

D-1.1 REPORT ON THE REVIEW OF DIAGNOSTIC MEASURES

MESAFE – MEntal health for aviation SAFETY



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SUMMARY

Problem area

Mental disorders can influence pilot and air traffic controllers' performance in many detrimental ways. Their effects can bring about incapacitation, which erodes safety margins and might disrupt normal operations. On a more critical level, they can lead to errors, violations, inappropriate automatic hurried actions or biased decision making.

Currently, there are no specific, standard, validated mental health assessment methods for aeromedical use, incorporating the specific operational needs, to address the incapacitation risk due to mental disorders in the framework of the fitness for duty certification process.

MESAFE stands for "MEntal health for aviation SAFETy". It is a research project, funded by EASA under the framework of the European Union's Horizon Europe research and innovation programme. Started in May 2022 and lasting 2 years, the project aims at overcoming challenges preventing the effective implementation of the Aeromedical certification process for pilots and air traffic controllers (ATCOs) with regards to the incapacitation risk associated with mental health conditions. The project will provide evidence-based recommendations for new medical developments for the early diagnosis as well as treatment of mental health conditions which could pose a safety risk for aviation and would consequently lead to pilot and ATCO unfitness or the limitation of their licence privileges for safety purposes.

Two questions are prominent in this light. The first question is: "Can the safety impact of mental disorders be assessed, both in qualitative as well as quantitative terms, given the proposed solutions and mitigations?". It is important to be aware that the total impact may be relatively small, but even then, it may be so that some aspects of the certification process will become less efficient, whereas others will become more efficient. A second question is "what will the impact on regulations be?". To answer this question, it is important to understand, given the proposed changes to aeromedical certification operations, what part of the regulation will be influenced by these changes, so as to be aware of the amount and type of adjustments to regulations that might be expected.

Description of work

The present document is the D-1.1 REPORT ON THE REVIEW OF DIAGNOSTIC MEASURES of the MESAFE project and provides an overview of existing evidence and procedures in assessing mental health.

In line with the EASA technical requirements, this document provides the following information:

- definition of mental health and well-being status;
- review of the mental disorders, including comorbidities among mental disorders, and associated incapacitation risks;
- review of the state-of-the-art psychodiagnostic measures;
- relevance of the diagnostic measures and the frequency required for the proper monitoring of certain mental pathologies;

- overview of mental health assessment methods and options currently used in the aeromedical certification process;
- gap analysis between state-of-the-art and aeromedical assessment methods.

Results and Application

Mental health problems can lead to total and subtle incapacitation.

There are more than 450 mental disorders and they are not all the same. For example, not all mental disorders are long-term and not all mental disorders are featured by abnormal, unpredictable and deviant behaviours. For example, the acute stress disorder lasts from 3 days to 1 month and it is featured by subtle incapacitation deriving from maladaptive psychophysiological reactions to stressors, which trigger it. The acute stress disorder is a good example also to highlight the relevance of life changing events and work-related stressors on mental health, whose impact should always be taken into account.

As a consequence, it is very important to evaluate the presence and severity of mental disorders and comorbidities in order to assess the incapacitation risks they pose to pilots and ATCOs, which can be low, moderate or high. Not all the mental disorders lead to the loss of medical fitness certification.

For many mental disorders denial is a relatively frequent symptom, leading to a reduced rate of self-declaration.

To make decisions about the certification of mental fitness, it is important to evaluate:

- The presence of a mental disorder and potential comorbidities in the history of the applicant;
- The presence of a mental disorders and potential comorbidities in the current timeframe;
- The risks related to the treatment;
- The Incapacitation risk level (including an evaluation of the impairment in performing flight duties and of the level of social dangerousness);
- Personal protective and risk factors (psychosocial circumstances, physical health, etc.).

An overview of the risks related to the treatment for mental disorders is available in D1.2_Report on the review of treatment options.

Psychodiagnostic tests taken as standalone assessment measures do not enable a diagnosis of a mental disorder. Still tests and questionnaires might be useful as objective measures to support the part of the interview addressing mental complaints. Very few dedicated and validated tests and questionnaires for pilots, ATCO's and other aviation professionals exist. However, valid norms for pilots and ATCOs are available for the MMPI-2.

To detect possible neurocognitive shortcomings the recommended aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses. It is therefore important that the AME is informed about the results of the simulator, line, and ATC checks.

The safety assumption according to which an applicant suffering from a mental health disorder will seek help and self-declare her/his condition might fail. International regulation and guidelines give little guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable.

The key challenges reported by AMEs with respect to the current procedures for the aeromedical mental fitness assessment, both for initial applicants and revalidation/renewal, are summarized as follows:

- Applicants' opposing attitudes to disclose information
- Difficulties in identifying symptoms
- Insufficient of training on mental health
- Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA
- Absence of clear, robust, and validated questionnaires and interviews
- Impossibility to access the applicant psychosocial and medical history; no access to earlier AME's record
- Insufficient of cooperation among AMEs and mental health specialists
- Too little time allocated to assess mental fitness of applicants

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ABBREVIATIONS

ACRONYM	DESCRIPTION
AD	Alzheimer’s disease
ADHD	Attention deficit hyperactivity disorder
AeMC	Aero-Medical Centres
AIDS	Acquired immunodeficiency syndrome
AMC	Acceptable Means of Compliance
AME	Aviation Medical Examiner
ANSP	Air navigation service provider
APA-Psychology	American Psychological Association
APA-Psychiatry	American Psychiatric Association
AsMA	Aerospace Medical Association
ATC	Air traffic Control
ATCO	Air Traffic Controller Operator
ATCS	Air Traffic Control Service
ATPL	Airline transport pilot licence
BPI	Basic Personality Inventory
BRFSS	Behavioral Risk Factor Surveillance System
CAT	Commercial air transport
CAA	Civil Aviation Authority
CBT	Cognitive behavioural therapy
CI	Cognitive impairment
CO	Carbon monoxide
CRM	Crew resource management
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
EAAP	European Association for Aviation Psychology
EASA	European Union Aviation Safety Agency
ECA	European Cockpit Association
ECCAIRS	European Co-ordination Centre for Accident and Incident Reporting Systems
ENT	Otorhinolaryngological
ESAM	European Society of Aerospace Medicine
EU	European Union
FAA	Federal Aviation Administration
GP	General Practitioner
HIV	Human immunodeficiency viruses
ICAO	International Civil Aviation Organization
ICD	International Classification of Diseases
IMC	Instrument meteorological conditions

HADS	Hospital Anxiety and Depression Scale
HEMS	Helicopter emergency medical services
HFCAS	Human Factors Analysis and Classification System
LBA	Luftfahrt-Bundesamt
MADRS	Montgomery- Asberg Depression Rating Scale
MCI	Mild cognitive impairment
MEG	Medical Experts Group
MMPI-2	Minnesota Multiphasic Personality Inventory-2
MMSE-2	Mini-Mental State Examination, 2 nd Edition
MoCA	Montreal Cognitive Assessment
NIA-AA	National Institute on Aging–Alzheimer’s Association
OCD	Obsessive-compulsive disorder
OSCI	Operationally Significant Cognitive Impairment
O3	Ozone
PAE	Psychological Assessment and Evaluation
PHQ-9	Patient Health Questionnaire-9
PTSD	Posttraumatic stress disorder
RH	Relative humidity
SCID	Structured Clinical Interview for DSM-5
SD	Standard deviation
SIPO	Single Pilot Operations
SPA	Society for Personality Assessment
SQ-48	Symptom Questionnaire-48
TAT	Thematic Apperception Test
TRACO	terminal radar approach control
US	United States
USA	United States of America
VFR	Visual flight rules
WAIS-IV	Wechsler Adult Intelligence Scale, 4 th edition
WHODAS 2.0	World Health Organization Disability Assessment Schedule 2.0
16-PF	16 Personality Factor Questionnaire

1. Introduction

The present document is the D-1.1 REPORT ON THE REVIEW OF DIAGNOSTIC MEASURES of the MESAFE project and provides an overview of existing evidence and procedures in assessing mental health.

MESAFE stands for “Mental health for aviation SAFETY”. It is a research project, funded by EASA under the framework of the European Union's Horizon Europe research and innovation programme. Started in May 2022 and lasting 2 years, the project aims at overcoming challenges preventing the effective implementation of the Aeromedical certification process for pilots and air traffic controllers (ATCOs) with regards to the incapacitation risk associated with mental health conditions.

To achieve this, MESAFE will assess new medical developments for the early diagnosis as well as treatment of mental health conditions which could pose a safety risk for aviation and would consequently lead to pilot and air traffic controller (ATCO) unfitness or the limitation of their medical certificate for safety purposes.

The MESAFE expected outcome will be as follows:

- evidence-based recommendations for updating the mental health requirements in Part-MED and Part-ATCO.MED in line with the medical developments;
- evidence-based recommendations for mental health assessment methods suitable for aeromedical fitness assessments;
- an impact assessment of the recommended regulatory changes;
- guidance material on the updates to the fitness assessment of applicants for aeromedical examiners and medical assessors;
- guidance material on mental health assessment and the updates to the fitness assessment of applicants for peer support groups and the trained peers involved in the peer support programs; and
- material to support the management of the proposed changes, e.g., presentations of the results obtained under this contract and training material suitable for professional audiences.

ME-SAFE will be a safety practitioner driven project, fostering the communication and cooperation among Aeromedical examiners, Mental Health Specialists, Aviation Psychologists and peer support groups, for the sake of civil protection of citizens in the fight against safety hazards related to mental disorders during flight and air traffic control operations by a set of cooperation actions. In line with this, the project will put at the centre of the research not only aeromedical examiners and medical assessors but also the applicants (pilots and ATCOs), and will assess and evaluate how the mental fitness certification process affects them, and how they perceive it, while respecting EU fundamental rights.

This deliverable includes a state-of-the-art synopsis of the recent scientific literature about mental health and well-being status as well as up to date methods and procedures to assess and monitor the presence of mental disorders, including comorbidities among them. This study will feed the next steps of the project, aimed at developing and validating assessment methods or assessing the applicability of existing methods for use in the aviation environment.

1.1 Background

This project was launched by EASA as an initiative to include the study of mental health of pilots and ATCOs as well as its screening and monitoring as one of the prioritised topics in the area of health to be updated in Aviation Medicine.

The Mental Health topic has been the subject of great attention after the Germanwings accident of 2015 and has led to important regulatory integrations for the mitigation of the related incapacitation risk. The Commission Regulation 2018/1042 was a first attempt for building proper barriers against the incapacitation risk due to mental disorders of safety-critical operators (EU Commission Regulation 2018/1042).

The Regulation introduced new technical requirements and administrative procedures related to implementing support programmes, psychological assessment of flight crew, as well as systematic and random testing of psychoactive substances to ensure medical fitness of flight and cabin crew members.

Mental Health has therefore been clearly identified as an element of risk and consequently the state of Well-being as an enabling factor. A different attention and treatment have been reserved to the pre-clinical states of the operational front-line staff to whom companies must offer a support service in a confidential and friendly atmosphere with peers or through suitable professionalism; this must be done promptly and long before crisis situations, which may arise as a result of life and work events, are structured in pathological disorders according to a line of progression (EASA, Easy access rules for the Commission Regulation 2018/1042).

This project works as follow-up of these activities, extending the commitment to address the psychological aspects in aviation as well as the management of the mental health elements of personnel seeking a certification of aeromedical fitness, including not only pilots and aircrew, but also air traffic controllers.

In compliance with the new requirements that have amended Regulation (EU) 1178/11 part MED (EASA, Easy access rules for the EU Regulation 1178/2011), this project has initiated a process to direct Aeromedical Examiners to deepen the relevant aspects of the psychological / psychiatric examination now entitled as 'MENTAL HEALTH' in the MED requirement. B.055 of Regulation (EU) 2019/27 (EU Commission Regulation 2019/27). Although in the European Aeromedical Centres there is already the assessment of mental health, in particular in the initial visits of 1 class, the European Regulator wanted to introduce new rules, valid for all EASA Member Countries, for the carrying out of an extended examination for class 1 and class 2, both initial and recurrent, with regard to the emotional and behavioural areas most able to report the presence of psychological discomfort.

For this purpose, the project, without excluding the diagnostic importance of the interview with the doctor and always keeping possible the referral to the mental health specialist, asks for the definition of a standard method that completes the medical report to support the certification of aeromedical fitness process.

1.2 Scope of the document

The present document is the first deliverable of the Task 1 of the project and includes the output of subtasks 1.1 and 1.2.

Task 1 *“Review and critique of the state-of-the-art in the diagnosis and care of mental health conditions”* lasts 6 months and runs in parallel to Task 3 *“Identify screening and confirmation tests for psychoactive substances suitable for use in aeromedical fitness assessment”*. The objective of this Task is to produce a gap analysis of currently available diagnostic methods and treatment options for mental health conditions in aviation aeromedical examinations for mental fitness, based on a review of currently existing diagnostic and treatment procedures.

Subtask 1.1, *“Review existing evidence and procedures in assessing mental health”*, has carried out a review of the state-of-the-art diagnostic options available in the current aeromedical certification process to assess the incapacitation risk associated with mental health conditions. To achieve this, a combined approach including desk research and stakeholders’ engagement has been applied, involving the Medical Expert Group (MEG),

whose members participated in an online survey to identify current gaps and needs. This document reports the results of this survey.

Subtask 1.2, “*Review the tests to assess mental fitness, comorbidities, psychosocial history, the frequency of performing tests/interviews, the data that should be determined, and the reasons for an extended mental health assessment*” started from a review of the mental disorders and comorbidities amongst them, including considerations about the different incapacitation risks and social dangerousness levels associated with the different conditions. Psychosocial history and environmental factors, including organisational stressors, has been taken into consideration as factors that can affect for better or for worse the mental health. As a second activity, the subtask carried out a review of the state-of-the-art mental disorders’ diagnostic methods, providing an overview of best practises in the diagnosis of mental pathologies.

In line with this and following the EASA technical requirements, this document provides the following information:

- definition of mental health and well-being status;
- review of the mental disorders, including comorbidities among mental disorders, and associated incapacitation risks;
- review of the state-of-the-art psychodiagnostics measures;
- relevance of the diagnostic measures and the frequency required for the proper monitoring of certain mental pathologies;
- overview of mental health assessment methods and options currently used in the aeromedical certification process;
- gap analysis between state-of-the-art and aeromedical assessment methods.

1.3 Structure of the document

This deliverable is structured as follows:

- Section 1 is the present section, introducing the document in the framework of the project and its research ambition and scope;
- Section 2 provides information about the medical and human factors aspects of safety sensitive jobs: training and certification process; duties, tasks and responsibilities; human performance; incapacitation;
- Section 3 includes a definition of mental health and well-being status, an overview of mental disorders, associated incapacitation risks and their causes; comorbidities among mental disorders; internalizing and externalizing symptoms of mental disorders; and self-declaration of mental disorders
- Section 4 provides a state-of-the-art for diagnostic measures: psychodiagnostics tests, questionnaires and interviews; the relevance of these diagnostic measures and frequency required for the proper monitoring of certain mental pathologies; and a review of (neuro-)cognitive tests on the subject of the incapacitation risk related to mild cognitive decline (irrespective of its causes) and their validity to predict safety flying performance;
- Section 5 provides an overview of mental health assessment methods and options currently used in aviation: EASA and ICAO evidence and procedures for assessing mental health (regulations and guidance materials for AMEs, pilots and ATCOs); problems AMEs face when trying to identify mental

health problems; trust and alliance between the applicant, the AME and the organizational context; and the current gaps and needs expressed by the AMEs MEG Group.

- Section 6 provides the main findings and recommendations of the document with take-away messages
- Section 7 is the list of the literature references
- Section 8 includes the questionnaire we distributed online to Aeromedical Examiners to collect data about their experience on the aeromedical mental health assessment

All the sections of this document end with a list of take-away messages, based on scientific evidence, which summarize the main findings that will be followed-up in the next tasks of the MESAFE project. Indeed the take-aways will be collected and translated into recommendations to be discussed with EASA and relevant stakeholders in the next phases of MESAFE.

2. Medical and Human factors aspects of safety sensitive jobs

This section describes first of all how to become a pilot/ATCO and what working as a pilot/ATCO means. Secondly, it provides information on medical and human factors aspects, including stressors, that might impact mental health.

2.1 Safety-sensitive jobs

2.1.1 Training and certification process

Meeting the regulatory requirements as defined by EASA and the ANSPs and after passing strict selection procedures, both pilots and ATCOs have to undergo a thorough training before they are considered eligible to obtain their licence. The theoretical and practical training makes high demands on intelligence, perseverance, cognitive abilities, and competencies.

Air traffic controller development stages include: initial training; training essential for the performance of control duties at operational units; ratings for specific positions, and training that supports qualified ATCOs in maintaining their competence. Training to be an air traffic controller takes between three and three and a half years (<https://atco.eurocontrol.int/#about>).

Pilot training stages to obtain an Air Transport Pilot Licence (ATPL) include obtaining a Private Pilot License (PPL), theoretical knowledge exams following the EASA 2020 syllabus, hours building (gain additional hours needed to continue training: up to 100 hours in single-engine piston aircraft; dual and solo flying); multi-engine piston class rating Commercial Pilot Licence & Instrument Rating; and Airline Pilot Standard Multi-Crew Cooperation. This training takes generally two years. In most cases pilots have to self-finance their training or have a contract with an airline. Thereafter training is continued through one's career with captain training, type ratings and recurrent training to maintain the licence.

During their professional life ATCOs and Pilots have to complete a multitude of training courses, proficiency checks, line checks (pilots), and position ratings (ATCOs). In addition to the regular checks of competence, each pilot and ATCO must undergo a periodical medical examination for the certification of her/his physical and mental fitness to perform flying tasks or ATC duties.

It is considered that the above characterization of the training load and certification process provides basic information that is relevant in the context of the present report. For detailed information of the training and certification requirements the reader is referred to the requirements for training and licensing as mandated by EASA regulations in: <https://www.easa.europa.eu/en/regulations/atco-air-traffic-controllers> for ATCOs; and for Pilots in Part FCL-Flight Crew Licensing https://www.easa.europa.eu/sites/default/files/dfu/Easy_Access_Rules_for_Part-FCL-Aug20.pdf

2.2 Duties, tasks and responsibilities

2.2.1 Working as an ATCO

Details on requirements and responsibilities of ATCO can be found in:

- <https://www.skybrary.aero/sites/default/files/bookshelf/3181.pdf> (EASA document AIR TRAFFIC CONTROLLERS' LICENSING AND CERTIFICATION)
- https://www.icao.int/MID/Documents/2018/CBT%20ATCO%20and%20ATSEP%20Wksp/Doc%2010056_EN.pdf

2.2.1.1 ATCO requirements

- Completion of the required number of training hours.
- Passing relevant tests, exams, and training.
- A relevant license and certification. Validity of medical license is 24 months and >40 years 12 months; there is no mandatory upper age limit for ATCOs. The ATCO retirement age ranges from ages of 50, 52.5 and 53 (Armenia, Moldova, Estonia) to 67 (Greece, Netherlands) to no compulsory retirement age (UK, New Zealand), Eurocontrol and FAA: 56 years. ICAO: maximum age is left for Individual States to decide.
- The ATCO task requires: Spatial Awareness, Simultaneous Capacity, Excellent Memory, Respect for Authority and the Rules, Making Decisions under Pressure, Exercising Effective Personal Authority, Paying Attention to Details, Visual-Motor Coordination, Teamwork Skills, and Emotional Stability.

Important parts of training are Unit Training and On-the-job training. Ratings that may be endorsed on an air traffic controller licence or record are:

- aerodrome control (ADC) rating;
- approach control procedural rating (APP);
- approach control surveillance rating (APS);
- area control procedural rating (ACP);
- area control surveillance rating (ACS); and
- approach precision radar control rating (APRC).

2.2.1.2 ATCO responsibilities

In general Air Traffic Controller responsibilities are:

- Monitoring and regulating ground and air traffic.
- Providing useful information related to weather, wind, flight paths, possible delays, and runway openings and closures.
- Maintaining communication with other air traffic control centers, pilots, and airport staff members to ensure safety, relate estimated arrival times, and prevent or respond to emergency situations.
- Inspecting, repairing and utilizing maps, reports, radios, telephones, computers, radar, and other technologies to monitor, analyze, and adapt to changes in conditions.
- Alerting response teams in the event of safety concerns or emergencies.
- Assisting in searches for missing aircraft.
- Compiling and analyzing data and reports to develop more effective flight plans and prevent delays.

The maximum shift length is 10 hours. As a basic rule: max 2 hrs in position followed by a minimum of 30 min. break. In case of low workload: 4 hours in position – 1 hr break (smaller airports) and in busy units: max 90 minutes in position – 30 min. break. ATCOs work in shifts which may cause typical shift work problems as poor sleep, sleepiness during the day, and fighting sleep pressure at night. Long-term shift work may cause mental health and/or cardiovascular problems in sensitive individuals.

2.2.1.3 Air Traffic Controller Work Environment

In ATC Single Person Operations (SPO) services are provided by an operational ATC where only one qualified ATCO is on duty. These operations are typically performed during night time, or low-workload windows, and on small airports.

