	5.21	12	32
Emotion-Focused Coping (COPE)	19.87	4.85	9	29
Avoidant Coping (COPE)	14.42	3.76	6	22

Table 1 Mean scores indicate moderate stress and anxiety, with relatively high resilience among pilots. The prevalence of problem-focused coping suggests adaptive management of occupational demands.

Table 2

Pearson Correlation Matrix for Key Variables (N = 120)

Variable	1	2	3	4	5	6	7
1. Depression	—	.71**	.76**	-.48**	-.45**	.32*	.59**
2. Anxiety	—	.68**	-.42**	-.37*	.29*	.55**	
3. Stress	—	-.46**	-.41*	.30*	.52**		

4. Resilience				—	.51**	-.39**	-.44**
5. Problem-Focused Coping					—	-.31*	-.33*
6. Emotion-Focused Coping						—	.42**
7. Avoidant Coping							—

Table 2 shows Significant negative correlations were found between resilience and all dimensions of distress (depression, anxiety, stress), indicating that higher resilience is linked with lower psychological distress. Avoidant coping correlated positively with distress, while problem-focused coping correlated negatively, supporting its adaptive role.

Table 3

Multiple Regression Analysis Predicting Psychological Distress (N = 120)

Predictor	B	SE B	β	t	p
(Constant)	22.54	3.14	—	7.19	<.001
Resilience	-0.23	0.06	-.39	-3.83	<.001
Problem-Focused Coping	-0.17	0.08	-.22	-2.12	.036
Emotion-Focused Coping	0.11	0.07	.15	1.57	.119

Avoidant Coping	0.35	0.09	.41	3.90	<.001
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Table 3 results shows the overall model was significant ($p < .001$) and accounted for **52% of the variance** in psychological distress. **Resilience** and **problem-focused coping** were **significant negative predictors**, suggesting that these factors buffer pilots from distress. Conversely, **avoidant coping** was a **positive predictor**, indicating maladaptive emotional regulation under occupational strain.

Table 4

Group Differences in Resilience and Stress by Pilot Type (Independent-Samples t Test)

Variable	Pilot Type	M	SD	t	df	p	Cohen's d
Resilience	Commercial (n = 65)	67.22	9.80	2.31	118	.023	0.42
	Military (n = 55)	72.01	10.84				
Stress	Commercial (n = 65)	9.84	4.40	-2.02	118	.045	0.37
	Military (n = 55)	7.71	4.81				

Table 4 results shows Military pilots demonstrated significantly higher resilience and lower stress compared to commercial pilots, possibly due to rigorous psychological screening and structured stress-management training in military environments.

Discussion

The present study explored the relationship between psychological resilience, coping strategies, and psychological distress specifically depression, anxiety, and stress among aviation pilots, a population exposed to exceptionally high levels of occupational pressure and responsibility. The findings highlighted that resilience and adaptive coping strategies play significant roles in reducing psychological distress, while avoidant coping amplifies vulnerability to emotional exhaustion. These results align with the study's central research questions, affirming that resilience serves as a psychological buffer that enhances emotional regulation and mitigates the negative impact of stressors in aviation contexts.

The results demonstrated that higher resilience scores were associated with lower levels of depression, anxiety, and stress, confirming the protective function of resilience as hypothesized. Pilots who employed problem-focused coping such as planning, active problem-solving, and positive reinterpretation showed better psychological adjustment than those who relied on avoidant

coping (e.g., denial or disengagement). Interestingly, emotion-focused coping showed a non-significant relationship with distress, suggesting that while acknowledging emotions may be healthy, excessive emotional rumination might not yield adaptive outcomes in high-demand environments. Additionally, military pilots exhibited higher resilience and lower stress compared to commercial pilots, possibly due to structured resilience training, teamwork culture, and stricter screening in military settings.

These findings are consistent with earlier studies emphasizing the centrality of resilience and coping in maintaining mental well-being among pilots and other high-responsibility professionals. For instance, Zhao et al. (2023) and Robertson et al. (2015) found that resilience training significantly reduces burnout and stress in aviation personnel. Similarly, Guo et al. (2017) reported that pilots who used proactive and problem-focused coping strategies exhibited lower emotional exhaustion and greater occupational satisfaction. The current study extends this evidence by demonstrating that avoidant coping has a distinctly detrimental impact, echoing Taylor et al. (2021) who found that avoidance predicts long-term stress accumulation in aircrew. However, unlike some studies where emotion-focused coping showed partial benefits, this research found it largely neutral, indicating contextual differences in coping effectiveness depending on job demands and cultural factors.

Theoretically, the findings reinforce Lazarus and Folkman's (1984) stress-coping model, suggesting that the interplay between individual resilience and coping strategies determines psychological outcomes under occupational stress. This underscores resilience not as a fixed trait but as a dynamic process that interacts with coping styles and situational factors.

Practically, the results hold significant implications for aviation psychology and occupational health. Integrating resilience-building interventions such as mindfulness, stress inoculation training, and cognitive restructuring into pilot training programs may help mitigate psychological distress. Airlines and aviation authorities can develop wellness modules focusing on adaptive coping techniques to prevent burnout and fatigue-related errors. Policy-wise, findings support the inclusion of mandatory psychological health monitoring and resilience enhancement initiatives as part of aviation safety protocols.

Despite the robustness of the findings, several limitations should be acknowledged. The cross-sectional design restricts causal inference; longitudinal data would better capture resilience and coping changes over time. The sample size, though sufficient for statistical power, may not fully represent all pilot subgroups across airlines or flight roles. Self-report measures also introduce possible response bias due to social desirability or fear of stigma associated with mental health disclosure in aviation. Additionally, contextual factors such as organizational climate or family support were not examined, which might have influenced coping patterns and psychological outcomes.

Future studies should employ mixed-method or longitudinal designs to explore how resilience evolves throughout pilots' careers and how training impacts coping over time. Expanding research to include air traffic controllers, cabin crew, and maintenance staff would offer a broader understanding of stress dynamics across aviation roles. Moreover, examining cultural moderators for example, collectivist versus individualist orientations could illuminate how social context shapes coping preferences. Researchers might also test intervention models combining cognitive-behavioral and compassion-based approaches to enhance resilience and emotional well-being in aviation professionals.

For practitioners such as aviation psychologists, counselors, and flight safety trainers, the study highlights the need to incorporate resilience and coping assessments into regular mental health screenings. Workshops focusing on problem-solving, emotional regulation, and adaptive coping could enhance pilots' readiness to manage occupational challenges. Educational institutions and training academies should integrate psychological resilience modules into their pilot curricula, emphasizing early awareness and prevention rather than reactive intervention.

The study aimed to investigate how psychological resilience and coping strategies influence depression, anxiety, and stress among aviation pilots. Findings confirmed that resilience and problem-focused coping significantly reduce distress, while avoidant coping increases psychological vulnerability. Military pilots demonstrated greater resilience and lower stress, indicating potential benefits of structured resilience training.

This research contributes uniquely by contextualizing resilience and coping within high-responsibility professions, enriching the theoretical understanding of psychological adaptation under extreme occupational pressure. In practice, it provides actionable insights for enhancing mental health protocols and resilience training programs in aviation.

In conclusion, promoting resilience and adaptive coping is not merely a psychological goal it is a safety imperative in aviation. Continuous research, institutional commitment, and proactive interventions are essential to safeguard both pilot well-being and flight safety, ensuring that those who bear immense responsibility in the skies remain psychologically fit to lead with clarity, calmness, and competence.

Professor at Department of Psychology ,University of Karachi, Pakistan

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