Most ATCOs work in an ATC team and teamwork skills are very important in such setting. Members of the team monitor and support each other team member. They perform different but interconnected tasks. In case of incapacitation of a team member this is in most cases timely seen by the team members or team leader and the incapacitated team member will be replaced by a colleague.

Three main types of ATCOs are identifiable. Different roles may derive from the specific aspects of traffic demand or the airspace:

- Tower Controller (Aerodrome control service), providing air traffic control services at an aerodrome and the in the vicinity of the aerodrome. They are called tower (TWR) controllers and the three major types of traffic served are: departures, arrivals and overflies.
- Approach Controller (Approach control service), providing air traffic control services for departing and arriving aircraft.
- Area Controller (Area control service), providing air traffic control services to flights during the cruise phase. They are also called en-route controllers. The main job of these controller is discover and solve conflicts between aircrafts.

ATCOs are supported by tools in order to perform their tasks and ensure safety of operations.

Surveillance tools are an important help to enhance ATCOs' situational awareness, allowing them to manage more traffic without compromising operations and safety. Automated systems can combine data from different sources to further enhance ATCOs' situational awareness and increase capacity.

2.2.2 Working as a pilot

2.2.2.1 Pilot requirements and Responsibilities

Pilot requirements and responsibilities generally include the following:

Pilot Requirements:

- Completion of the required number of training hours.
- Passing relevant tests, exams, and training (CRM).
- A relevant license and certification.
- Strong communication skills and ability to function under pressure.
- Excellent leadership skills, situational awareness, and professionalism.

Pilot Responsibilities:

- Performing pre and post-flight inspections of fuel, equipment, and navigational systems.

- Operating the aircraft safely and maintaining a good degree of professionalism at all times.
- Monitoring weather conditions and communicating with air traffic control during flights.
- Liaising with co-pilots and flight crew throughout the flight.
- Updating and reassuring passengers and crew during emergencies.
- Determining the safest routes and analyzing flight plans prior to takeoff.
- Getting enough rest between flights.
- Anticipating issues and maintaining professionalism during emergencies.
- Keeping up to date with aircraft advancements and equipment.

The maximum age for Class 1 pilots is currently 60 years of age for single pilot operations and 65 years for multi-pilot operations. Flight Time Limitations and Flight Duty Time Limitations are strictly regulated by EASA according to complex rules depending on type of operation (e.g. long-haul / short-haul), time of day, time zone crossing, etc. : <https://understandingeasa2016ftl.files.wordpress.com/2017/04/easa-combined-ftl-2017.pdf>

2.2.2.2 Pilot Work environment

A career as a pilot brings the individual into situations not usually met in other professions. These situations are discussed below.

The ambient pressure in the aircraft cabin may be as low as 0.75 atmosphere. The consequent increment of the partial oxygen pressure causes the oxygen saturation of the blood to decrease by 5–8 per cent. Although there is no convincing evidence that this would affect cognitive function, this phenomenon may contribute to the feeling of weariness and subjective fatigue. This feeling might be further intensified by the low relative humidity (RH) prevailing in the cockpit (RH 10-20%). In addition, high ambient temperature, noise, vibrations and turbulence may contribute to fatigue and uncomfortable symptoms in sensitive individuals. Crew may be potentially exposed to air contaminants, such as ozone (O₃), carbon monoxide (CO), various organic chemicals, and biological agents. Over the years, aircrew have repeatedly raised questions regarding air quality in the aircraft cabin and some aircrew associate the occurrence of in-flight fume events with neurological, neuropsychiatric, or oncological symptoms (de Ree H et al., 2014). Anti-icing fluid gives off fumes which, if allowed to enter the fuselage, can be harmful. Ethylene glycol, which is often used, can cause kidney damage.

The ambient pressure changes during ascent and descent in both pressurised and non-pressurised aircraft may in some cases lead to barotrauma to the middle ears or sinuses, particularly in susceptible pilots and those undergoing an upper respiratory tract infection.

Acceleratory forces that are important physical and sensory stressors in military fighter pilots (G-forces), are not associated with adverse physical effects in airline pilots during normal flight operations. However, vestibular illusions such as for example the somatogyral and somatogravic illusions may sometimes lead to spatial disorientation. Motion sickness can also in some cases be a problem.

The work environment also includes shiftwork, which means occasional to frequent night flying and sleeping during the day.

Operational factors determining workload and work stress can roughly be divided in short-haul and long-haul operations. Short haul (and medium-haul) aircrew is often faced with irregular work schedules, early morning departures, and late arrivals, resulting in impaired sleep and in-flight sleepiness (e.g. Simons, 2017). Short-haul and medium-haul flights generally last up to 3 hours to 6 hours respectively and the aircrew generally makes several flights on a roster day. Stresses are caused by time pressure (short turnaround times), delays, high density of air traffic, multiple take-offs and landings.

Long-haul operations are characterised by rapidly alternating time-zone transitions and night flying (e.g. Simons, 2017). Stresses may be caused by circadian disruption (causing sleep problems and chronic fatigue in sensitive individuals), large amount of time away from home/family, long time on task (up to 13 hours), and night flying (fighting sleep trying to remain alert in a stimulus-poor environment). During a night flight aircrew may experience high sleep pressure and lowered alertness levels, while the recuperative quality of daytime sleep is in most cases poorer than the quality of night time sleep. Short-haul as well as long-haul flight operations can both result in sleep deficit and high fatigue levels and may trigger mental health problems. For long-haul crew this picture is further complicated by time-zone crossings leading to circadian desynchronisation.

Noise levels in aircraft may, in addition to contributing to fatigue, lead to noise-induced hearing loss in susceptible individuals. This can be due to noise from the engines and the pressurisation system on board, as well as transient noise levels from electronic communication. Helicopters particularly have high noise levels, typically well over 90 dB(A), and are also subject to higher vibration levels than fixed wing aircraft.

The ergonomic working environment may be a challenge in some aircraft - and in helicopters this can become particularly problematic leading to a high incidence of low back pain particularly. Low back pain in pilots seems to be particularly related to long-duration flights. (Hansen & Wagstaff, 2005).

The above list is not necessarily complete, but indicates some of the many working environment challenges pilots are subject to. These work environment challenges may act separately or together in a combined fashion to affect performance and health outcomes in many ways. A consideration of mental health issues in pilots must therefore take into account the significant stressors pilots are subject to at work; the effects on flight safety and performance are a result of the interaction between the working environment and the health issues of the pilot. As such, the working environment is an important consideration for any evaluation of mental health issues a pilot is subject to.

2.3 Human performance in safety-critical systems

As highlighted in the previous sections, ATCOs and airline pilots are carefully selected, highly trained individuals, able to carry out a wide range of complex tasks under high cognitive demand, operating under stressful conditions in a safety-critical environment.

According to ICAO (1998) an understanding of the predictable human capabilities and limitations and the application of this understanding are the primary concerns of Human Factors. The ICAO SHELL Model (see below), as described in ICAO Doc 9859, is a conceptual tool used to analyse the various interactions between system components that influence each other in the aviation industry.

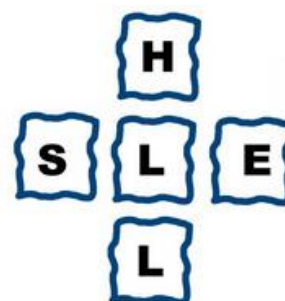
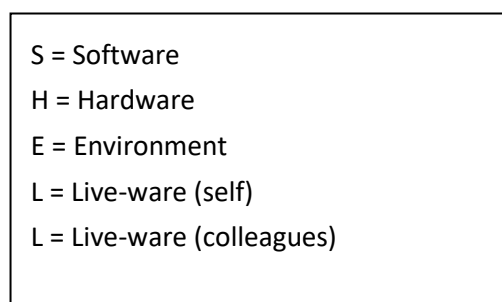


Figure 1 - ICAO SHELL Model

- Software stands for the rules, procedures, training, support, and written documents etc., which are part of the standard operating procedures.
- Hardware refers to the machine and equipment.

- Environment: the situation in which the L-H-S system must function, the social and economic climate as well as the natural environment.
- Live-ware: the human beings - the controller with other controllers, flight crews, engineers and maintenance personnel, management and administration people within the system.

In the centre of the model (the central block “L”) are the humans who work at the front line of operation. Humans do not interface perfectly with the various components of the world in which they work. To avoid tensions that may compromise human performance, the effects of irregularities at the interfaces between the various SHELL blocks and the central Live-ware block must be understood. To avoid the stress in system other blocks of model must be optimised carefully. A mismatch between the Live-ware and other four components can contribute to human error. Thus, these interactions must be assessed and considered in all sectors of the aviation system.

Although it is emphasised that an optimal interaction of all system components is important to maximize safety, a discussion of the Software, Hardware, and Environment system components is considered to be beyond the scope of present report in which the focus is on the Live-ware (pilots and ATCOs).

With the aim to understand the underlying causal factors that lead to an incident or accident, the Human Factors Analysis and Classification System (HFACS) was developed by Wiegmann & Shappell (2003). HFACS is based upon James Reason's Swiss cheese model (Reason, 1990). The HFACS framework provides a tool to assist in the investigation process and target training and prevention efforts. Investigators are able to systematically identify active and latent failures within an organisation that culminated in an incident or accident.

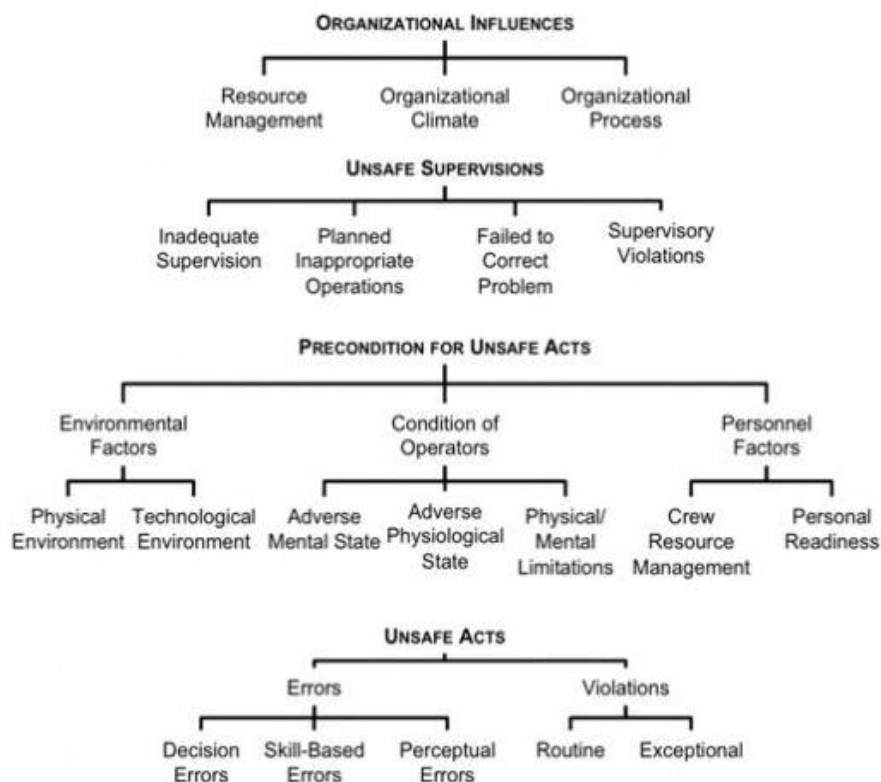


Figure 2 - Schematic picture of the Human Factors Analysis and Classification System (HFACS). The levels of Organizational Influences, Unsafe Supervisions, and Precondition for Unsafe Acts are considered as latent failures that can lead to Unsafe Acts.

Latent conditions are issues that reside in a system and organization and create error conditions (e.g., time pressure due to fuel policies, poorly designed interfaces, fatiguing rosters).

Unsafe Acts are acts of slips, lapses, mishandling, mistakes, and procedural violations committed by people in direct contact with a system. Organizational Influences, unsafe supervisions, and preconditions for unsafe acts, as depicted in figure X, are considered as latent failures that can lead to unsafe acts. The impact of unsafe acts on safety is illustrated by Incident and accident investigations which revealed that human error contributes for 70-80% to incidents and accidents in aviation.

In the context of the present project, which deals with the aeromedical concerns about the relation between (un)fitness and safety, the HFACS level of “Precondition of Unsafe Acts” and particularly its sub-level “Condition of Operators” will be discussed. “Condition of operators” (aircrew and ATC personnel) includes adverse mental and/or physiological states and mental and/or physical limitations of the aircrew and ATCOs.

Personal Factors which may precondition for unsafe acts, and thus may contribute to cause error, are:

- Fatigue
- Lack of skill
- Misunderstanding
- Multitasking
- Lack of communication /information
- Distraction
- Lack of work satisfaction
- Mental Health problems
- Life events and Stress caused by work related problems, financial worries, health concerns, bereavement issues, relationship / family difficulties, separation from family, and social demands
- Physical Health problems

A cornerstone of Human Factors training courses worldwide is the “Dirty Dozen” concept developed in 1993 by Gordon Dupont (transport Canada). The Dirty Dozen refers to twelve of the most common human error preconditions, or conditions that can act as precursors, to accidents or incidents. These twelve elements influence people to make mistakes. Although there are many more (around 300) human error accident precursors known all areas of the aviation industry use the Dirty Dozen to open discussions into human error in their businesses, organisations, and workplaces. The list is used for pilots. ATC personnel, maintenance, cabin crew and in health care.

The Dirty Dozen list includes the following (there is no order of priority):

Table 1- “Dirty Dozen” concept, Gordon Dupont (1993)

1. Lack of communication	5. Complacency	9. Lack of knowledge
2. Distraction	6. Lack of teamwork	10. Fatigue
3. Lack of resources	7. Pressure	11. Lack of assertiveness

4. Stress	8. Lack of awareness	12. Norms
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Because these error preconditions are considered to play an important role as human error preconditions, each item of the Dirty Dozen list will be briefly discussed below:

Lack of communication

Poor communication is a top causal factor in accident reports. Language skills diminish as tension rises during in-flight emergencies. Tasks take priority which means that controllers may have to concentrate in order to deliver slow, clear speech, especially those for whom English is not their first language. Distraction with an emergency may cause slips with communications with other aircraft. Workload may increase vagueness and imprecision. Jargon and acronyms may confuse pilots or controllers. On average one miscommunication happens every hour per radio frequency where there is frequent communication such as in terminal radar approach control (TRACO). Use of Standard Aviation English phraseology is a major contribution to the reduction of ambiguity in aircraft/ATC communications

Using "no" instead of "negative" or "yes" instead of "affirm" (or "affirmative" in FAA ATC phraseology) can start a chain reaction that leads to runway incursions or near-misses. Numbers are one of the biggest sources of communication problems between pilots and air traffic controllers, especially the homophones "two", "too", and "to" and "four" and "for." A clear example was a Boeing B747 crash at Kuala Lumpur in 1989, where the ATC clearance was, "Descend two four zero zero" (two thousand four hundred feet) to which the pilot replied, "OK, four zero zero" (four hundred feet). Maintaining vigilance for critical but infrequent events, such as a pilot reading back an incorrect level, is an important part of air traffic control.

English speaking pilots are particularly likely to cause misunderstandings when speaking to non-native English speaking ATCOs. E.g., a British pilot mentioning that the aircraft is "running low on fuel" may be interpreted as a mere concern and not an emergency situation.

In cases of high stress pilots and/or ATCOs will often return to old procedures that may no longer be applicable. High stress levels also cause them to use non-standard phraseology when communicating and to return to the use of their native language.

Distraction

Distraction is caused by anything that draws a person's attention away from the task on which they are employed. Some distractions in the workplace are unavoidable, such as loud noises, requests for assistance or advice, and day-to-day safety problems that require immediate solving.

Lack of Resources

Resources can include personnel, time, data, tools, skill, experience and knowledge, etc. A lack of any of these resources can interfere with one's ability to complete a task. It may also be the case that the resources available, including support, are of a low quality or inadequate for the task.

Stress

Acute stress arises from real-time demands placed on our senses, mental processing and physical body; such as dealing with an emergency or working under time pressure with inadequate resources. Chronic stress results from long-term demands placed on the physiology by life's demands, such as domestic problems, family relations, finances, illness, bereavement, divorce, critical incidents, relationships with colleagues and management, poor job conditions, stability of employment, atypical employment, and company pressure.

Because stress is cumulative, personal stressors can make what would normally be a small stressor into a bigger problem or trigger higher stress levels. Coping abilities to stresses show large inter-individual and also intra-individual variation (coping ability can change with the phases of life).

The most common sources of stress caused by work circumstances in ATC are:

- Peaks of traffic load
- Time pressure
- Limitations in equipment
- Shift work
- Organisational aspects: shift management and conflicting roles

For aircrew, the most common sources of stress caused by work circumstances are:

- Demanding schedules/rosters / fatigue / circadian disruption / shift work
- High density of air traffic and delays
- Time pressure
- Job security
- “Atypical employment” (e.g., pay per flight hour)
- Periodic competency checks,
- Poor physical condition, diseases (for pilots with diseases the periodic medical examination may be a stressor).
- Cockpit environmental factors (e.g., cramped workspace, air quality, lighting conditions, vibration, temperature) or flight related stressors (e.g., weather conditions, airport conditions, flight delays)

Common effects of stress on task performance are:

- Difficulty concentrating, reduced vigilance - easily distracted
- Errors, omissions, mistakes, incorrect actions, poor judgment, and memory
- Fixation on single issues or even a mental block
- Increase in risk-taking leading to an increase in the number of violations, especially when frustrated with failures
- Tendency to cut corners, skip items and look for the easiest way out
- Bad teamwork, rapidly irritated

Complacency

Complacency is a feeling of self-satisfaction accompanied by a loss of awareness of potential dangers. Such a feeling often arises when conducting routine activities that have become habitual and which may be considered as easy and safe. A general relaxation of vigilance results and important signals will be missed, with the individual only seeing or hearing what s/he expects to see or hear.

Lack of teamwork

In aviation many tasks and operations are team affairs. Lack of teamwork can have serious safety consequences. In aviation, each individual job can affect others. Working in a vacuum without regard for others can contribute to unsafe conditions.

Mental pressure and Time pressure

Direct or indirect mental pressure from the company and from colleagues may lead to stress and impaired task performance. However, one of the most common sources of pressure is self-inflicted by taking on more work than can be handled, by trying to save face, and by positively promoting superpowers that one does not possess.

Time pressure is notorious for causing unsafe acts of aircrew. It may be considered as a latent failure residing in the system, but it can also be caused or complicated by the mental condition of the pilot. Unreasonable pressure to get to the destination, whether self-generated or externally imposed, can cause an aircrew to decide to continue to their planned destination despite conditions being unsuitable to do so. Critical time pressure, known in aviation as “Press-on-it is,” is the decision to continue to the planned destination or toward the planned goal even when significantly less risky alternatives exist. Press-on-it is also known as “get-home-itis,” “hurry syndrome,” “plan continuation” and “goal fixation” (Flight Safety Foundation).

Examples of critical effects of ‘Press-on-it is’ that are considered a threat to safety, are:

- Violating Minimum Descent Altitude minima
- Flying VFR into IMC without being appropriately rated and/or without appropriate equipment
- Failure to abide by aircraft performance limits
- Failure to go around from an unstabilized approach
- Failure to plan for a go-around or diversion.

Lack of awareness

Working in isolation and only considering one’s own responsibilities can lead to tunnel vision; a partial view, and a lack of awareness. Lack of awareness may also result from other human factors, such as stress, fatigue, pressure and distraction.

Lack of knowledge

A lack of on-the-job experience and specific knowledge can lead workers into misjudging situations and making unsafe decisions. It may also be a source of work stress.

Fatigue

Fatigue is defined by ICAO as a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member’s alertness and ability to safely operate an aircraft or perform safety-related duties.

When becoming more fatigued one’s ability to concentrate, remember and make decisions reduces. Therefore, one is more easily distracted and loses situational awareness. Fatigue will also affect a person’s mood, often making them more withdrawn, but sometimes more irrational and angrier. In the context of fatigue, it is useful to consider that both ATCOs and airline pilots may be exposed to shift work which is characterised by circadian factors such as high sleep pressure during the night shift and poor daytime sleep (which may cause extra fatigue).

Effects of fatigue, that affect safe functioning, are:

- Pre-occupation with one task, often a side-issue
- Impaired alertness
- Impaired awareness of dangerous situations
- Missing alarm signals
- Choosing risky options

- Neglecting normal checks and procedures
- Unawareness of impaired task performance
- Rapid irritation - bad teamwork

Common causes of fatigue and reduced alertness include both external and internal factors. External factors are related to the environmental as well as organisational sources of fatigue, while internal factors are related to the individual sources of fatigue. External factors include, but are not limited to:

- Long time on task
- Long time since awake
- Insufficient or poor Pre-Duty Sleep
- Night duty, shift work
- High workload / Boredom
- Resuming flying activities after a period of inactivity, such as after the COVID 19 lock down
- Internal factors include, but are not limited to: Medication-related risk factors for fatigue (e.g. hypnotics, first generation anti-histamines)
- Physical health-related risk factors for fatigue (e.g. obstructive sleep apnoea, hypothyroidism, long-COVID). It is important not to underestimate the impact of these issues on fatigue: according to a review reported by the EU-OSHA, diabetes or sleep apnoea reduce alertness and may lead to work disability (<https://osha.europa.eu/en/tools-and-resources/eu-osha-thesaurus/term/70245i>)
- Risks factors for fatigue related to mental disorders (e.g. depressive episode)
- Life stressors, (e.g. bereavement, relationship issues)
- Use or misuse of psychotropic substances (e.g. alcohol)
- Lifestyle

Lack of assertiveness

Unassertive team members can be forced to go with a majority decision, even when they believe it is wrong and dangerous to do so.

Norms

“The way we do things round here” may have become norms. Unfortunately, such practices follow unwritten rules or behaviours, which deviate from the required rules, procedures and instructions. These norms can then be enforced through peer pressure and force of habit.

Conclusion

The Human Factors Analysis and Classification System (HFACS) provides a provides a clear understanding that latent failures in the organisation and supervision components of aviation industry systems may have negative effects on preconditions for unsafe acts and consequently may affect the mental health state of pilots and ATCOs. Personal factors such as fatigue, physical and mental health problems, life events and life stresses may act as preconditions for unsafe acts. The most common human error preconditions as mentioned in the “Dirty

Dozen” may be affected by or interact with these personal factors, showing more specifically the interrelation between mental (and physical) health and human factor errors and accidents.

2.4 Incapacitation

The term “incapacitation” as is used in aviation and aeromedical literature has a more specified meaning than the term incapacitation commonly used in general literature or colloquial language. In the context of the present report, the following definitions and descriptions of the term incapacitation will be used:

Definition according to ICAO (ICAO, 2012): “incapacitation” means any reduction in medical fitness to a degree or of a nature that is likely to jeopardize flight safety. For aircrew, this generally means that the incapacitation occurs in-flight and for ATCOs it means that the incapacitation occurs during their ATC duties.

Sudden incapacitation: A reduction in medical fitness jeopardizing flight safety can occur suddenly without heralding signs or symptoms. This is described as sudden incapacitation.

Total incapacitation: the reduction in medical fitness jeopardizing flight safety can be total (100%) and this is described as total incapacitation (e.g., sudden death, acute coronary syndrome, epileptic seizure, panic attack). In a multi-pilot cockpit, a total incapacitation is considered a major failure condition that will be clearly noticed by the colleague pilot, who will take action according to the instructions of the incapacitation procedures as trained in the incapacitation training of each ATPL pilot. In a multi-ATCO ATC setting a total incapacitation will be noticed by team-colleagues who will take over the tasks of the incapacitated colleague. In a multi-pilot flight operation as well as in a multi-ATCO ATC setting the safety risk will be mitigated considerably because the colleague pilot or ATCO takes over all tasks according to standard procedures.

In single pilot (SIPO) or Single Person Operations in ATC, total incapacitation is considered a catastrophic condition because tasks cannot be taken over by colleagues.

Subtle incapacitation: a mild, sometimes difficult discernible reduced state of alertness, a mental preoccupation which may result in a lack of appreciation of significant factors, increased reaction time, and impaired judgement. Subtle incapacitations can be either mental or physical in origin, as physical conditions can lead to distractions. Examples of physical conditions which can lead to subtle incapacitation could be back pain, bowel symptoms, heart palpitations or headache. Many mental conditions or states can cause subtle incapacitation, such as mild depression, fatigue, or preoccupation with thoughts of unresolved or towering personal issues. A particular category of subtle incapacitations has been identified as “cognitive.” The problem created by these incapacitations is how to deal with a pilot or ATCO who is “mentally disoriented, mentally incapacitated or obstinate, while physically able and vocally responsive” (ICAO, 2012). The safety risks of subtle incapacitation may be significant because a colleague may not immediately be aware of the dysfunction of his/her colleague and/or finds it difficult to take over the tasks because the subtly incapacitated colleague might deny or be unaware of any dysfunction. In single pilot (SIPO) or Single Person Operations in ATC, subtle incapacitation will only be noticed via communication with the subtly incapacitated pilot or ATCO, but s/he cannot be replaced, which may lead to very significant safety risks.

2.4.1 Overview of incapacitation risks and their causes

2.4.1.1 In-flight incapacitation: prevalence, causes

In a systematic literature study, it was found that total in-flight incapacitation of pilots due to a medical cause is a rare event, which is estimated to occur up to 0.45 times per 10⁶ flight hours or 0.25% per annum (DeJohn et al., 2004; Evans & Radcliffe, 2012; Simons et al., 2019). Evaluating the medical causes of incapacitation is

hindered by reports lacking details about a possible cause, and by differences in diagnostic criteria that were applied: e.g., transient loss of consciousness can be categorized as “cardiovascular”, “neurological”, “psychiatric”, or “syncope of unknown cause”. Simons et al. (2019) concluded that the usefulness of the European Co-ordination Centre for Accident and Incident Reporting Systems (ECCAIRS) database to identify medical causes of in-flight incapacitation was very limited. In many cases information on (medical) cause, age, and operational consequences was lacking (the cause of the medical incapacitation was unknown in 64% of the 257 in-flight incapacitation occurrences).

Of in-flight incapacitations, 50 to 70% are caused by problems that cannot be predicted during the periodical medical screening and are barely preventable: acute gastroenteritis, laser strikes, headache, and ear/sinus conditions (ICAO, 2012; James & Green, 1991). The remaining 30–50% of total in-flight incapacitations is, to a great extent, caused by potentially preventable causes, such as sudden cardiac death, acute coronary syndrome, cardiac arrhythmias, pulmonary embolism, stroke, and panic attacks (Evans & Radcliffe, 2012; Simons et al., 2019). Of 76 total incapacitation events concerning UK-based pilots in 2004, three episodes were attributed to panic disorder/anxiety attack, all presenting in flight-associated situations: one while flying and two in the simulator (Evans & Radcliffe, 2012).

In a survey performed in 2016, ICAO requested its Member States information on causes of medical in-flight incapacitation of professional pilots (Jordaan, 2017). The results mention “Mental health” to have caused 16% of the incapacitations (cardiovascular 14%, metabolic 9%, gastro-intestinal 6%, respiratory 6%, vision 5%, otorhinolaryngological (ENT) 4%, neurological 4%, “general ailment” 4%, and 21% “causes not reported”). It is likely that the category mental health included both psychological and psychiatric problems and disorders. It should be mentioned that in this global survey diagnostic criteria and demographic and epidemiological disease patterns may vary between different parts of the world.

There are no reliable data concerning subtle incapacitation because it is not systematically reported. It is assumed that subtle incapacitation is far more frequent than total incapacitation and is often not reported, or not clearly recognised. As it represents a high risk for flight safety, prevention of subtle incapacitation is of utmost importance. Identifying psychological and cognitive problems should therefore be an important aim of the aeromedical examination.

Disqualification or (temporary) grounding of pilots for medical reasons is based on the consideration that the medical condition concerned bears an unacceptable risk of inability to safely perform flying tasks or unacceptable risk of in-flight incapacitation. Data of the medical conditions related to grounding of pilots can, therefore, provide indicators of the health status of the pilot population and additional knowledge regarding the medical conditions that should be considered in the context of incapacitation risk.

In 2016, ICAO sent a survey to its Member States requesting information on medical causes of medium and long-term loss of licence (grounding six months to two years and two years or more) of professional pilots, general aviation pilots and air traffic controllers (Jordaan, 2017). Calculating the mean of the percentages of medium term and the long-term loss of licence, it was found that among professional pilots’ cardiovascular causes accounted for 23.5% of the cases, mental health for 22.5%, and neurology for 11.5%.

Table 2 shows that psychiatric and psychological disorders are an important reason to declare pilots unfit for flying duties. Frequencies ranged from 10% to 15% for psychiatric diagnoses. When combining the frequencies of psychiatric (11%) and psychological (10%) diagnoses to calculate the frequency of mental health problems as a reason for grounding pilots, Simons et al. (2019) came to 21% which is in agreement with the findings of the 2-16 ICAO Survey.

Table 2 - Studies of medical reasons for grounding of pilots: the most frequently reported (>5%) reasons for grounding. CAT=Commercial Air Transport; ENT=Ear Nose Throat.

Reference	Cohort/Data (study period)	Report based on:	Diagnostic category	frequency
Årva & Wagstaff (2004)	Norwegian CAT pilots - 48,229 pilot-years (1982-2001)	Medical reasons for grounding of 275 CAT pilots Rate 5.7/1,000 pilot-years.	Cardiovascular	35%
			Neurological	15%
			Musculoskeletal	13%
			Psychiatric	13%
			ENT	8%
Evans & Radcliffe (2012)	16,145 Class 1 UK commercial pilots (2004)	Analysis of reasons of (temporary) unfitness of 720 pilots	Accidents	18%
			Musculoskeletal	18%
			Cardiovascular	14%
			Psychiatric	10%
			Gastrointestinal	8%
Høva et al. (2017)	Norwegian CAT pilots - 12,552 pilot-years (2006 - 2010)	Medical reasons for grounding of 85 CAT pilots Rate: 6.8/1,000 pilot-years	Neurological	26%
			Cardiovascular	18%
			Psychiatric	15%
			ENT	15%
			Musculoskeletal	12%
Jordaan (2017)	Loss of licence insurance of 65,000 professional pilots (Jan 2015-June 2016)	Medical reasons for claims concerning loss of licence	Musculoskeletal	19%
			Cardiovascular	18%
			Neurological	11%
			Psychiatric	10%
			Endocrine/Metabolic	7%
			Neoplasms/cancer	7%
			Digestive System	6%
Simons et al. (2019)	50,101 Class 1 and 32,334 Class 2 pilots of 6 EASA member states (2017-2018)	Medical reasons for grounding of 1,072 Class 1 and 652 Class 2 pilots Rate: 2.1% unfit of 82,435 pilots	Cardiovascular	19%
			Psychiatric	11%
			Psychological	10%
			Neurological	10%
			Endocrine/Metabolic	6%

It can be concluded that mental health disorders represent a significant cause for grounding pilots. **Table 3** shows that psychiatric and psychological problems are particularly frequent in the younger age groups.

Table 3 - The relative contribution of the most frequent diagnostic categories causing unfitness to the total number of unfitness cases per age group (Simons et al., 2019)

Age (yrs)	Cardiovascular	Respiratory	Metabolic Endocrine	Neurology	Psychiatry	Psychology
20-40	8%	3%	4%	7%	15%	20%
41-50	13%	1%	4%	11%	14%	8%
51-60	21%	2%	6%	10%	10%	4%
61-65	28%	2%	13%	11%	8%	2%
>65	48%	0%	6%	13%	2%	1%

2.4.1.2 Incapacitation of ATCOs

Data concerning total incapacitation of ATCOs are very sparse while data of the prevalence of subtle incapacitation are completely absent.

The data of the 2016 ICAO survey among member states on causes of in-flight incapacitation of ATCOs are the only available source of such data (Jordaan, 2017). The data show that mental health was in 6% of the cases a cause of incapacitation while on duty.

Data of the 2016 ICAO survey with regards to information on medical causes of medium and long-term loss of ATCO licence show that a mental health problem or disorder was the cause of loss of licence in 18% of the cases, only preceded by cardiovascular diagnoses (21%) (Jordaan, 2017).

Data of unfitness reports by occupational medicine departments of global air navigation service providers (ANSPs) indicate that the number one cause of ATCO unfitness is psychological, followed by cardiological, and neurological causes. Data from the occupational health department of an ANSP with approximately 300 ATC staff show that from the 22 cases of unfitness (reported over 21 years) 10 cases were caused by psychological problems and 4 cases by alcohol misuse (personal communication Dr. R. Vermeiren).

2.4.1.3 Conclusion

It can be concluded that

- total in-flight, or on-duty, incapacitation of pilots or ATCOs is a rare event which sometimes, although with a very low probability, may be caused by a mental health disorder
- the frequency of subtle incapacitation is unknown.
- subtle incapacitation may represent a significant threat to flight safety.
- The results of the grounding studies, shown in table X and table XY, provide convincing evidence that mental health disorders or problems contribute significantly to unfitness of pilots and ATCOs.

Because the studies of grounding include only recognized health disorders, it can be assumed that the actual prevalence of disorders in pilots and ATCOs is higher, since it is unlikely that all disorders are diagnosed and recognized. This would in particular apply to mental disorders since there are less objective findings in such disorders, and any recognition of such disorders would rely on the pilot or ATCO volunteering to disclose the information about his/her problems. The assumption that the actual prevalence of mental disorders in pilots

and ATCOs is higher than is shown by the results of the grounding studies is supported by data of prevalence of mental disorders among Europe’s general population. These data show that in 2005 27.4% of the adult EU population (aged 18–65) had at least one mental disorder in the past year: substance use, psychoses, depression, and anxiety (Wittchen et al., 2011). In 2010 the prevalence was increased to 38.2%, but this higher estimate is entirely due to the inclusion of 14 new disorders also covering childhood/adolescence as well as the elderly (Wittchen et al., 2011). The most frequent disorders are anxiety disorders (14.0%), insomnia (7.0%), major depression (6.9%), somatic symptom disorder (6.3%), alcohol and drug dependence (> 4%), and ADHD (5%). Multiple studies have been done in Europe with a focus on the assessment of the prevalence of depression. These studies suggested that the prevalence of depression across Europe is between 5% and 10%, with potentially large differences between countries (e.g., 10% in the UK and 7% in Germany) (Arias-de la Torre et al., 2021). Because pilots and ATCOs might have different population characteristics than the general population, it is possible that the actual prevalence of mental health disorders in these professional groups might differ from the percentage of 27 % found by Wittchen et al. (2011).

The above conclusions emphasize that mental health disorders or problems will play an important role in aeromedical determination of pilots’ and ATCO’s job fitness. As not all mental health problems may be identified by AMEs/AeMCs, mental health problems can lead to total and subtle incapacitation.

2.5 Take-away messages

Personal factors such as fatigue, physical and mental health problems, life events and personal as well as organizational stressors may act as preconditions for unsafe acts.

Total in-flight, or on-duty, incapacitation of pilots, or ATCOs is a rare event which may, although probably infrequently, be caused by a mental health disorder.

The frequency of subtle incapacitation is unknown. However, subtle incapacitation may represent a significant threat to flight safety.

The results of studies of causes of unfitness of pilots and ATCOs provide convincing evidence that mental health disorders or problems contribute significantly to unfitness of pilots and ATCOs. Because the studies of causes of grounding of pilots include only recognized health disorders, it can be assumed that the actual prevalence of mental disorders in pilots and ATCOs may be higher, since it is unlikely that all mental disorders are diagnosed and recognized.

These conclusions emphasize that mental health disorders or problems will play an important role in aeromedical determination of pilots’ and ATCO’s job fitness. As not all mental health problems may be identified by AMEs/AeMCs, mental health problems can lead to total and subtle incapacitation.

For the scope of MESAFE, the following take-away can be taken into consideration:

Take away ID	Take away message
2.1	Mental health problems can lead to total and subtle incapacitation.

Table 4 - Take-away messages on Medical and Human factors aspects of safety sensitive jobs

3. Mental disorders and associated incapacitation risks

What mental disorders can lead to incapacitation?

3.1 Definition of mental health and well-being status

The aim of this section is to define the trade-off between mental health and mental illness and identify what mental disorders can bring about mental incapacitation thus representing a hazard for aviation safety.

To date there is no universal agreement on the definition of mental illness. However, seven indicators of psychological disease have been codified. No single indicator is sufficient to determine a behaviour as abnormal. However, the more a person has difficulty in the areas described below, the more s/he is likely to have some form of mental disorder. The indicators are clearly described as follows:

Table 5 - Mental disorders indicators

1	Subjective distress	If people suffer or otherwise experience psychological pain, we are inclined to consider this as one of the aspects of abnormality. Depressed people clearly report that they feel bad as well as those who suffer from anxiety disorders. But what about the manic patient whose mood is exalted? He or she might say not to suffer at all. In fact, many of these patients do not like to take the drugs precisely because they do not want to lose their manic state of alteration. On the other hand, one might have an important exam one day and be extremely concerned the previous day, but this would be hardly labelled as anomalous. Although suffering is a distinguishing element of mental illness, in many cases it is neither a sufficient condition (however necessary) nor a necessary condition (a characteristic that all types of disorder must demonstrate to consider them pathological).
2	Maladaptiveness	Maladaptive behaviour is often an indicator of abnormality. For example, the person suffering from anorexia can limit his food intake to the point of becoming so emaciated that s/he needs to be hospitalized. The person with depression can withdraw from friends and relatives and then can no longer be able to work for weeks or even months. A person with acute stress symptoms might be temporarily incapacitated in performing job tasks and duties. Maladaptive behaviour interferes with well-being and the ability to enjoy work and relationships in general.
3	Statistical deviance	The word abnormal literally means “away from the normal”. However, considering statistically rare behaviour as abnormal does not provide a solution to the problem of how to define psychological abnormality. Genius is statistically rare as is a perfect intonation of the voice, but we do not consider people with this type of skills as abnormal. Also, the fact that something is common doesn't necessarily make it normal: the banal cold for example is certainly very common but it's still always a disease. On the other hand, mental retardation, which is statistically rare and represents a deviation from the norm, is considered an anomaly. This suggests to us that in defining normality we use value judgments. If something is rare and undesirable, as a severe decrease in intellectual functioning, we are more likely to consider it abnormal than something that is rare but highly desirable, as the genius, or something that's very common but not desirable, like rudeness.

4	Violation of the standards of society	<p>All cultures have rules. Some are formalized as laws; others make up the moral norms and standards that have taught us to follow, although many social rules are to some extent arbitrary. When people belonging to a certain cultural group stop following social conventions and moral rules, such behaviours are considered anomalous. To make an example, only a generation ago those who showed tattoos, nose or navel piercings were referred to as highly deviant and it was immediately wondered if they were mental healthy people or not. Today, however, these types of adornment are absolutely common and no longer attract much attention. Obviously, a lot depends on the degree of the violation and how constantly the rule is violated also by others. As shown in the previous example, a behaviour is easily considered as abnormal at the time when it violates the standards of society and whether statistically it is deviant or perhaps rare. Yet each of us has parked the car in prohibition of parking at least once in our lives. This inability to always follow the rules is so common that we cannot consider it abnormal in its own right, but, the moment a mother drowns her son, the abnormality of the gesture is instantly recognized.</p>
5	Social discomfort	<p>Not all rules are explicit, and not all rules bother us when they are violated. However, when someone violates an implicit or unwritten social rule, those around him or her may experience a sense of discomfort or unease. Imagine you are in a half-empty bus: rows and rows of unoccupied seats and suddenly someone sits next to you. How would you feel? Is that person's behaviour abnormal? Why? The person is not breaking any formal laws: s/he paid her/his ticket and so can sit wherever s/he likes to. Yet your sense of social discomfort ("but why right next to me with all this free space?") leads you to believe that it's somehow abnormal behaviour. In other words, social unease is another powerful indicator that makes us recognize abnormality, but, again, much depends on the circumstances. If the person who gets on board was an acquaintance, then it would be strange that he didn't come and sit next to you.</p>
6	Irrationality and unpredictability	<p>People are expected to behave in socially acceptable ways and abide by social rules. For example, if someone next to you started screaming and yelling obscenities at nothing, this behaviour would be viewed as unpredictable, disorganized, and irrational. The disordered speech and the disorganized behaviours of the schizophrenia patients are often irrational. Such behaviours are also a characteristic of the manic phase in bipolar disorders. Probably the most important factor, however, is our assessment of the degree of control that the person can exert over his/her behaviour. Few of us would consider as abnormal a roommate who would start playing the King Lear if we knew he was preparing to perform in Shakespeare's next presentation, so as if he were a melodramatic person of his own and who sometimes lets himself go to the extravagant outbursts. Another thing would be to find the roommate lying on the ground waving madly and reciting Shakespeare: in that case we might consider asking for assistance if this was far from her/his usual way of behaving and we knew that there is no logical reason to behave in such a manner.</p>
7	Dangerousness	<p>It seems quite reasonable to think that who is dangerous to themselves and or to others is psychologically abnormal. Therapists are therefore required to hospitalize those at risk of suicide and or call the police if there was a threat of harm to other people, even if the object of the threat is the person itself. As for all other elements of abnormality, if we rely only on dangerousness as single indicator, we will surely run into further difficulties. For example, should we consider a soldier a mentally ill person? And what about who is a bad driver?</p>

	<p>Both could be dangerous to others, but we certainly wouldn't consider them mentally ill people. Why? And why are people who practice extreme sports or highly dangerous hobbies (such as diving in freediving, making motor racing, keeping poisonous snakes as pets) not referred to as mentally ill? Just because we can become a danger to ourselves or to others doesn't necessarily mean being mentally ill. In clinical practice, it is important to evaluate whether the dangerous behavior is normal for the patient, or whether it is different from the usual. In the latter case, the probability of a mental disorder is higher. For example, an Arbus A320 captain who also holds a PPL, and who makes a monthly flight in a Cessna 172 near his hometown, but one day says he will be heading for a transatlantic VFR-flight in his Cessna that day, likely suffers from a mental disorder. In case of a ferry pilot who makes the crossing several times a year, it is not. On the contrary, we cannot state that those who have a mental disorder are by definition dangerous to themselves or to others. Although some mentally ill people commit serious crimes, there is no denying that daily serious crimes are committed by people without any sign of mental illness. In fact, research suggests that in people who are sick of their minds, dangerousness is more an expectation than the rule. The far majority of patients with mental disorders never develop criminal behaviour of behaviour that is dangerous to others.</p>
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Based on the possible combinations among the aforementioned indicators of mental illness, it had been possible to define and classify several mental disorders.

In many Western countries, the accepted international standard for the classification and definition of mental disorders is the Diagnostic and Statistical Manual of Mental Disorders, commonly referred to as the DSM and updated from time to time.

DSM defines “mental disorder” as a syndrome that involves in a clinically significant way a behavioural disorder, the regulation of an emotion or the cognitive functioning. Mental disorders are thought to be the result of dysfunctions in biological, psychological, or developmental processes that are necessary for mental functioning and correspond to significant distress in the work, social and/or other areas of daily life.

3.2 Overview of the mental health disorders

The current version of the DSM (DSM-5) was published in 2013 and contains a total of 451 mental disorders. Its revised version published in 2022 (DSM-5-TR) is the latest scientific thinking in criteria, content, and organizational structure of mental disorders. DSM-5-TR clusters all the mental disorders into 20 chapters. Each chapter is a diagnostic category including all the mental disorders which share a common ground of underlying vulnerabilities and symptom characteristics.

The organization of the chapters reflects a life-based approach: the Manual begins with the most diagnosed disorders in the early stages of life (Neurodevelopmental Disorders) and ends with those relevant to older age (Neurocognitive Disorders).

The 20 categories of mental disorders are:

- **Neurodevelopmental Disorders:** “group of conditions with onset in the developmental period. The disorders typically manifest early in the development and are characterized by developmental deficits or differences in brain processes that produce impairments of personal, social, academic, or occupational functioning. The range of developmental deficits varies from very specific limitations of learning or control of executive functions to global impairment of social skills and intellectual ability” (DSM-5-TR, 2022, p.35).

- **Schizophrenia Spectrum and Other Psychotic Disorders:** “are defined by abnormalities in one or more of the following five domains: delusions, hallucinations, disorganized thinking (speech), grossly disorganized or abnormal motor behaviour (including catatonia), and negative symptoms” (DSM-5-TR, 2022, p.101).
- **Bipolar and Related Disorders:** “are recognized to bridge two diagnostic classes, specifically the schizophrenia spectrum and the psychotic disorders, in terms of symptomatology, family history, and genetics. They are characterized by manic, hypomanic, depressive episodes” (DSM-5-TR, 2022, p.139).
- **Depressive Disorders:** “the common feature of depressive disorders is the presence of sad, empty, or irritable mood, accompanied by related changes that significantly affect the individual’s capacity to function. What differs among them are the issue of duration, timing, or presumed etiology” (DSM-5-TR, 2022, p.177).
- **Anxiety Disorders:** “disorders that share features of excessive fear and anxiety and related behaviour disturbances. Fear is the emotional response to real or perceived imminent threats, whereas anxiety is anticipation of further threats” (DSM-5-TR, 2022, p.215).
- **Obsessive-Compulsive and Related Disorders:** “obsessive-compulsive disorder is characterized by the presence of obsessions and / or compulsions. Obsessions are recurrent and persistent thoughts, urges, or images that are experienced as intrusive or unwanted, whereas compulsions are repetitive behaviours or mental acts that an individual feels driven to perform in response to an obsession or rules that must be applied rigidly” (DSM-5-TR, 2022, p.263).
- **Trauma- and Stressor-Related Disorders:** “disorders in which exposure to traumatic or stressful event is listed explicitly as a diagnostic criterion (i.e., posttraumatic stress disorder) (DSM-5-TR, 2022, p.295).
- **Dissociative Disorders:** are characterized by a disruption of and/or discontinuity in the normal integration of consciousness, memory, identity, emotion, perception, body representation, motor control, and behaviour. Dissociative symptoms can potentially disrupt every area of psychological functioning” (DSM-5-TR, 2022, p.329).
- **Somatic Symptom and Related Disorders:** “all these disorders share a common feature: the prominence of somatic symptoms and/or illness anxiety associated with significant distress and impairment. A distinctive characteristic of these disorders is not the somatic symptom per se, but the way individuals present and interpret them” (DSM-5-TR, 2022, p.349).
- **Feeding and Eating Disorders:** “characterized by a persistent disturbance of eating or eating-related behaviour that results in the altered consumption or absorption of food and that significantly impairs physical health or psychosocial functioning” (DSM-5-TR, 2022, p.371).
- **Elimination Disorders:** “involve the inappropriate elimination of urine or feces and are usually first diagnosed in childhood or adolescence” (DSM-5-TR, 2022, p.399).
- **Sleep-Wake Disorders:** “individuals with these disorders typically present with sleep-wake complaints of dissatisfaction regarding the quality, timing, and amount of sleep. Resulting daytime distress and impairment are core features shared by all these sleep-wake disorders” (DSM-5-TR, 2022, p.407).
- **Sexual Dysfunctions:** “are a heterogeneous group of disorders typically characterized by a clinically significant disturbance in a person’s ability to respond sexually or to experience sexual pleasure” (DSM-5-TR, 2022, p.477).
- **Gender Dysphoria:** “the distress that may accompany the incongruence between one’s experienced or expressed gender and one’s assigned gender” (DSM-5-TR, 2022, p.511).

- **Disruptive, Impulse-Control, and Conduct Disorders:** “includes conditions involving problems in the self-control of emotions and behaviours. Differently from other disorders that involve problems in emotional and/or behavioural regulation, these disorders are unique in that these problems are manifested in behaviours that violate the rights of others and/or that bring the individual into significant conflict with societal norms or authority figures” (DSM-5-TR, 2022, p.521).
- **Substance-Related and Addictive Disorders:** “substance use disorder is used to describe the wide range of the disorder, from a mild form to a severe state of chronically relapsing, compulsive pattern of drug taking” (DSM-5-TR, 2022, p.543).
- **Neurocognitive Disorders:** “group of disorders in which the primary clinical deficit is in cognitive function, and that are acquired rather than developmental” (DSM-5-TR, 2022, p.667).
- **Personality Disorders:** “is an enduring pattern of inner experience and behaviour that deviates markedly from the norms and expectations of the individual’s culture, is pervasive and inflexible, has an onset in adolescence or early adulthood, is stable over time, and leads to distress or impairment” (DSM-5-TR, 2022, p.733).
- **Paraphilic Disorder:** “disorders denoted by any intense and persistent sexual interest greater than or equal to nonparaphilic sexual interests, and some of them entail actions for their satisfaction that, because of their noxiousness or potential harm to others, are classed as criminal offense” (DSM-5-TR, 2022, p.779).
- **Other Mental Disorders and Additional Codes:** “provides diagnostic codes for psychiatric presentations that are mental disorders but that do not meet diagnostic requirements for any of the mental disorders in the prior chapters” (DSM-5-TR, 2022, p.803).

Within each chapter, each disorder is featured by distinct diagnostic criteria, reflecting its characteristics, risk factors, typical course and development, prognosis. Other information is the age of onset of the disorder (for personality disorders, for example, onset in adolescence) and a differential diagnosis comparing disorders that could be associated with the same symptoms. Moreover, for each mental disorder, a brief description of the so-called “general functioning” in the relevant areas of everyday life (working, of personal care, relational) is carried out. The general functioning alludes, in broad lines, to the stress management strategies of the individual, namely the styles of emotional regulation and the contact with reality.

Just as any organic disease (be it a simple cold or a flu or any other malaise) requires different care and recovery times from case to case, so any mental disorder must also be considered, accepted and treated in an appropriate and specific way.

Therefore, mental illness is not black or white. As a consequence, it cannot be assumed that all mental disorders are hazardous for transport safety and lead to loss of license.

3.3 Mental health disorders and associated incapacitation risks

To address the incapacitation risk related to mental disorders it is possible to review the latter in the light of the following parameters: maladaptiveness, subjective distress, social danger, irrationality and unpredictability, violation of society standards and rules.

Table 5 summarizes the 20 DSM-5-TR disorder categories as a function of these parameters. This is based on experts’ advice and experience.

Table 6 - 20 DSM-5-TR disorder categories as a function of mental disorders indicators

Mental Disorders and associated level of social risk	Dangerousness (to themselves and others)	Violation of society standards	Subjective Distress	Maladaptiveness	Irrationality and Unpredictability
Neurodevelopmental Disorders	2	2	2	3	3
Schizophrenia Spectrum and Other Psychotic Disorders	2/3	2	2/3	3	3
Bipolar and Related Disorders	2/3	3	2	2	2
Depressive Disorders	2	1	3	2	1
Anxiety Disorders	1	0	3	1	0
Obsessive-Compulsive and Related Disorders	1	0	3	2	2
Trauma- and Stressor-Related Disorders	1	0	3	2	0
Dissociative Disorders	2	0	3	2	1
Somatic Symptom and Related Disorders	1	0	3	2	0
Feeding and Eating Disorders	2	0	3	2	2
Elimination Disorders	1	0	3	2	0
Sleep-Wake Disorders	2	0	2	3	0
Sexual Dysfunctions	0	0	3	1	0
Gender Dysphoria	0	0	3	3	0
Disruptive, Impulse-Control, and Conduct Disorders	3	3	1	3	0
Substance-Related and Addictive Disorders	3	3	2	3	0
Neurocognitive Disorders	3	2	2	3	3
Personality Disorders (cluster B)	3	3	1	2	2
Paraphilic Disorder	2	1	0	2	2

Mental Disorders and associated level of social risk	Dangerousness (to themselves and others)	Violation of society standards	Subjective Distress	Maladaptiveness	Irrationality and Unpredictability
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0-3 scores have been assigned in accordance to the risk associated to the mental disorder. Where 0 is absent, 1 is low risk, 2 is moderate risk, and 3 is high risk.

What follows provides a description of relevant disorders.

1. Neurodevelopmental disorders (DSM-5-TR, 2022, p.35)

This category includes a group of conditions with onset in the developmental period. These disorders are characterized by developmental deficits or differences in brain processes that produce impairments of personal, social, academic, or occupational functioning.

The neurodevelopmental disorders frequently co-occur with one another, e.g., individuals with autism spectrum disorder often have intellectual developmental disorder (intellectual disability), and many children with attention-deficit/hyperactivity disorder (ADHD) also have specific learning disorder.

1.1. Autism spectrum disorder (DSM-5-TR, 2022, pp.56-67)

- A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by all of the following, currently or by history:
 - 1. Deficits in social-emotional reciprocity, ranging, for example, from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions, or affect; to failure to initiate or respond to social interactions.
 - 2. Deficits in nonverbal communicative behaviours used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal communication; to abnormalities in eye contact and body language or deficits in understanding and use of gestures; to a total lack of facial expressions and nonverbal communication
 - 3. Deficits in developing, maintaining, and understanding relationships, for example, from difficulties adjusting behaviour to suit various social contexts; to difficulties in sharing imaginative play or in making friends; to absence of interest in peers
- B. Restricted, repetitive patterns of behaviour, interests, or activities, as manifested by at least two of the following, currently or by history:
 - 1. Stereotyped or repetitive motor movements, use of objects, or speech
 - 2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behaviour
 - 3. Highly restricted, fixated interests that are abnormal in intensity or focus
 - 4. Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment
- C. Symptoms must be present in the early developmental period (but may not become fully manifested until social demands exceed limited capacities, or may be masked by learned strategies in later life).
- D. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning
- E. These disturbances are not better explained by intellectual developmental disorder (intellectual disability) or global developmental delay. Intellectual developmental disorder and autism spectrum disorder frequently co-occur; to make comorbid diagnosis of autism spectrum disorder and intellectual developmental disorder, social communication should be below that expected for general developmental level.

Current severity of the autism spectrum disorder is specified based on social communication impairments and restricted, repetitive patterns of behaviours

- Requiring very substantial support
- Requiring substantial support
- Requiring support

They may be:

- With or without accompanying intellectual impairment

- With or without accompanying language impairment

They may be:

- Associated with a known genetic or other medical condition or environmental factor
- Associated with neurodevelopmental, mental, or behavioural problem

They may be:

- With catatonia

1.1.1. Asperger syndrome

The UK CAA provides information about Asperger Syndrome. “Asperger syndrome is an autistic spectrum disorder characterised by impaired social interaction and restricted, repetitive, and stereotyped patterns of behaviour. The DSM-5 diagnostic criteria also include significant impairment in social or occupational functioning. Nevertheless, language skills and cognitive development are not impaired, and someone diagnosed with Asperger syndrome may be able to acquire the skills necessary to function safely as a pilot or air traffic controller. Interpersonal difficulties may arise or emerge in the Crew Resource Management environment of the modern professional airline cockpit. It is, of course, essential that an applicant with Asperger syndrome undergoes assessment by a psychologist with expertise in the condition before embarking on a career in aviation”.

The most of the impairments of people suffering from the Asperger syndrome are related to social abilities. The latter are required to work, both in nominal and abnormal situations (emergencies, time pressure), to be in a team or to attend unstructured moments such as coffee breaks. Included in social skills are also those of managing conflicts, talking to others and negotiating an employment relationship.

Hazardous behaviours might appear during deeper and personal conversations, or in situations of time pressure, or may be triggered by certain behaviours by colleagues. That's why even colleagues who populate the workplace should be prepared, especially for certain relevant aspects such as interpersonal and sensoriality issues. As for the latter, for an ordinary person it is difficult to guess that an Asperger person can have annoyance for example for neon lights, for loud noises, for the chaotic environment. For this reason it could be experienced as a snob, difficult or with particular characteristics of anxiety, when it is something that is part of its structure, of its DNA, instead. All these aspects must be prepared, as well as the discourse related to performance anxiety or social phobia. It must be done before sending the person to a work environment. Then, once employed, it must still be supported and not left alone in its path.

People with Asperger also have very poor short-term working memory, but often have better long-term memory than most normal people. They might have great difficulty with tasks that require high demands in short-term working memory (for example high information load at a time), and can't handle multiple tasks at once.

On the other hand, for some types of jobs, Asperger's people function better than neurotypical. Attention to detail, tenacity and the predisposition to prolonged concentration are characteristics that together with the ability to focus strongly on a goal over time are winning for some job types. Quality check processes, or certain types of design where they can bring an alternative view compared to neurotypical people, are two examples.

The amount of impairment varies from person to person, and although the presence of Asperger syndrome or another form of autism spectrum disorders need to be taken seriously, it is primarily important to assess the actual degree of impairment and possible comorbidities, as well as the skills that someone may have developed to overcome the social impairments. It is not uncommon that people with mild forms of autism spectrum disorder have learned social behaviour well, and that the impairments only appear during deeper and more personal conversations.

Autism Spectrum disorder: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO

Individuals with autism spectrum disorder are at greater risk for suicide death compared with those without autism spectrum disorder. Children with autism spectrum disorder who had impaired social communication had a higher risk of self-harm with suicidal intent, suicidal thoughts, and suicide plans by age 16 years compared with those without impaired social communication. Adolescents and young adults with autism spectrum disorder have an increased risk of suicide attempts compared with age- and sex-matched control subjects, even after adjustments for demographic factors and psychiatric comorbidities. However, the biggest impediment for working as a pilot may not stem from suicidal behaviour, but from the communication problems inherently related to this disorder, as well as the lack of cognitive flexibility, which may make it impossible to deal with the continuously changing conditions commercial pilots and ATCO's have to be able to deal with. In the less severe cases, where sometimes even the diagnosis may be doubted, people may function excellently as a pilot or ATCO, but more severe cases of ASS will almost always be disqualifying.

1.2. Attention-Deficit/Hyperactivity Disorder (ADHD) (DSM-5-TR, 2022, pp.68-75)

- A. A persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, as characterized by (1) and/or (2):
 - 1. Inattention: Six or more of the following symptoms have persisted for at least 6 months to a degree that is inconsistent with developmental level and that negatively impacts directly on social and academic/occupation activities:
 - a. Often fails to give attention to details or makes careless mistakes in schoolwork, at work, or during other activities
 - b. Often has difficulty sustaining attention in tasks or play activities
 - c. Often does not seem to listen when spoken to directly
 - d. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workspace
 - e. Often has difficulty organizing tasks and activities
 - f. Often avoid, dislikes, or is reluctant to engage in tasks that require sustained mental effort
 - g. Often loses things necessary for tasks or activities
 - h. Is often easily distracted by extraneous stimuli
 - i. Is often forgetful in daily activities
 - 2. Hyperactivity and impulsivity: Six or more of the following symptoms have persisted for at least 6 months to a degree that is inconsistent with developmental level and that negatively impacts directly on social and academic/occupational activities:
 - a. Often fidgets with or taps hands or feet or squirms in seat
 - b. Often leaves seat in situations when remaining seated is expected
 - c. Often runs about or climb in situations where it is inappropriate
 - d. Often unable to play or engage in leisure activities quietly
 - e. Is often "on the go", acting as if "driven by a motor"
 - f. Often talks excessively
 - g. Often blurts out an answer before a question has been completed
 - h. Often has difficulty waiting his or her turn
 - i. Often interrupts or intrudes on others
- B. Several inattentive or hyperactive-impulsive symptoms were present prior to age of 12 years
- C. Several inattentive or hyperactive-impulsive symptoms are present in two or more settings

- D. There is clear evidence that the symptoms interfere with, or reduce the quality of, social, academic, or occupational functioning
- E. The symptoms do not occur exclusively during the course of schizophrenia or another psychotic disorder and are not better explained by another mental disorder

They whether are:

- Combined presentation: if both criterion A1 (inattention) and criterion A2 (hyperactivity-impulsivity) are met for the past 6 months
- Predominantly inattentive presentation: if criterion A1 is met but criterion A2 is not met for the past 6 months
- Predominantly hyperactive/impulsive presentation: if criterion A2 is met but criterion A1 is not met for the past 6 months

They may be:

- In partial remission: when full criteria were previously met, fewer than the full criteria have been met for the past 6 months, and the symptoms still result in impairment in social, academic, or occupational functioning

They may be:

- Mild: few, if any, symptoms in excess of those required to make the diagnosis are present, and symptoms result in no more than minor impairments in social or occupational functioning
- Moderate: symptoms or functional impairment between mild and severe are present
- Severe: Many symptoms in excess of those required to make the diagnosis, or several symptoms that are particularly severe, are present, or other symptoms result in marked impairment in social or occupational functioning

ADHD: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO

ADHD is a risk factor for suicidal ideation and behaviour in children. Similarly, in adulthood, ADHD is associated with an increased risk of suicide attempts, when comorbid with mood, conduct, or substance use disorders, even after controlling for comorbidity. Suicidal thoughts are also more common in ADHD population than in non-ADHD control subjects. ADHD predicted persistence of suicidal thoughts in U.S. army soldiers.

For most aviation professionals however, the suicide risk may not be the biggest problem of ADHD. However, the attention difficulties which are central to this diagnosis will almost always be problematic for the safe performance of commercial pilot or ATCO duties, as the core symptoms of ADHD influence some of the core qualities pilots and ATCOs should have.

Complicating the picture is the fact that an inaccurate diagnosis of ADHD is not uncommon (Lukkala et al., 2017). The process of correctly diagnosing ADHD is difficult and time-consuming. Under time constraints and in an effort to respond to patient (or parent) concerns, medical professionals will occasionally diagnose ADHD or prescribe medication to treat it without sufficient supporting data. As a result, there is a subgroup of the adult population with a known history of receiving treatment for ADHD, some of whom likely did not actually have the disorder and others who did.

Therefore, anyone applying for pilot licensing who has been diagnosed with this condition must undergo neuropsychological assessment to assess the likelihood of them being able to perform safely as a pilot. An individual with ongoing ADHD will not (by definition) be able to complete pilot training. Medication used for this disorder is normally disqualifying (Dyslexia, Asperger Syndrome and ADHD General information, CAA).

2. Schizophrenia Spectrum and Other Psychotic Disorders (DSM-5-TR, 2022, pp.101-104)

The main diagnoses present in the schizophrenia spectrum and other psychotic disorders include schizophrenia, other psychotic disorders, and schizotypal (personality) disorder. They are defined by abnormalities in one or more of the following five domains: delusions, hallucinations, disorganized thinking (speech), grossly disorganized or abnormal motor behaviour (including catatonia), and negative symptoms.

Delusions are fixed beliefs that are not amenable to change in light of conflicting evidence. Their content may include a variety of themes e.g., persecutory, referential, somatic, religious, grandiose.

Hallucinations are perception-like experiences that occur without an external stimulus. They are vivid and clear, with the full force and impact of normal perceptions, and not under voluntary control. They may occur in any sensory modality, but auditory hallucinations are the most common in schizophrenia and related disorders.

Disorganized thinking (formal thought disorder) is typically inferred from the individual's speech. The individual may switch from one topic to another, answers to questions may be obliquely related or completely unrelated, and rarely speech may be so severely disorganized that it is nearly incomprehensible and resembles receptive aphasia in its linguistic disorganization.

Grossly disorganized or abnormal motor behaviour may manifest itself in a variety of ways, ranging from childlike "silliness" to unpredictable agitation. Problems may be noted in any form of goal-directed behaviour, leading to difficulties in performing activities of daily living.

Negative symptoms are a substantial portion of the morbidity associated with schizophrenia but are less prominent in other psychotic disorders. Two particular prominent negative symptoms in schizophrenia are diminished emotional expression and avolition. Other negative symptoms include alogia, anhedonia, and asociality.

Schizophrenia spectrum and other psychotic disorders: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO.

Due to the impaired judgement, the increased suicide risk, the cognitive problems and the difficulties in interpersonal communication, a diagnosis of a disorder in the schizophrenia spectrum will almost always be disqualifying. The considerable risk of relapse when antipsychotic treatment is discontinued, as well as the fact that negative symptoms often remain present after the psychotic symptoms have come in remission, makes certification after a psychotic episode difficult.

3. Bipolar Disorder

The main diagnoses are Bipolar I Disorder, Bipolar II Disorder, Cyclothymic Disorder, Substance / Medication induced bipolar and related disorders, bipolar and related disorder due to another medical condition, other specified bipolar and related disorder, and unspecified bipolar and related disorder. For the objectives of the project, only Bipolar I and Bipolar II disorders will be presented. To have more knowledge about the other bipolar disorders we invite to read the DSM-5-TR.

3.1. Bipolar I Disorder (DSM-5-TR, 2022, pp. 139-149)

Derived from the classic manic-depressive disorder or psychosis, differing from the classic nineteenth century definition since neither the psychosis nor the lifetime experience of a major depressive episode is a requirement. However, most individuals whose symptoms meet the criteria for a fully syndromal manic episode also experience major depressive episodes during their lives (DSM-5-TR, 2022).

3.1.1. Diagnostic criteria

For a diagnosis of bipolar I disorder, a manic episode may have been preceded by and may be followed by a hypomanic or major depressive episodes. Diagnostic criteria for the bipolar I disorder are:

3.1.1.1. Manic Episode

- A. distinct period during which there is an abnormally, persistently elevated, expansive, or irritable mood and persistently increased activity or energy that is present for most of the day, nearly every day, for at least 1 week
- B. Three or more of the following symptoms are present to a significant degree and represent a noticeable change from usual behaviour:
 - 1) Intensified self-esteem or grandiosity
 - 2) Decreased need for sleep
 - 3) More talkative than usual or pressure to keep talking
 - 4) Flight of ideas or subjective experience that thoughts are racing
 - 5) Distractibility
 - 6) Increase in goal-directed activities or psychomotor agitation
 - 7) Excessive involvement in activities that have a high potential for painful consequences
- C. The mood disturbance is sufficiently severe to cause marked impairment in social or occupational functioning or to necessitate hospitalization to prevent harm to self or others, or there are psychotic features
- D. The episode is not attributable to the physiological effects of a substance or another medical condition.

3.1.1.2. Hypomanic Episode

- A. A distinct period of abnormally and persistently elevated, expansive, or irritable mood and abnormally and persistently increased activity or energy lasting at least 4 consecutive days and present most of the days, nearly every day.
- B. During the period of mood disturbance and increased energy and activity, three or more of the following symptoms have persisted, were a noticeable change from usual behaviours, and have been present to a significant degree:
 - 1) Intensified self-esteem or grandiosity
 - 2) Decreased need for sleep
 - 3) More talkative than usual or pressure to keep talking
 - 4) Flight of ideas or subjective experience that thoughts are racing
 - 5) Distractibility
 - 6) Increase in goal-directed activities or psychomotor agitation
 - 7) Excessive involvement in activities that have a high potential for painful consequences
- C. The episode is associated with a change in functioning that is uncharacteristic of the individual when not symptomatic
- D. The mood disturbance functioning change is observable by others
- E. The episode is not severe enough to cause marked impairment in social or occupational functioning. If there are psychotic features, the episode is, by definition, manic.
- F. The episode is not attributable to the physiological effects of a substance or another medical condition.

3.1.1.3. Major Depressive Episode

- A. Five or more of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is (1) depressed mood or (2) loss of interest or pleasure:
 - 1) Depressed mood most of the day, nearly every day
 - 2) Markedly diminished interest or pleasure in almost all activities most of the day, nearly every day
 - 3) Significant weight loss or weight gain, or decrease or increase in appetite nearly every day
 - 4) Insomnia or hypersomnia nearly every day
 - 5) Psychomotor agitation or retardation

- 6) Fatigue or loss of energy
 - 7) Feeling of worthlessness or excessive or inappropriate guilt
 - 8) Diminished ability to think or concentrate, or indecisiveness
 - 9) Recurrent thoughts of death, recurrent suicidal ideation without a specific plan, or a specific attempt or a specific plan for committing suicide
- B. Symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning
- C. The episode is not attributable to the physiological effects of a substance or a medication

3.1.2. Diagnostic features

It is characterized by a clinical course of recurring mood episodes (manic, depressive, and hypomanic), but the occurrence of at least one manic episode is necessary for the diagnosis of bipolar I disorder. The essential feature of a manic episode is a distinct period during which there is an abnormally, persistently elevated, expansive, or irritable mood and persistently increased activity or energy that is present for most of the day, nearly every day, for at least 1 week, accompanied by at least three additional symptoms from Criterion B.

3.1.3. Associated features

During a manic episode, individuals often do not perceive that they are ill or in need of treatment. Mood may shift very rapidly to anger or depression; some individuals may become hostile and physically threatening to others and, when delusional, become physically assaultive or suicidal.

3.1.4. Prevalence

In the US, the lifetime prevalence ratio in men (1.6%) to women (1.5%) is circa 1.1:1.

3.1.5. Development and Course

The peak age at onset is between 20 and 30 years. More than 90% of individuals who have a single manic episode go on to have recurrent mood episodes. Approximately 60% of manic episodes occur immediately before a major depressive episode.

The course of bipolar I disorder is very heterogeneous.

3.1.6. Risk and Prognostic Factors

Environment. Childhood emotional traumas, family conflicts, etc., are a known risk factor. Cannabis and other substances are associated with exacerbation of manic episodes and onset of manic symptoms.

Genetic and physiological. Genetic processes strongly affect the predisposition up to 90% in twins. Risk of bipolar I disorder in the general population is 1%. The heritability involves complex genetic mechanisms. Bipolar disorders share a genetic origin with schizophrenia.

3.1.7. Culture-Related Diagnostic Issues

Bipolar I disorder tend to be consistent across cultural contexts, with slightly differences in symptoms expression and interpretation.

3.1.8. Sex- and Gender-Related Diagnostic Issue

Women are more likely to experience rapid cycling and mixed states, and to have pattern of comorbidity that differ from those of men, including eating disorders, and a higher lifetime risk of alcohol use disorder.

3.1.9. Association with suicidal thoughts

The lifetime risk of suicide is estimated to 20-to 30-fold greater than in the general population. 5/6% of individuals with bipolar disorder die by suicide. Suicide attempts are higher for women, while lethal suicide is

more common for men. Almost half of the bipolar I disorder are associated with an alcohol use disorder, with a greater risk for suicide attempts or death.

3.1.10. Functional consequences

30% of individuals show severe impairment in work role functioning, with fully functionality between episodes. Cognitive impairment persists through the lifespan.

Bipolar I Disorder: compatibility with performing pilot or ATCO duties

Manic episodes are absolutely incompatible with flying and ATCO duties, due to the impaired concentration and judgement. Also, people at risk to develop a manic episode will therefore need to be disqualified. During the depressive episodes, the risks are similar to depressive disorders, and mainly the suicide risk and diminished cognitive ability will be problematic. Therefore, a diagnosis of a bipolar I disorder will almost always impede certification. In many cases, even if the condition is stable with the use of medication, the risk of a relapse will be too large, and the consequences of a relapse too big, to allow certification.

3.2. Bipolar II Disorder

The strength of the manic episodes brought on by each kind of bipolar disease is the primary distinction between bipolar 1 and bipolar 2. A full manic episode will be experienced by a person with bipolar 1, while just a hypomanic episode (a period that is less severe than a full manic episode) will be experienced by a person with bipolar 2.

Bipolar II Disorder: compatibility with performing pilot or ATCO duties

This depends on the severity of the hypomanic and depressive episodes, but only stable patients with a history of mild symptoms will in some cases be able to be classified.

4. Personality Disorders (DSM-5-TR, 2022, p. 733)

In the DSM-5-TR, personality disorders are divided in clusters. **Cluster A.** Paranoid personality disorder, Schizoid personality disorder, Schizotypal personality disorder; **Cluster B.** Antisocial personality disorder, Borderline personality disorder, Histrionic personality disorder, Narcissistic personality disorder; **Cluster C.** Avoidant personality disorder, Dependant personality disorder, and Obsessive-compulsive personality disorder.

A general personality disorder can be defined as such if an enduring pattern of inner experience and behaviour that deviate markedly from the norms and expectations of the individual's culture is present; if the pattern is manifested in two or more of the following areas: cognition, affectivity, interpersonal functioning, and impulse control; if the enduring pattern is inflexible and pervasive across personal and social situations; if the pattern leads to clinically significant distress or impairment (social, occupational); if the pattern is stable for a long duration; if the pattern is not better explained by another mental disorder or physiological effects of a substance or medical condition.

In this chapter, mainly Cluster B personality disorders will be presented, since they represent the personality disorders with more antisocial attitudes, impulsivity, and emotional dysregulation, that lead to higher social risks.

4.1. Antisocial Personality Disorder (DSM-5-TR, 2022, pp. 748-752)

4.1.1. Diagnostic criteria

Diagnostic criteria for the antisocial personality disorder are:

- A. A pervasive pattern of disregard for and violation of the rights of others, occurring since age 15 years, as indicated by three or more of the following:
 - 1) Failure to conform to social norms with respect to lawful behaviours, as indicated by repeatedly performing acts that are grounds for arrest
 - 2) Deceitfulness, as indicated by repeated lying, use of aliases, or conning others for personal profit or pleasure
 - 3) Impulsivity or failure to plan ahead
 - 4) Irritability and aggressiveness, as indicated by repeated physical fights or assaults
 - 5) Reckless disregard for safety of self or others
 - 6) Consistent irresponsibility, as indicated by repeated failure to sustain consistent work behaviour or honour financial obligations
 - 7) Lack of remorse, as indicated by being indifferent to or rationalizing having hurt, mistreated, or stolen from another
- B. The individual is at least age 18 years
- C. There is evidence of conduct disorder with onset before age 15 years
- D. The occurrence of antisocial behaviour is not exclusively during the course of schizophrenia or bipolar disorder

4.1.2. Associated features

Antisocial personality disorders frequently lack empathy and tend to be callous, cynical, and contemptuous of the feelings, rights, and suffering of others. They may be exploitative and irresponsible in their sexual relationships. They may be irresponsible as parents, as evidenced by malnutrition, illnesses in the child. These individuals may receive dishonourable discharges from the armed services. Individuals with this personality disorder are more likely than the general population to die prematurely from natural causes and suicide.

4.1.3. Prevalence

In two US surveys the prevalence was estimated at 0.6% and at 3.6%. The highest prevalence is observable among males with alcohol use disorders and from substance abuse clinics, prisons, or other forensics settings. Prevalence may be higher in samples affected by adverse socioeconomics or sociocultural factors.

4.1.4. Development and course

It has a chronic course but may become less evident or remit as the individual grow older, often by age 40.

4.1.5. Risk and prognosis factors

Environmental. Child abuse or neglect, unstable and undisciplined parenting may increase the likelihood.

Genetic and physiological. It is more common among the first-degree biological relatives, also increasing the risk for somatic symptoms disorders and substance use disorders. In the family, males more often have antisocial personality disorders and substance use disorders, while females have somatic symptoms disorders.

4.1.6. Culture-related diagnostic features

It has been associated with low socioeconomic status and urban settings. Context with high rates of child maltreatment or exposure to violence tend to have elevated prevalence of antisocial behaviours, suggesting either risk factors for the development of an antisocial personality disorder or an adverse environment that evokes reactive and contextual antisocial behaviours that do not represent pervasive and enduring personality traits.

4.1.7. Sex- and Gender-related diagnostic issues

Antisocial personality disorder is three-time as common in men than in women.

4.2. Borderline Personality Disorder (DSM-5-TR, 2022, pp. 752-756)

4.2.1. Diagnostic criteria

The borderline personality disorder can be described as a pervasive pattern of instability of interpersonal relationship, self-image, and affects, and marked impulsivity, beginning by early adulthood and present in a variety of contexts, as indicated by five or more of the following:

- 1) Frantic efforts to avoid real or imagined abandonment
- 2) A pattern of unstable and intense interpersonal relationships characterized by alternating between extremes of idealization and devaluation
- 3) Identity disturbance: markedly and persistently unstable self-image or sense of self.
- 4) Impulsivity in at least two areas that are potentially self-damaging (e.g., substance use, spending, sex, reckless drive, binge eating)
- 5) Recurrent suicidal behaviours, gestures, or threats, or self-mutilating behaviours
- 6) Affective instability due to a marked reactivity of mood
- 7) Chronic feelings of emptiness
- 8) Inappropriate, intense anger or difficulty controlling anger
- 9) Transient, stress-related paranoid ideation or severe dissociative symptoms

4.2.2. Associated features

Individuals with borderline personality disorder may have a pattern of undermining themselves at the moment a goal is about to be realized. Some individuals may develop psychotic-like symptoms during time of stress. Premature death from suicide may occur in individuals with this personality disorder, especially in those with co-occurring depressive disorders or substance use disorders. Physical handicaps may result from self-inflicted abuse behaviours or failed suicide attempts. Recurrent job losses, interrupted education, and separation/divorce are common. Physical and sexual abuse, neglect, hostile conflict, and early parental loss are more common in the childhood histories of those with borderline personality disorders. Death from other causes, such as accidents or illnesses, are more than twice as common as death by suicide.

4.2.3. Prevalence

In the three US studies the prevalence was estimated between 1.4-2.7-5.9%. The borderline personality disorder is about 6% in primary care settings, and about 20% among psychiatric patients.

4.2.4. Development and course

Borderline personality disorder symptoms have been observed in adolescents as young as age 12 or 13 years. It is not known the actual onset age. For long, it has been thought of as a disorder with a poor symptomatic course, which tended to lessen in severity entering 30s and 40s. Follow-up studies have found really common 1-8 years stable remissions.

4.2.5. Risk and prognosis factors

Environmental. Associated with child abuse and emotional neglect.

Genetic and physiological. Five times more common among first-degree biological relatives of those with the disorder than in the general population.

4.2.6. Sex- and Gender-related diagnostic issues

It is more common among women than men in clinical samples, while in community samples there are no difference in the prevalence.

4.2.7. Association with suicidal thoughts or behaviour

Impulsive and antisocial behaviours were associated with increased suicide risk. In an hospital sample followed for 24 years, 6% died by suicide.

4.3. Narcissistic Personality Disorder (DSM-5-TR, 2022, pp. 760-763)

4.3.1. Diagnostic criteria

The narcissistic personality disorder is a pervasive pattern of grandiosity (in fantasy or behaviours), need for admiration, and lack of empathy, beginning by early adulthood and present in a variety of contexts, as indicated by five or more of the following:

- 1) Has a grandiose sense of self-importance
- 2) Is preoccupied with fantasies of unlimited success, power, brilliance, beauty, or ideal love
- 3) Believes that he/she is special and unique and can only be understood by, or should associated with, other special or high-status people or institutions
- 4) Requires excessive admiration
- 5) Has a sense of entitlement (i.e., unreasonable expectations of especially favourable treatment)
- 6) Is interpersonally exploitative (i.e., takes advantage of others to achieve their ends)
- 7) Lack empathy is unwilling to recognize or identify with the feelings and needs of others
- 8) Is often envious of others or believes that others are envious of him or her
- 9) Shows arrogant, haughty behaviours or attitudes

4.3.2. Associated features

Vulnerability in self-esteem makes individuals with this personality disorder very sensitive to criticism or defeat. Although they may not show it outwardly, such experiences may leave them feeling ashamed, humiliated, degraded, hollow, and empty. They may react with disdain, rage, or defiant counterattack. It can also lead to social withdrawal or humility to mask and protect the grandiosity.

4.3.3. Prevalence

Prevalence in US studies was between 1.6% and 6.2%

4.3.4. Development and course

Narcissistic traits may be particularly common in adolescents but do not necessarily indicate that the individual will develop them in adulthood. Traits or manifestations may first come to clinical attention in the context of unexpected or extremely challenging life experiences or crises.

4.3.5. Culture-related diagnostic features

These traits may be elevated in individual and personally autonomous sociocultural contexts.

4.3.6. Sex- and Gender-related diagnostic issues

In adults, 50-75% are men. Gender differences include stronger reactivity in response to stress and compromised emphatic processing in men as opposed to self-focus and withdrawal in women.

4.3.7. Association with suicidal thoughts or behaviour

In the context of severe stress, given the perfectionism, exposure to imperfection, failure and overwhelming emotions can evoke suicidal ideation. Suicide attempts tend to be less impulsive and are characterized by higher lethality.

What deserves to be mentioned among the personality disorders of Cluster A is the Paranoid personality disorder, for its avoidance, rigidity, and impairment of reality testing.

4.4. Paranoid Personality Disorder (DSM-5-TR, 2022, pp. 737-740)

4.4.1. Diagnostic criteria

- A. A pervasive distrust and suspiciousness of others such that their motives are interpreted as malevolent, beginning by early adulthood and present in a variety of contexts, as indicated by four or more of the following:
- Suspects, without sufficient basis, that others are exploiting, harming, or deceiving him or her
 - Is preoccupied with unjustified doubts about the loyalty of trustworthiness of friends or associates
 - Is reluctant to confide in others because of unwarranted fear that the information will be used maliciously against him or her
 - Reads hidden demeaning or threatening meanings into benign remarks or events
 - Persistently bears grudges
 - Perceives attacks on his or her character or reputation that are not apparent to others and is quick to react angrily or to counterattack
 - Has recurrent suspicion, without justification, regarding fidelity of spouse or sexual partner
- B. Does not occur exclusively during the course of schizophrenia, a bipolar disorder, or a depressive disorder with psychotic features, or another psychotic disorder and is not attributable to the physiological effects of another medical condition

4.4.2. Associated features

Individuals with paranoid personality disorder are generally difficult to get along and have problems with close relationships. Their excessive suspiciousness and hostility may be expressed in overt argumentativeness, in recurrent complaining, or by hostile aloofness. They display a labile range of affect, with hostile, and sarcastic expressions predominating. Their combative and suspicious nature may elicit a hostile response in others, which then serves to confirm their original expectations. They lack trust in others, and they have a high degree of control over those around them. They are often rigid, critical of others, and unable to collaborate, although they have difficulties in accepting criticism themselves.

4.4.3. Prevalence

From US surveys and studies, the probability is between 2.3%, 3.2% and 4.4%. In forensic settings, the estimated prevalence may be as high as 23%.

4.4.4. Development and course

Paranoid personality disorder may first appear in childhood and adolescence with solitariness, poor peer relationships, social anxiety, underachievement in school, and interpersonal hypersensitivity. Adolescent onset is associated with a prior history of childhood maltreatment, externalizing symptoms, bullying of peers.

4.4.5. Risk and prognosis factors

Environmental. Exposure to social stressors such as socioeconomic inequity, marginalization, and racism is associated with decreased trust, which sometimes is adaptive. The combination of social stress and childhood maltreatment accounts for the increased prevalence of paranoid symptoms.

Genetic and Physiological. There is some evidence of paranoid symptoms in relatives of probands with schizophrenia.

4.4.6. Sex- and Gender-related diagnostic issues

Depending on the studies, the paranoid personality disorder has been found to be more common in men than in women.

Compatibility of personality disorders with performing pilot or ATCO duties

Although personality disorders may not directly affect the ability to fly an aircraft or to manage air traffic, the strong and recurrent pattern of difficulties in interpersonal relationships is a hallmark feature of all personality disorders. It is widely recognized that in 21-century aviation, good interpersonal communication and the ability to work together with colleagues is paramount to flight safety, and may sometimes even be more important than good flying skills. By their very nature, personality disorders may influence this ability negatively. In practice this risk may be even more important than the suicide risk, as it is far more likely (almost certain) to occur in personality disordered. Therefore, pilots or ATCO's suffering from an established personality disorder (which is different from personality traits, which are far more common and generally not indicating a disease) should only be certified after a thorough mental evaluation.

5. Substance-Related and Addictive Disorders (DSM-5-TR, 2022, p. 543)

The substance-related disorders encompass 10 classes of drugs: alcohol; caffeine; cannabis; hallucinogens; inhalants; opioids; sedatives, hypnotics, or anxiolytics; stimulants; tobacco; and other substances. Drugs taken in excess have the ability to activate the brain reward system, reinforcing behaviours and establishing memories, neglecting normal activities. Drugs, with their variable rewards, typically activate the system and produce feelings of pleasure leading, from a mild form to a severe state of chronically relapsing, compulsive pattern of drug taking. Substance-related disorders, in the DSM-5-TR, are classified in substance use disorders and substance-induced disorders (symptomatic presentation that are due to the physiological effect of an exogenous substance on the nervous system).

Substance-related and addictive disorders have to be acknowledged among the mental disorders with a high social risk due to their dangerousness and violation potential. This will be addressed in detail in *D3.1 Report on the analysis of the suitability of screening and confirmation tests*.

6. Depressive Disorders (DSM-5-TR, 2022, p. 177)

This category includes disruptive mood dysregulation disorder, major depressive disorder, persistent depressive disorder, premenstrual dysphoric disorder, substance/medication-induced depressive disorder, depressive disorder due to another medical condition, other specified depressive disorder, and unspecified depressive disorder. The common feature to all of these disorders is the presence of sad, empty, or irritable mood, accompanied by related changes that significantly affect the individual's capacity to function (e.g., somatic and cognitive changes in major depressive disorder and persistent depressive disorder). What differs among them is the duration, timing, or presumed etiology.

The major depressive disorder represents the classic condition in this group of disorders. It is characterized by discrete episodes of at least 2 weeks' duration (although most episodes last considerably longer) involving clear-cut changes in affect, cognition, and neurovegetative functions and interepisode remissions. A diagnosis based on a single episode is possible, although the disorder is a recurrent one in the major cases.

A more chronic form of depression, persistent depressive disorder, can be diagnosed when the mood disturbance continues for at least 2 years in adults.

Bereavement is among the risk factors and can lead to depression (Hammen, 2005).

A large number of substances of abuse, some prescribed medications, and several medical conditions can be associated with depression-like phenomena.

Depressive disorders: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO

Patients suffering from a depressive disorder will often be less able to concentrate, may be fatigued because of sleep problems, may be distracted because of negative thoughts and may be at an increased risk of suicide. Pilots and ATCO's suffering from a depressive disorder therefore cannot fly. However, when the symptoms are largely or completely in remission, they may safely resume their work.

7. Anxiety Disorders (DSM-5-TR, 2022, pp. 215-216)

These disorders share features of excessive fear and anxiety and related behavioural disturbances and are: separation anxiety disorder, selective mutism, specific phobia, social anxiety disorder, panic disorder, agoraphobia, generalized anxiety disorder, substance/medication-induced anxiety disorder, anxiety disorder due to another medical condition. Fear and anxiety often overlap, but they also differ, with fear being more associated with surges of autonomic arousal necessary for fight or flight, thoughts of immediate danger, and escape behaviours, and anxiety being more often associated with muscle tension and vigilance in preparation for future danger and cautious or avoidant behaviours. Panic attacks feature prominently, but are not limited, within the anxiety disorders as a particular type of fear response.

The anxiety disorders differ from one another in the:

- Types of objects/situations that induce fear, anxiety, avoidance behaviours, and the associated cognition
- Fear or anxiety being excessive or persisting beyond developmentally appropriated periods
 - o Transient fear or anxiety (often stress-induced)
 - o Persistent fear or anxiety

In **panic disorder** (DSM-5-TR, 2022, pp. 235-237), the individual experiences recurrent unexpected panic attacks and is persistently concerned or worried about having more panic attacks or changes their behaviours in maladaptive ways because of the panic attacks (e.g., avoidance of unfamiliar locations). Panic attacks are abrupt surges of intense fear or intense discomfort that reach a peak within minutes, accompanied by physical and/or cognitive symptoms. Panic attacks may be expected (in response to a typically feared object/situation), or unexpected (the panic attack apparently occur for no reason).

Anxiety disorders: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO

Although suicidality here is not very common, untreated anxiety disorders may negatively influence flight safety because the pilot may be distracted because of anxious thoughts. Also, a pilot may not dare to perform all elements of the operation anymore, e.g., a captain who always asks his first officer to be the pilot flying because of anxiety. In case of severe social anxiety, communication may be impaired. A panic disorder may result in an incapacitation, and is a relatively common cause for emergency landings due to a pilot incapacitation. Therefore, untreated anxiety and panic disorders are often not compatible with the ability to fly or perform ATCO duties safely. In the evaluation, special concern should be given to the high rate of comorbidity with depressive disorders.

8. Trauma- and Stressor-Related Disorders (DSM-5-TR, 2022, p.295)

Trauma- and stressor-related disorders have been introduced in 2013 as a standalone chapter to specifically indicate those disorders that involve the exposure to a traumatic or stressful event and, consequently, clinically significant signs and symptoms of psychological discomfort and mental health problems. The exposure to stressful events is listed explicitly as a diagnostic criterion. The chapter includes all those disorders that are featured by some maladaptive psychophysiological reactions to stress.

Life stressors such as bereavement, work related problems, financial worries, health concerns, relationship / family difficulties, separation from family, social demands, can themselves lead to subtle incapacitation (Bor et

al., 2017), as they trigger acute stress symptoms, or can lead to more severe mental disorders (Hammen, 2005; Young, 2008).

Two of the trauma-related disorders are acute stress disorder and posttraumatic stress disorder (PTSD). Other Trauma- and stressor-related disorders include reactive attachment disorder, disinhibited social engagement disorder, posttraumatic stress disorder (PTSD), acute stress disorder, adjustment disorders, and prolonged grief disorder.

All these disorders are featured by having experienced, firsthand, a stressful event / trauma with the following onset of clinically significant emotional and behavioral symptoms. The symptomatic manifestations can be very different from person to person. In some cases, psychological trauma can manifest itself through emotions of fear and anxiety, often linked to the stressful context. In other cases, however, instead of anxiety, it is possible to observe other symptoms such as anhedonia or dysphoria, feelings of anger and aggression, or even dissociative symptoms.

Trauma- and stressor-related disorders can be short-term or long-term.

8.1. Posttraumatic stress disorder (PTSD) (DSM-5-TR, 2022, p.301)

In this chapter only the PTSD in individuals older than 6 years old will be presented.

- A. Exposure to actual or threatened death, serious injury, or sexual violence in one or more of the following ways:
 - 1. Directly experiencing the traumatic event(s)
 - 2. Witnessing, in person, the event(s) as it occurred to others
 - 3. Learning that the traumatic event(s) occurred to a close family member or close friend. In cases of actual or threatened death of a family member or friend, event(s) must have been violent or accidental
 - 4. Experiencing repeated or extreme exposure to aversive details of the traumatic event(s)
- B. Presence of one or more of the following intrusion symptoms associated with the traumatic event(s), beginning after the traumatic event occurred:
 - 1. Recurrent, involuntary, and intrusive distressing memories of the traumatic event(s)
 - 2. Recurrent distressing dreams in which the content and/or affect of the dream are related to the traumatic event(s)
 - 3. Dissociative reactions (e.g., flashbacks) in which the individual feels or acts as if the traumatic event(s) were recurring.
 - 4. Intense or prolonged psychological distress at exposure to internal or external cues to symbolize or resemble an aspect of the traumatic event(s)
 - 5. Marked physiological reactions to internal or external cues that symbolize or resemble an aspect of the traumatic event(s)
- C. Persistent avoidance of stimuli associated with the traumatic event(s), beginning after the traumatic event(s) occurred, as evidenced by one or both of the following
 - 1. Avoidance of or efforts to avoid distressing memories, thoughts, or feelings about or closely associated with the traumatic event(s)
 - 2. Avoidance of or efforts to avoid external reminders that arouse distressing memories, thoughts, or feelings about or closely associated with the traumatic event(s)
- D. Negative alterations in cognitions and mood associated with the traumatic event(s), beginning or worsening after the traumatic event(s) occurred, as evidenced by two or more of the followings:
 - 1. Inability to remember an important aspect of the traumatic event(s)
 - 2. Persistent and exaggerated negative beliefs or expectations about oneself, others, or the world

3. Persistent, distorted cognitions about the cause or consequences of the traumatic event that lead the individual to blame himself/herself or others
 4. Persistent negative emotional state
 5. Markedly diminished interest or participation in significant activities
 6. Feelings of detachment or estrangement from others
 7. Persistent inability to experience positive emotions
- E. Marked alterations in arousal and reactivity associated with the traumatic event, beginning or worsening after the traumatic event occurred, as evidenced by two or more of the following:
1. Irritable behaviour and angry outbursts typically expressed as verbal or physical aggression toward people or objects
 2. Reckless or self-destructive behaviour
 3. Hypervigilance
 4. Exaggerated startle response
 5. Sleep disturbance
- F. Duration of the disturbance (Criteria B, C, D, E) is more than 1 month
- G. The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.
- H. The disturbance is not attributable to the physiological effects of a substance or another medical condition

It may be

- With dissociative symptoms: the individual's symptoms meet the criteria for PTSD, and in addition, in response to the stressor, the individual experiences persistent or recurrent symptoms of either of the followings:
 - Depersonalization: persistent or recurrent experiences of feeling detached from, and as if one were an outside observer of, one's mental processes or body
 - Derealization: persistent or recurrent experiences of unreality of surroundings

To use this subtype, the dissociative symptoms must not be attributable to the physiological effects of substances or another medical condition.

It may be:

- With delayed expression: if the full diagnostic criteria are not met until at least 6 months after the event

8.2 Acute stress disorders

Acute stress disorder and PTSD are similar except that the acute stress disorder is short-term. In fact, it typically begins immediately after the trauma and lasts from 3 days to 1 month, whereas PTSD lasts for > 1 month, either as a continuation of acute stress disorder or as a separate occurrence that begins up to 6 months after the trauma.

Acute stress disorder is part of the disorders related to stress and anxiety and is featured by the development of symptoms that are similar to those of post-traumatic stress disorder. Specifically, these symptoms occur no later than 3 days after the traumatic event and no later than the first month after the event. As in PTSD, acute stress disorder is linked to traumatic or highly stressful experiences, during which the individual has experienced danger to their physical or psychological health.

The substantial difference between acute stress disorder and post-traumatic stress disorder is related to the duration of the disorder. If these symptoms are present up to a month after the traumatic event, then we speak of acute stress disorder, when instead it exceeds the month and the symptoms continue to be present is PTSD.

8.3 Adjustment disorder

The adjustment disorder is featured by emotional and behavioral symptoms in response to an identifiable stressful event. The disorder can be linked to a single event (for example the end of a relationship) or to a series of stressful events. It can be short- or long- term.

Stressful events can be life-changing (mourning), recurrent (for example related to moments of crisis at work or within a relationship) or continuous (for example the discovery of a serious illness). Stressful events can affect the individual, a family, a working group or an entire community. In case of bereavement, the adjustment disorder can be diagnosed when emotional and behavioral reactions are considered excessive and disproportionate in intensity, quality and persistence.

Trauma- and Stressor-Related Disorders: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO

Traumatic events such as childhood abuse or sexual trauma increase an individual's suicide risk in both civilians and veterans. PTSD is associated with suicidal thoughts, suicide attempts, and death from suicide. The presence of PTSD has been associated with an increased likelihood of transitioning from suicidal thoughts to a suicide plan or attempt, and this effect of PTSD occurs independently of the increased risk of mood disorders on the likelihood of suicidal behaviours. Among adolescents there is also a significant relationship between PTSD and suicidal thoughts or behaviour even after adjustment for the effects of comorbidity. Besides the suicide risk, difficulties with concentrating due to intrusions or fatigue because of bad sleeping hinders the ability to work as a pilot or ATCO. Intrusions may even lead to very short moments of incapacitation which during certain phases of the flight or during busy periods as an ATCO, may be quite dangerous. Also here, the high comorbidity with depressive disorder is important to keep in mind.

9. Somatic Symptoms and Related Disorders (DSM-5-TR, 2022, p. 349)

This section includes the diagnoses of somatic symptoms disorder, illness anxiety disorder, functional neurological symptom disorder (conversion disorder), psychological factors affecting other medical conditions, factitious disorder, other specified somatic symptoms and related disorders, and unspecified somatic symptoms and related disorder. All of these disorders share a common feature: the prominence of somatic symptoms and/or illness anxiety associated with significant distress and impairment.

9.1. Somatic Symptom Disorder (DSM-5-TR, 2022, p. 351)

- A. One or more somatic symptoms that are distressing or result in significant disruption of daily life
- B. Excessive thoughts, feelings, or behaviours related to the somatic symptoms or associated health concerns as manifested by at least one of the following:
 - 1. Disproportionate and persistent thoughts about the seriousness of one's symptoms
 - 2. Persistently high level of anxiety about health or symptoms
 - 3. Excessive time and energy devoted to these symptoms or health concerns
- C. Although any one somatic symptom may not be continuously present, the state of being symptomatic is persistent (typically more than 6 months)

It may be:

- With predominant pain: this specifier is for individuals whose somatic symptoms predominantly involve pain

It may be:

- Persistent: a persistent course is characterized by severe symptoms, marked impairment, and long duration (more than 6 months)

Severity:

- Mild: only one of the symptoms specified in criterion B is fulfilled
- Moderate: Two or more of the symptoms specified in criterion B are fulfilled
- Severe: Two or more of the symptoms specified in criterion B are fulfilled, plus there are multiple somatic complaints

Somatic symptom disorder: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO

Somatic symptom disorder is associated with suicidal thoughts and suicide attempts. It is likely that suicidal thoughts and behaviours are partly explained by the diagnostic overlap and frequent comorbidity of somatic symptoms disorder and depressive disorders. In addition, dysfunctional illness perceptions and the severity of somatic symptoms appear to be independently associated with an increased risk of suicidal ideation. More importantly, worries about their physical health may be distracting and may cause sleeping difficulties, causing problems with concentrating.

10. Feeding and Eating disorders (DSM-5-TR, 2022, pp.371)

Feeding and eating disorders are characterized by a persistent disturbance of eating or eating-related behaviours that result in the altered consumption or absorption of food and that significantly impairs physical health or psychosocial functioning. In the DSM-5-TR diagnostic criteria are provided for pica, rumination disorder, avoidant/restrictive food intake disorder, anorexia nervosa, bulimia nervosa, and binge-eating disorder. Some individuals with these disorders report eating-related symptoms resembling those typically endorsed by individuals with substance use disorder, such as craving and patterns of compulsive use. This resemblance may reflect the involvement of the same neural systems, including those implicated in regulatory self-control and reward, in both group of disorders. However, the relative contributions of shared and distinct factors in the development and perpetuation of eating and substance use disorder remains insufficiently understood. Obesity is not included in the DSM-5 as a mental disorder. It results from the long-term excess of energy intake relative to energy expenditure. A range of genetic, physiological, behavioural, and environmental factors that vary across individuals contribute to its development, thus not considering it as a mental disorder; however, there are robust associations between obesity and a number of mental disorders (e.g., binge-eating disorder, depressive and bipolar disorders, schizophrenia).

Feeding and eating disorders: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO.

Patients suffering from eating disorders are at an increased risk for suicide. Even more important, in more severe cases the preoccupation with eating may hinder the ability to concentrate on flight duties. Furthermore, severe underweight causes cognitive rigidity and impaired decision making. Therefore, more severe cases of eating disorder will almost always be incompatible with certification. Mild eating disorders may be compatible with flying or ATC duties however, especially if the applicant is being treated by a mental healthcare professional.

11. Obsessive-Compulsive and Related Disorders (DSM-5-TR, 2022, pp. 263-264)

This category includes obsessive-compulsive disorder (OCD), body dysmorphic disorder, hoarding disorder, trichotillomania (hair-pulling disorder), excoriation (skin-picking) disorder, substance/medication-induced obsessive-compulsive and related disorder, obsessive-compulsive and related disorder due to another medical condition, other specified obsessive-compulsive and related disorder (e.g., nail biting, lip biting, cheek chewing, obsessional jealousy, olfactory reference disorder), and unspecified obsessive-compulsive and related disorder.

OCD is characterized by the presence of obsessions and/or compulsions. Obsessions can be defined as recurrent and persistent thoughts (often referred to intrusive thoughts), urges, or images that are experienced as

intrusive and unwanted, whereas compulsions can be defined as repetitive behaviours or mental acts that individual feels driven to perform in response to an obsession or according to rules that must be applied rigidly.

Obsessive-Compulsive and related disorders: association with suicidal thoughts or behaviour and the ability to work as a pilot or ATCO.

Obsessions may be distracting, and compulsions may, if severe, interfere with the necessity of performing certain tasks. It may be especially troublesome if work-related tasks become part of the OCD (eg. performing elements of a checklist repeatedly with no reason). Also, the distress caused by the disorder may lead to a general difficulty with concentrating.

3.4 Comorbidities among mental disorders

The mutual occurrence of more than one mental disorder in the same patient at the same time is common, especially in the more specialised mental healthcare settings. In many cases patients will fulfil the formal diagnostic criteria of several mental disorders, but it is also quite common that patients suffering from one disorder, also suffer symptoms of other mental disorders without formally fulfilling all diagnostic criteria. As diagnosing mental disorders is much more than just checking whether a patient fulfils all the DSM or ICD diagnostic criteria, it is a matter of clinical experience to judge whether symptoms should be attributed to one disorder, or to two comorbid disorders (De Rooy, 2019).

For example: there is a large comorbidity between post-traumatic stress disorder (PTSD) and depressive disorders. Both disorders can cause sleeping difficulties. It is a matter of clinical experience to decide whether the sleeping problems of a patient can be fully attributed to the PTSD (for example, if the sleep is disturbed by nightmares about the traumatic event), or to the comorbid depressive disorder (for example, if the patient also suffers from a depressed mood and an inability to enjoy things).

Although comorbidities among almost all mental disorders occur, some patterns occur more often than others. For aeromedical evaluations, especially the high comorbidity of depressive and anxiety disorders is relevant, as well as the high comorbidity between depressive disorders and PTSD, between depressive disorders and personality disorders and between substance use disorders and several other mental disorders.

The high comorbidity between mental disorders and the fact that symptoms of various disorders overlap, suggests that in fact mental disorders may be better explained by underlying latent factors instead of the nowadays used taxonomies, and also that several mental disorders may share similar genetic risk factors (Plana-Ripoll et al 2019).

Recognizing comorbid disorders is important but recognizing underlying traits of other disorders or recognizing underlying personality features, even if no formal diagnosis of another disorder can be established, is even more important, as it may influence the prognosis and it may have treatment consequences. For example, both SSRI's and Cognitive Behavioural Therapy are effective in both depressive and anxiety disorders. However, when these disorders occur together, often a combined pharmacological and psychotherapeutic treatment is preferred. Although CBT is an effective treatment option for both, it needs to be tailored to address both the mood and the anxiety complaints (Penninx, 2021).

Depressive disorders and anxiety disorders

About half of the patients suffering from a depressive disorder, will at some point during their life, also suffer from an anxiety disorder and vice versa. Generally, the prognosis is worse in case of comorbidity (Kessler 2015, Penninx 2021). In many cases, a combined pharmacological and psychotherapeutic treatment is preferred. If complaints have been present for a long time, (for example, anxiety started in early adolescence

and remained ever since, and a patient comes into treatment in his early thirties for a depressive disorder), many psychiatrists will advise to continue an effective and well-tolerated drug treatment for a longer period of time or life-long, as there is a strong indication of an underlying biological vulnerability.

Post-traumatic stress disorders

There is a high comorbidity with depressive and anxiety disorders. It is important that these are recognized. In general, except for the very severe cases, the presence of a comorbid depressive disorder or anxiety disorder does not need to hinder the PTSD-treatment. In most cases, the PTSD precedes the development of the depressive or anxiety disorder (Zorgstandaard Psychotrauma en stressorgerelateerde stoornissen 2020). Here it is paramount that the PTSD is treated well, although this treatment may be supported by an antidepressant treatment.

Personality disorders

Especially for those working in aviation, most patients with a personality disorder will, if seeking treatment, present themselves with depressive or anxiety complaints, or with stress-related symptoms. For the psychiatrist or clinical psychologist examining these patients, it is important to address underlying personality features, and to diagnose a personality disorder if present. Also, if no formal diagnoses of a personality disorder can be made, but there are notable personality traits, these need to be recognized, and ideally they are addressed during the treatment, as addressing them will help to prevent a relapse and improve long-term outcomes. Of course, the specific characteristics of working in an aviation environment need to be taken into account. An overconfident or fairly paranoid presentation may be wrongfully identified as a narcissistic or paranoid personality disorder, whereas in some pilots it may be a normal coping mechanism for dealing with the stress of a mental examination and the possibility of losing a licence (Bor & Hubbard 2006). Although not necessarily signs of a disorder, it is important to recognize these features, as a mental examination can only be performed reliably if the patient is open enough, and treatment can only be successful if the patient feels confident and there is a good therapeutic relationship.

Substance-use disorders

In some cases, it is debatable whether in case of a substance use disorder and a comorbid mental disorder, first the substance use disorder or the comorbid disorder should be treated (as this disorder in many cases will have caused the substance abuse disorder). However, in case of severe substance abuse, treatment of a comorbid disorder is generally little effective, and psychotropic drugs may interact with some substances, so here, first a detoxification is preferred.

3.5 Internalizing and externalizing symptoms

An interesting aspect of the DSM V is that the presentation of mental disorders within the manual is done in accordance with what are called internalizing factors and externalizing factors.

Externalizing symptoms relate to situations where subjective distress flows outwards, causing a disturbance in the surrounding environment. In the presence of externalizing symptoms, the behaviour is characterized by the following characteristics:

- claim that personal needs take precedence over the needs of others;
- resort to aggression to get what is wanted;
- opposition and violation of social and legal norms.

According to the international diagnostic categories, we often find these characteristics in three types of mental disorders:

- bipolar disorders
- antisocial and narcissistic personality disorders
- borderline personality disorder

It is important to point out that externalizing symptoms can result in a mental disorder when:

- the behaviour takes on extreme characteristics;
- such characteristics of the behaviour tend to become chronic, that is, they do not disappear in a short time;
- the behaviour causes harmful consequences for the subject and for other people.

These disorders might be very hazardous for safety: on one hand, neither immediately visible nor considered as a disease by the person suffering from them, who would generally avoid seeking help; on the other hand, at high risk of dangerous behaviours. This happens because these disorders are featured by a dysfunctional relationship between the emotions and their regulation. For example, fear and anger (not unlawful and unacceptable as such) could be transformed into hostility in the form of crime planning and on-duty execution (definitely illegal and unacceptable). The emotional expression and regulation lays at the borders between mental health and psychopathology: what is pathological is not the emotion as such, but some dysfunctional ways of reacting to it.

Internalizing symptoms are characterized by hyper control, that is, the person tends to regulate her/his emotional and cognitive states in an excessive and inappropriate way. The term "internalizing" indicates precisely that the problems in question are developed and maintained internally. Internalizing symptoms are often misinterpreted or overlooked because, unlike the overpoweringly obvious externalizing ones, they are difficult to detect exclusively with external observation.

Although the internalizing manifestations are numerous and complex, it is possible to divide them into four main types:

- Anxiety
- Depression
- Social withdrawal
- Psychophysiological problems (complaints of discomfort or physical pain that have no established medical basis).

It is possible that these manifestations are accompanied by low self-esteem, work-related stress problems and poor social relations. Internalizing symptoms can lead to incapacitation as they might impair decision making and analytical reasoning.

Nevertheless, internalized symptoms are usually recognized as uncomfortable by the person suffering from those, who generally seek for help and tend to follow the standard rules of society, thus generally ensuring the safety of her/himself and others.

3.6 Self-declaration of mental disorders

The safety assumption according to which an applicant suffering from a mental health disorder will seek help and self-declare her/his condition might fail. The following barriers might act as obstacles:

- Stigma and blame culture
- Vulnerability

- Mistrust
- Fear of repercussions
 - loss of medical
 - impact on professional ambition and career
 - financial risk

Indeed, the self-declaration principle may hardly fail when externalizing symptoms are concerned. This happens because people suffering from externalizing symptoms usually either do not recognize their own distress as a symptom (and, as a consequence, do not communicate it as such) or consider it as acceptable, if not even just, and, as a consequence, keep hiding it until they have the possibility to publicly show its effects.

Feeling ashamed of one's own symptoms, thus hiding them on purpose, might also play a role, when both externalizing and internalizing symptoms are concerned.

Shame is also related with the cultural environment in which individuals have been raised.

Unfortunately, the role of culture in the processes of mental health and psychological distress is often put in the background and it is rarely taken into account how much this deficiency also has cultural roots. In fact, the idea of seeking the cause and solution of an individual's mental health issue in the person herself/himself is in turn a culturally constructed idea, which is rooted, specifically, in an individualistic culture (Quaranta, 2010).

3.7 Cultural impact on mental health

In the collective imagination, mental health is generally traced back to the personality and attitude of the individual: it is widespread the idea that everyone should dedicate themselves to their personal well-being by implementing behaviors and lifestyles suitable for it.

It is certainly important that the individual is able to exert a substantial influence on his own well-being and discomfort, but the need to broaden the analysis of discomfort and well-being in order to also understand the influence of culture on them remains valid, in order to establish a more balanced and organic perspective on mental health.

Although there have been many authors in the history of psychology (and not only) who have emphasized, through their work, the critical importance of cultural factors in mental functioning and its malfunction, their voices have always constituted a marginalized minority compared to the current mainstream vision in psychology, psychiatry and other care professions (Cuèllar & Paniagua, 2000). Indeed, the disciplines that have offered their contribution to the interdependence between culture and mental health (cultural psychology, ethnopsychiatry, transcultural psychotherapy, multicultural psychology, cultural psychiatry, transcultural psychiatry, social psychiatry, community psychiatry, medical anthropology ...) are numerous and, constituting themselves all as interdisciplinary approaches, are characterized by often labile and not strongly delineated boundaries of delimitation.

More rarely, however, it is possible to find, within these disciplines, a clear research interest in the study of the influence that Western culture itself exerts on the mental health of individuals who are immersed in it.

This research interest was born as a reaction to the cognitive revolution that took place in psychology during the 60s of the last century, supporting, in particular, a critical view towards a conception of a mental life as universal, abstract and exclusively interior. The person, according to traditional cognitive science, can be understood when compared to an information processor system, such as the computer; In this sense, the task of psychology consists in the study of the operational specificities of mental processes, through a purely individualistic approach, where the subject is separated from her/his world. A cultural vision of psychology instead marries the approach of continuity between psyche and culture: the psyche is considered as a

particular, individual incarnation of culture, which in turn is constituted by the concurrence of the particular expressions of the first (Coppo, 2003). According to this approach, mental structures and individual psychological processes can be better understood if we take into account the specific cultural context the subject belongs to (Inghilleri, 2009) and the cultural values that characterize it (Eckersley, 2006).

In line with this, Cultural and cross-cultural psychology has specialized in the study of the interaction between culture and the individual through the theorization of two general cultural trends: individualism and collectivism. Each social group or community chooses its own way of combining so-called centripetal forces (which push towards belonging) with centrifugal forces (which push instead towards self-realization) (Salonia, 2005); at the two extremes of this continuum we find the dichotomy individualism versus collectivism (Hofstede, 1983). Individualism is a cultural trend that is based on putting the individual, his potential, his personal freedom and choice at the center and reflects a state of emotional independence and personal autonomy (Hofstede, 1984). In individualistic cultures, such as Europe and North America, the goal of society is to create the right situations to support individuals in achieving their individual satisfaction (thus privileging centrifugal forces). On the other hand, in collectivist cultures, such as Asia, Africa and South America, group aspects prevail (hence prevalence of centripetal forces).

Neither individualistic nor collectivistic societies are good or bad as such. They both have pros and cons.

People belonging to these two different cultural tendencies are led to the construction of two different types of Self: the Independent Self and the Interdependent Self (Markus & Kitayama, 1991). The Independent Self characterizes people who are part of individualistic societies, which tend to emphasize separation, subjective qualities and the uniqueness of individuals. In these societies, as we have seen, individual objectives play a primary role with respect to the objectives of the group which they belong to and the others represent more a means for social comparison than a means of defining one's own identity. The Independent Self, defined as stable, contained and unitary, remains separate from the social context and aims at the realization of its internal characteristics and the promotion of its goals by relying on its individual abilities.

The individual is not so much regulated by an external order, by a conformity to the law, whose infringement generates feelings of guilt, but must appeal to her/his internal resources, to her/his mental skills, to achieve those results from which s/he will be evaluated. In the attempt to realize her/himself, the individual finds her/himself in a condition of continuous movement between the right to choose her/his own life and the imposition of having to do so on her/his own. The collective drive for happiness and well-being excludes the possibility that psychological discomfort can also have social causes, placing the origin of responsibility and blame for the discomfort in the weakness and vulnerability of the individual.

Although the individualism/collectivism dichotomy is commonly used to study the differences between people belonging to different countries, it has been argued that these two dimensions are not mutually exclusive, but that they can coexist. Triandis and Gelfand (1998), for example, consider individualism and collectivism on two levels: psychological and social. In cultures of homogeneous and static type the two levels can coincide producing individualistic subjects in individualistic cultures, rather than collectivist subjects in collectivist cultures. In societies rich in change, variety of information and high mobility, situations may arise in which psychological and social individualism do not coincide uniformly.

These reflections help framing mental health within a culturally and socially situated perspective. The efforts of psychological research, in this sense, should be directed to increase the awareness of civil society and institutions on the psycho-social variables that can affect well-being and mental health, and those that can hinder them, widening the field of attention and action in order not to focus exclusively on the individual characteristics of a person.

In this sense, all studies agree that one of the key resources for people's well-being is social support: people who perceive that they have high social support maintain a better degree of mental and physical health than those who perceive low social support (for a review: Hobfoll, 2002).

For the scope of MESAFE, the following general assumptions can be summed up (Inghilleri, 2009):

1. Culture and thought and behavior are indistinguishable and inseparable
2. Mental structures and individual psychological processes can only be understood if the specific cultural context of belonging of the subject is taken into account.
3. The meanings and practices of a cultural group influence and shape the mental structures and psychological processes of the people who are part of it (even dysfunctional ones)
4. To really understand the behaviour of people, we need to analyze the everyday practices, the artifacts present within the cultural and organizational context of the subjects, and the way in which individuals relate to them.

3.8 Take-away messages

There are more than 450 mental disorders and they are not all the same. For example, not all mental disorders are long-term and not all mental disorders are featured by abnormal, unpredictable and deviant behaviours. For example, the acute stress disorder lasts from 3 days to 1 month and it is featured by subtle incapacitation deriving from maladaptive psychophysiological reactions to stressors, which trigger it. The acute stress disorder is a good example also to highlight the relevance of life changing events and work-related stressors on mental health, whose impact should always be taken into account.

As a consequence, it is very important to evaluate the presence and severity of mental disorders and comorbidities in order to assess the incapacitation risks they pose to pilots and ATCOs, which can be low, moderate or high. Not all the mental disorders lead to the loss of medical fitness certification.

For many mental disorders denial is a relatively frequent symptom, leading to a reduced rate of self-declaration.

Mutual occurrence of more than one mental disorder in the same patient at the same time is common. Consequently, diagnosing mental disorders is much more than just checking whether a patient fulfils all the DSM or ICD diagnostic criteria, it is a matter of clinical experience to judge whether symptoms should be attributed to one disorder, or to two comorbid disorders. Recognizing comorbid disorders is important but recognizing underlying traits of other disorders or recognizing underlying personality features, even if no formal diagnosis of another disorder can be established, is even more important, as it may influence the prognosis and it may have treatment consequences.

Mental structures and individual psychological processes can only be understood if the specific cultural context the subject belongs to is taken into account. Indeed, the meanings and practices of a cultural group influence and shape the mental structures and psychological processes of the people who are part of it (even dysfunctional ones).

In line with this, the cultural and organizational environment which individuals belong to have an impact on their possibility and willingness to self-declare mental health issues. A blame culture on mental health issues might in fact generate feelings of shame and guilt in people suffering from mental disorders, to the extent that they could hide them on purpose, thus promoting under reporting of possible safety issues related to mental health. On the other hand, one of the key resources for people's well-being is social support: a supportive and just-culture oriented environment towards mental health and psychological discomfort might help self-

declaration of possible mental issues before they escalate into negative effects for safety and for the health of people suffering from them.

For the scope of MESAFE, the following take-away can be taken into consideration:

Take away ID	Take away message
3.1	More than 450 mental disorders exist. They are not all the same. Not all mental disorders lead to loss of medical fitness certification.
3.2	Not all mental disorders are long-term. Many of them are short-term.
3.3	Not all mental disorders are featured by abnormal, unpredictable and deviant behaviours. Some of them are featured by maladaptive psychophysiological reactions to life changing events and stressors.
3.4	Life changing events and work-related stressors have an impact on mental health.
3.5	To make decisions about the certification of mental fitness in case a mental disorder is present, it is important to evaluate: <ul style="list-style-type: none"> • Comorbidities • Incapacitation risk (i.e., impairment in performing flight duties) • The level of social dangerousness associated to that condition • The presence of life changing events • Risks related to the treatment – if that leads to suicidal ideation, depression or to slow reaction times that may be a risk for flight safety even if the condition itself is not anymore. • The risk of relapse after recovery
3.6	Many mental disorders impede the ability to concentrate and cause sleeping difficulties, which is much more frequent than suicidal behaviour, and also an important risk for flight safety.
3.7	The safety assumption according to which an applicant suffering from a mental health disorder will seek help and self-declare her/his condition might fail. Indeed, for many mental disorders denial is a relatively frequent symptom leading to a reduced rate of self-declaration. Feelings of shame and guilt can also reduce the rate of self-declaration.
3.8	The cultural and organizational environment which individuals belong to have an impact on their possibility and willingness to self-declare mental health issues. A supportive and just-culture oriented environment towards mental health and psychological discomfort might help self-declaration of possible mental issues before they escalate into negative effects for safety and for the health of people suffering from them.

Table 7 - Take-away messages on Mental disorders and associated incapacitation risks

An overview of the risks related to the treatment options for mental health is available in D1.2_Report on the review of treatment options.

4. Assessing mental health

The Society for Personality Assessment (SPA, 2008) defines psychological evaluation as follows: "With psychological evaluation we refer to the scientific methods that mental health specialists employ to understand the human personality and behaviour. When combined with information from interviews, observations, and other sources, evaluation can help the client explore new and more effective ways of solving their problems. Once the evaluation procedures are completed and the results are obtained, mental health specialists typically provide their clients with feedback. The aims are the promotion of a greater capacity for self-understanding and the possibility of planning appropriate treatment. In this way, psychological evaluation can reduce the time of a treatment based solely on the clinical interview.

This definition highlights the importance of the three components: the psychometric, the clinical and the one linked to the promotion of change in which the person is at the center. Assessing mental health, therefore, means not only applying standardized methods to collect information ("taking tests"), but also integrating the information derived from the tests with other information (anamnesis, physical examination and interview). The report plays a central role in both gathering information and promoting change. Working with tests also means not only having skills on the application of tests, but also having clinical and relational skills ("doing assessment").

Psychological assessment is also used to provide information that helps answer questions posed by other professionals. This is the case of the mental health assessment for aeromedical purposes.

The American Psychological Association (APA) in early 2020 produced *Guidelines for Psychological Assessment and Evaluation* (PAE) "to assist and inform psychologists of best practice when psychological instruments, including psychometric tests and collateral information, are used within the practice of psychological assessment and/or evaluation" (APA-psychology, 2020). The 17 guidelines developed by APA are summarized as follows (for a more comprehensive read we suggest consulting the *APA Guidelines for Psychological Assessment and Evaluation*):

Competence.

1. Psychologists who conduct psychological testing, assessment, and evaluation strive to develop and maintain their own competence. This includes competence with selection, use, interpretation, integration of findings, communication of results, and application of measures.
2. Psychologists who conduct psychological testing, assessment, and evaluation seek appropriate training and supervised experience in relevant aspects of testing, assessment, and psychological evaluation.
3. Psychologists who conduct psychological testing, assessment, and evaluation strive to be mindful of the potential negative impact and subsequent outcome of those measures on clients/patients/examinees/employees, supervisees, other professionals, and the general public.
4. Psychologists strive to consider the multiple and global settings (e.g., forensic, education, integrated care) in which services are being provided.

Psychometric and measurement knowledge.

5. Psychologists who provide psychological testing, assessment, and evaluation demonstrate knowledge in and seek to appropriately apply psychometric principles and measurement science as well as the effects of external sources of variability such as context, setting, purpose, and population.

Selection, administration, and scoring of tests.

6. Psychologists who conduct psychological testing, assessment, and evaluation endeavour to select (a) assessment tools that demonstrate sufficient validity evidence for their uses, sufficient score reliability, and sound psychometric properties and (b) measures that are fair and appropriate for the evaluation purpose, population, setting, and context at hand.
7. Psychologists who conduct psychological testing, assessment, and evaluation strive to use multiple sources of relevant and reliable clinical information collected according to established principles and methods of assessment.
8. Psychologists who conduct psychological testing, assessment, and evaluation strive to be aware of the need for test selection, scoring, and administration to reflect the appropriate normative comparison, situational influences, effort, and standardized administration as indicated.

Diverse, underrepresented, and vulnerable populations

9. Psychologists who conduct psychological testing, assessment, and evaluation strive to practice with cultural competence.
10. Psychologists who conduct psychological testing, assessment, and evaluation aspire to ensure awareness of individual differences, various forms of biases or potential biases, cultural attitudes, population appropriate norms, and potential misuse of data.
11. Psychologists who conduct psychological testing, assessment, and evaluation endeavour to recognize the nature of and relationship among individual, cohort, and group differences.
12. Psychologists who conduct psychological testing, assessment, and evaluation seek to consider the unique issues that may arise when test instruments and assessment approaches designed for specific populations are used with diverse populations.

Training and supervisory qualifications and role

13. Psychologists who educate and train others in testing, assessment, and evaluation strive to maintain their own competence in training and supervision and competency in assessment practice.
14. Psychologists who supervise employees or individuals who lack training in testing, assessment, and evaluation strive to ensure that supervision ultimately provides examinees/clients with testing, assessment, and evaluation that meets the ethical and professional standard of care and scope of practice.

Technology

15. Psychologists who use technology when testing, assessing, or evaluating psychological status strive to remain aware of technological advances; of the influence of technology on assessment; and of standard practice, laws, and regulations in telepsychology.
16. Psychologists who conduct services using technology for online or in-person testing, assessment, and evaluation make every effort to ensure their own competency.
17. Psychologists who use technology-based assessment instruments are encouraged to take reasonable steps to ensure the security, transmission, storage, and disposal of data. Psychologists also strive to ensure that security measures are in place to protect data and information related to their clients/patients/ examinees from unintended access, misuse, or disclosure.

Based on these guidelines, the following principles can be identified for the scope of MESAFE with regard to the Mental Health Specialists who conduct psychological testing, assessment, and evaluation:

- They shall be well trained

- They shall be mindful of the potential negative impact and subsequent outcome of those measures on applicants
- They shall consider the global settings in which services are being provided
- They shall select assessment tools that demonstrate sufficient validity evidence for their uses, sufficient score reliability, and sound psychometric properties and (b) measures that are fair and appropriate for the evaluation purpose, population, setting, and context at hand.
- They shall use multiple sources of relevant and reliable clinical information collected according to established principles and methods of assessment
- They shall be aware of the need for test selection, scoring, and administration to reflect the appropriate normative comparison
- They shall consider cultural differences

Indeed, when performing clinical diagnosis, cultural and social context need to be integrated. The DSM-5-TR (2022, pp. 859-879) provides a section with key terms (culture, race, and ethnicity), cultural formulation, and cultural concepts of distress to be considered while performing a diagnosis, since the relevant influence environmental factors may have on the development of mental illness.

The following list represents a summary of the recommendations provided by the American Psychiatric Association (APA) on which elements the Mental Health Specialist should consider for mental health assessment (APA-psychiatry, 2016).

1. Review of Psychiatric Symptoms, Trauma History, and Psychiatric Treatment History
2. Substance Use Assessment
3. Assessment of Suicide Risk
4. Assessment of Risk for Aggressive Behaviours
5. Assessment of Cultural Factors
6. Assessment of Medical Health
7. Quantitative Assessment
8. Involvement of the Patient in Treatment Decision Making
9. Documentation of the Psychiatric Evaluation

4.4 State-of-the-art diagnostic measures

To assess mental health, the following measures are available:

- Psychodiagnostics tests
- Questionnaires
- Interviews

The following sections provide detailed explanation of each of them.

4.4.1 Review of psychodiagnostic tests

Psychodiagnostic tests are standard measures devised to assess behaviour objectively and are used by psychologists and psychiatrists to help identifying mental disorders and helping people in their decision making towards their life well-being.

These tests can be classified on their construction and administration. They can be individual and group tests, speed and power test, computer assisted tests, pencil paper and performance tests.

Carefully developed and researched tests have several pillar characteristics: standardization, objectivity, reliability, validity, and test norms. In order to be replicable, tests need to have standard procedures and contents. Moreover, these tests should have norms to compare the individual test score to a known group.

Currently, different types of psychological tests exist.

A macro classification distinguishes between tests of maximum performance and tests of typical performance (Pedrabissi and Santinello, 1997).

Maximum performance tests are those in which right and wrong answers are presented and in which, usually, there is a time limit. The person is asked to give the best of him/herself, and the goal is to check how much he is able to solve a certain task. A classic example of a maximum performance test are the intelligence and aptitude tests that are centered on reasoning skills, but also attention tests (for example, barrage tests) and memory tests (re-enactment, repetition, narrated memory). These tests are used to evaluate the person's cognitive functioning. The timing of administration is extremely variable, ranging from tests that can be very fast, such as the MMSE-2 - Mini-Mental State Examination, 2nd Edition -, which requires from 5 to 20 minutes depending on whether you use the short, standard or extended form, and tests which take a long time, as in the case of the WAIS-IV - Wechsler Adult Intelligence Scale, Fourth Edition (2013) -, which requires about 90 minutes. The timing of administration is fundamental and to be considered according to the context and light conditions.

The performance tests are those aimed at knowing the typical behavioral of the person, so they do not examine what s/he is able to do but what he does in everyday life. Since the theoretical basis underlying these tests is broader and more heterogeneous (this includes tests of personality, temperament, preferences, values, etc.) there is less agreement on what are the characteristics detected by a performance test. Unlike maximum performance tests where it is not possible to distort (unless the person wants to simulate a disorder of the cognitive sphere), in the tests of typical performance it is possible (and probable) that people distort trying to make believe that a certain trait is more or less present in them than it actually is. For this reason, in the performance tests (self-report) are reported scales of validity, to understand if the person has distorted in an improved or worsening sense or if he has responded at random. Clearly in a maximum performance test you cannot make believe that you have a greater ability than you have. Performance tests are generally self-report (e.g., MMPI-2), but can also be interviews (e.g., SCID interviews). In both cases, the person speaks directly to the assessor and chooses how much to open, what to share and what not. The answers are given on the basis of awareness: in other words, the person reads the question, understands it and consciously chooses what to answer (lies might be a possible option). So, when choosing to work with a self-report, it is essential that a relational context has been created such that the person feels he can trust and in which he feels safe, precisely to avoid those attitudes just described. In addition, following the guidelines indicated in the manuals regarding the rules of administration is essential to better manage the response behavior of the person. Very often it happens that, for a long time, some tests in which it is explicitly indicated to supervise the administration phase, are left to the person, giving the opportunity to do them alone. It is not the best way to manage the administration: people, in fact, can do them in different moments or distract themselves with phone calls and the internet, or not have something clear, needing explanations.

Among the typical performance tests there are personality tests and psychodiagnostic tests.

Personality Tests (i.e., 16 Personality Factor Questionnaire (16-PF), Basic Personality Inventory (BPI), Thematic Apperception Test (TAT)) are not meant to diagnose and assess mental disorders. Indeed they can be used in the framework of the selection process of pilots and ATCOs to evaluate their fitness with the required organizational profiles they are applying for.

Psychodiagnostics Tests (i.e., Minnesota Multiphasic Personality Inventory (MMPI-A), Rorschach Test, Beck Depression Inventory (BDI), Anxiety Inventory) are meant to assess the presence of a mental disorder, or the

severity of its symptoms. Among these tests there is the MMPI and MMPI-2, which have accumulated seven decades of validation with pilots and other aerospace personnel. Valid pilot and ATCS norms are available for the MMPI-2 which is recommended by the FAA for pilot and ATCS assessments (FAA, Guide for Aviation Medical Examiners, MMPI-2 Versus MMPI-3). Indeed, it is important to use tests that are validated in the reference aviation population when assessing mental health of pilots and ATCOs for the sake of mental fitness certification.

Besides this, it is important to evaluate whether psychodiagnostics tests are meant to be used only for an initial mental health evaluation. If yes, these tests cannot be used for monitoring purposes.

From the DSM-5-TR (2022, pp. 841-858) assessment measures for the diagnosis of mental disorders are:

1. Cross-Cutting Symptom Measures
 - Level 1 Cross-Cutting Symptom Measures: Is a self- or informant-rated measure that assesses the domains that are important across psychiatric diagnoses. The adult version of the measure consists of 23 questions that assess 13 psychiatric domains, including depression, anger, mania, anxiety, somatic symptoms, suicidal ideation, psychosis, sleep problems, memory, repetitive thoughts and behaviours, dissociation, personality functioning, and substance use.
 - Level 2 Cross-Cutting Symptom Measures: provide one method of obtaining more in-depth information on potentially significant symptoms to inform diagnosis, treatment planning, and follow-up.
2. Clinical-Rated Dimensions of Psychosis Symptom Severity: dimensional assessment capture meaningful variation in the severity of symptoms, which may help with treatment planning, prognostic decision-making, and research on pathopsychological mechanisms. It provides scales for the dimensional assessment of the primary symptoms of psychosis including hallucinations, delusions, disorganized speech, abnormal psychomotor behaviour, and negative symptoms. The Clinical-Rated Dimensions of Psychosis Symptom Severity is an 8-item measure that may be completed by the clinician at the time of a clinical assessment to rate the severity of each symptom as experienced by the individual when it was at its most severe during the past 7 days.
3. World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0): the adult self-administered version of the WHODAS 2.0 is a 36-item measure that assesses disability in adults age 18 years and older. It has been validated across numerous cultures and demonstrated sensitivity to change. It assesses disability across six domains including understanding and communicating, getting around, self-care, getting along with people, life activities (i.e., household, work, and/or school activities), and participation in society.

The tests are based on statistics, so they are prone to errors. If, for example, the test one uses is returning the correct result 99% of the time, it means that it is wrong 1% of the time (when it comes to statistical processes we always have an error percentage). It is important to emphasize this aspect because, when one decides to use the tests, the probability of finding "wrong" result might increase. Going on the practical: if we use just 10 tests a year, in 30 years we will have applied at least 300 tests, so almost certainly the wrong result will have happened to us.

Another limitation is given by the fact that each test measures one or more constructs (characteristics or psychological traits under investigation, such as anxiety or depression); knowing the construct allows the assessor to examine some aspects but excludes the possibility of measuring others. For example, a test that measures anxiety understood as cognitive anxiety detects the expectation of negative events, the rumination and the cognitive beliefs centered on a state of alertness with respect to potential dangers. Instead, it will not detect the aspects related to affective anxiety (feeling of tension, apprehension, and nervousness) or physiological (somatic expression of anxiety such as tachycardia, sweaty hands, shortness of breath, etc.). Therefore, when an assessor approaches the test, it is essential to immediately understand what is the construct or constructs investigated, to know what it will be able to measure and what not.

Finally, tests are standardized objective measurement instruments. The investigated dimension, therefore, is the objective one; therefore, the subjective dimension of the experience must be evaluated with other instruments (interview or examination of the mental state, that is, the "direct observation" of the person, etc.). In the tests, the score obtained by a person is compared - by the software - with that of a reference sample and his score is evaluated as high, medium or low depending on how far it deviates from the average. Going to the extreme and simplifying it can be said that if one person at MMPI-2 takes a score equal to 70 T points in the Depression scale (high score, which denotes the considerable presence of that feature) and another person takes the same score on the same scale, from the point of view of the test the two subjects are equal in terms of the presence of the feature. However, the individual meanings, the coping strategies and the personal/social resources might be different (subjective experience) and to deepen this subjectivity the tests are not instruments of choice; also, for this reason a test, however thorough and well constructed, will never replace the clinical evaluation.

Best practices to overcome these challenges are:

- Check if the reference model (features investigated by the test) fits assessment needs. Tests manuals usually contain this information and can be consulted in specialized libraries and bookstores.
- avoid taking the results of the tests literally
- integrate test's results with other assessment measures
- discuss them together with the client

4.4.2 Questionnaires

Questionnaires to support the diagnostic process

In mental healthcare, it is common practice to use questionnaires to support the diagnostic process, and to monitor the treatment of patients. It is generally accepted however, that the use of a questionnaire cannot replace clinical history taking or a mental examination.

When using questionnaires, it is important that they are validated in the population they are used in. There are many differences between the questionnaires that are used in each country, and this is not a problem, as long as the questionnaire is available in the patient's language and it has been validated in the relevant population. For example, in the Netherlands the SQ-48 on common mental complaints is often used (Carlier et al, 2012).

For monitoring mental disorders, the use of the right questionnaire depends on the disorder. For example, for depressive disorders, often the MADRS (Montgomery- Asberg Depression Rating Scale) is used, as well as the HADS (Hospital Anxiety and Depression Scale)(Montgomery SA & Åsberg (1979, Hamilton 1959, Hamilton 1960). When monitoring mental disorders, it is useful to use the same questionnaire over time, so that results over time can be compared.

Using questionnaires as a screening tool in aviation professionals

Although questionnaires are often used in mental healthcare, their use in the medical evaluation of aviation professionals is difficult. First of all, many questionnaires have been developed to monitor the severity of mental disorders, not to diagnose them. Questionnaires developed for diagnostic purposes are often unreliable when used without a formal mental examination. Furthermore, these questionnaires have mainly been developed to be used in patients that suffer from mental complaints and decide to seek help, which is an entirely different population from the people that are being examined for a Class I, II or III medical certificate. Although questionnaires are often used in the selection of airline pilots, these questionnaires are often lengthy and generally measure personality traits and capabilities and are not suitable for screening for and diagnosing mental disorders. This is especially risky when screening instruments on personality *traits* are used to detect

mental *disorders*. Although certain personality traits, such as a high level of neuroticism, may increase chances of developing mental disorders, for many people this will not be the case. Regarding a personality trait as a mental disorder then would lead to false-positive findings, and of course would be discriminatory against the pilots involved, as it would wrongfully assume that a personality trait is the same as a mental disorder.

Often, questionnaires are protected by copy-right, and only available for a fee.

The biggest problem with the use of questionnaires, however, is that subjects may not give honest answers (Vuorio & Bor 2021). For example, when a questionnaire asks for difficulties with concentration or having suicidal thoughts, most pilots will understand that answering that they experience this, will have consequences for their medical fitness. Consequently, the chance that they provide dishonest answers is huge. The same applies to questions on sleep, alcohol and drug use, feelings of anger and aggression towards others etc. A recent study in police-officers found a substantial rate of underreporting in self-administered questionnaires (Marshall et al, 2021).

For use in the routine medical examination of aviation professionals, ideally a questionnaire should be:

- Concise, so that it can be completed within a limited amount of time
- A reliable screening instrument for the presence of common mental disorders
- Able to be administered and interpreted with no or a small amount of training
- Available for free or at a low cost
- Available in the native language of the subject
- Not be experienced as intrusive
- Not be vulnerable to underreporting of mental complaints
- Have been adjusted to and validated for use in the airline pilot / ATC / drone-operator population.

Unfortunately, no such questionnaire exists. In that respect, there is no state of the art of using questionnaires when screening for mental disorders in the medical evaluation of aviation professionals (in contrast to the common practice of using questionnaires during the psychological selection process, which can by no means be regarded as a screening for or prediction of mental disorders).

Questionnaires to support the interview

However, there is a wide experience with screening instruments for common mental disorders in the general population and as a part of scientific research studies. Although these questionnaires do not protect against the risk of underreporting, they might be helpful in guiding the interview on mental complaints. In their study on depressive complaints in airline pilots, Wu et al used the PHQ-9. This questionnaire measures the features of a depressive disorder according to the Diagnostics and Statistics Manual of the American Psychiatric Association, and includes questions like having little interest or pleasure in doing things, feeling tired and having little energy, and thoughts about being better off dead. (Wu 2016, Kroenke 2001), For good reasons, the authors decided to distribute this questionnaire anonymously. Still, the questionnaire might be used as a starting point for discussing mental complaints. Another questionnaire that can be used broadly is the SQ-48, which is being included as an appendix. A specific advantage of this questionnaire is that it also addresses other elements of well-being, such as feeling satisfaction from work or feeling slower than usual.

In a recent review of brief mental health disorder screening questionnaires for Public Safety Personnel, Shields et al reviewed the psychometric properties of brief screening questionnaires. (Shields et al 2021). They recommend using Patient Health Questionnaire 4 (Kroenke et al 2009), The Brief Panic Disorder Symptom Screen-Self Report (Forsell et al 2019), the Short-Form Posttraumatic Checklist 5 (Zuromski et al 2019) and the Alcohol Use Disorders Identification Test-Consumption (Bush et al 1998), for screening on generalised anxiety disorder, panic disorder, post-traumatic stress disorder and alcohol use disorder.

There are currently several mental health screening questionnaires used by AMEs/AeMCs. These health screening questionnaires are not harmonized between member states and are not validated for use in the framework of a mandatory aeromedical examination. The questions regarding alcohol and drugs use (see e.g.: Rios Tejada, 2018) seem useful for AMEs to be used as mnemonic and to be “woven-in” into the face-to-face medical history taking, but have limited value when asked as part of a paper/pencil or electronic mental health questionnaire because pilots and ATCOs will know what they should answer to be declared fit.

Importantly, these questionnaires should not be used to diagnose mental disorders, and they can never replace addressing them during the interview. However, they may assist in discussing mental complaints.

A new development: digital phenotyping

Recently, researchers have proposed to use information from digital sources such as smartphones and wearable technology to objectify patient mental health characteristics. Using big data analysis methods, patterns can be detected. This is called digital phenotyping. The value of digital phenotyping is that it offers a multidimensional and measurable method to objectively gather patient data, and compared to classic questionnaires, it will likely to be less or even not at all be susceptible to underreporting. Nevertheless, based on the currently available evidence, digital phenotyping is most promising for monitoring those with already identified mental conditions, on a voluntary basis. It should not be used for random screening for mental disorders. This would be a too large infringement of privacy. Especially when people are under pressure by their employer, they might be persuaded to agree to giving access to their information, while not actually consenting to the privacy risks. Also, in an unselected population, the risk of false-positive results increases, which means that someone is wrongly identified as being at risk for or having a mental disorder. Still, it is an interesting innovation, which developments should be watched closely, but critically. It has potential to be beneficial in the monitoring and -at some moment- perhaps even the screening for mental disorders in aerospace medicine, but as of 2022 there are still important technical and ethical challenges, regarding effectiveness, privacy and regulation. (Müller & De Rooy 2021).

Conclusion

So, although questionnaires are essential in mental healthcare, using them in the medical screening of aviation professionals is difficult. On the one side there is the risk of false-positive findings when the wrong questionnaire is being used (for example a questionnaire on personality traits for detecting a depressive disorder), on the other side is the risk of false-negative findings due to underreporting of mental complaints. No dedicated and validated questionnaire for pilots, ATCO’s and other aviation professionals exists. Still questionnaires might be useful to support the part of the interview addressing mental complaints. Developments with regards to smartphone and wearable technology are worth to be followed critically.

4.4.3 Interviews

Establishing the presence of a mental disorder is impossible without a history taking and a mental status examination. Mostly, these two are not performed separately, but are combined during the clinical interview. Furthermore, during the same interview, an assessment of risk of suicide and other risky behaviours is made. Most patients will not notice the distinction between these three elements, but the way clinicians think is different in each part.

Although research into performing diagnostic interviews has been done, and in several countries guidelines have been made, it is generally regarded as a skill that is learned through practice, not by studying books (just like for example auscultating the heart and lungs) (Gelder et al, 1999). Also, there are many differences between how the interview is performed in each country, and the psychiatric interview is relatively largely

influenced by cultural factors (Hengeveld et al 2020). In that respect, there is no state of the art, but there are some generally accepted principles that are worth discussing.

It is impossible to say whether a mental status examination is performed more reliably by an unstructured interview by a clinician, or by a structured interview or even a questionnaire. The reason for this is simple. In research on diagnostic reliability, mainly the DSM-diagnosis is regarded as the Gold Standard. Most structured interviews ask for the DSM-5 criteria, and it is not surprising that interviews asking for features of the DSM-5 criteria show more overlap with the DSM-5 criteria than the clinical judgement of a psychiatrist or clinical psychologist. However, the question that should be asked is not whether interviews or questionnaires match better with the DSM-5 criteria, but which of the two has the highest clinical relevance. This is an impossible thing to study, as it would mean that patients would have to be randomly assigned to receive either treatment on the basis of meeting DSM-5 criteria, or on the basis of a regular clinical examination by a physician. Of course, no medical ethical committee would allow such a study to be done. An important advantage of a clinical interview is that for many disorders, symptoms overlap. A clinician can take this into account, whereas questionnaires cannot. They would see several different disorders, where a clinical would understand that in many cases, various symptoms can be ascribed to the same disorder. In conclusion, although questionnaires may help the clinician, they can never replace the clinical interview (Weis Roberts 2017, Hengeveld et al 2020).

Mental history taking

The diagnostic interview starts with checking the patient's name and date of birth, if this has not already been done so. The following elements should all be addressed during a mental interview, but there is no strict order in which this should be done. Each psychiatrist will do it slightly differently, but in the end they will largely discuss the same elements (Gelder 1999, Weiss-Roberts 2017, Sadock and Kaplan 2018, Hengeveld 2020). Some psychiatrists will first ask about any previous treatments by or other encounters with mental health professionals. Others will start with discussing the chief complaint. Of course, in the case of aeromedical examinations, most subjects won't have a chief complaint, but a good starting point may be to ask if someone has any mental complaints. When addressing mental complaints, it is important to ask when they started and how they have developed over time, what things may (have been) helpful and what (may have) made things worse. It is paramount also to ask the patients' own opinions and thoughts on what might have caused the complaints, and the things that may be helpful. If someone has no complaints at all, it might be useful to discuss someone's normal life, for example, can he describe a regular day? And what does he like to do when free of work? Any hobbies? If positive or negative events are reported, what emotion did the patient feel? Did it make him sad, angry, or didn't he feel any emotion at all? Often, then the symptoms of the major mental health conditions like depressive and anxiety disorders are checked, with questions on the mood, sleep, anxiety, appetite, concentration, feelings of anger and guilt, suicidal feelings, obsessive-compulsive complaints, psychotic symptoms, traumatic events and if these still give complaints, manic symptoms, deliberate self-arm, problems with eating (binge-eating, deliberate excessive weight loss, induced vomiting etc), and any addictions.

In each examination, the family history for mental complaints should be addressed.

During the standard mental interview, also somatic symptoms and complaints, and the somatic history of the patient as well as any medication and substance use are addressed, but of course during an aeromedical evaluation this is already done during the other parts of the examination.

It is also paramount to address the social functioning of the patient. Questions into the social functioning address whether someone has a relationship, children, and how relations with friends and families and work are. Many mental disorders may cause problems in relationships with other people, but especially personality problems deeply influence social functioning.

The Biography

At the end of the interview, usually a biography is taken. The biography addresses whether someone was wished as a child, any problems and complications during gestation, at birth or in infancy. Then, the first memories and relationships with the parents and brothers and sisters are addressed. Subsequently, it is asked how it was to go to kindergarten and primary school, if someone had friends, if someone had any problems with learning, if there were any problems with teachers, and if someone had been bullied. These questions are also asked with regards to secondary school. It is also important to address whether family relations changed during this period, if someone's parents stayed together or got divorced, etcetera. This can also be a good starting point for addressing the psychosexual development and possible early relationships, but this can also be addressed during a later stage of the biography. In the case of aeromedical evaluations, the psychosexual development may be discussed in a superficial way as questions about this may be perceived as being intrusive, and only upon indication, for example if someone reports having experienced negative events or other problems with this, more extensively. Subsequently, the professional education and work history is addressed. It might be good to end with the later relationships, someone's current relationship and someone's current relationships with family and friends.

Mental status examination

The mental status examination is partly based on direct questions asked by the examiner, but mostly on the clinical observations made by the examiner. There are many differences between how this is being performed in various countries, but there are some general elements that are quite universal. (Weiss Roberts 2017, Sadock et al 2018, Hengeveld et al 2020).

First, the examiner notes the appearance of the patient. It is noted whether someone looks well-cared, any remarkable clothing the person is wearing, and how the patient makes contact with the examiner (friendly, formal, hostile etc). Difficulties in establishing some casual talk about work, family or hobbies may indicate the presence of a mental disorder. Subsequently, the speech (fast or slow, loud or quiet) is noted. Alertness, memory and concentration are assessed. In most cases, this is done implicitly, but in case of any doubts the examiner may ask direct questions (eg "Do you know which day it is today?"). Then, the intelligence and insight in their mental functioning are assessed. The presence of hallucinations is addressed, as well as the thinking. With regards to thinking, it is important both to assess the form (slow or fast, organised or disorganised) and the contents (if there are any delusions). In some cases, this can be done implicitly, in doubt specific questions have to be asked (eg. "Do you feel that a conspiracy is going on towards you? Do you feel that you have any supernatural powers?"). One of the most important elements of the mental status examination is the mood and the affect, which can be depressed, happy, angry, anxious etc. The affect can be defined as the visible and audible expression of the emotional reaction of the patient on internal and external stimuli and occurrences (Hengeveld 2020). Whereas the mood tends to be the same over a longer time, the affect can change often, even in seconds or minutes. This is normal. In normal situations, the affect reflects the mood of the patient, and if there is a continuous discrepancy between mood and affect, this is a strong indication of mental problems. For example, if someone tells about the loss of a relative, and says it makes him sad, but at the same time he smiles, this is suggestive of the presence of a mental disorder. It is common to also address any notable personality features, risky behaviours and self-harm and the risk of suicide.

(Suicide) risk assessment

Assessing the risk of suicide and other risky behaviours is generally assumed to be based on two major principles: the quality of the contact with the patient, and epidemiological risk factors (Van Hemert et al, 2012). Whereas the first is to some extent a subjective feeling, the second is more objective.

A good question to ask about suicidal thoughts is: "Do you sometimes feel so bad that you think you would be better off dead?". Then, it is important to explore what the patient actually thinks. The examiner should explain

that thinking about suicide in itself is quite common, and that having suicidal thoughts does not have to mean that someone will commit suicide, and that in many cases, people feel much ambivalence towards their suicidal thoughts. (Van Hemert et al, 2012). Does the patient just think that he would want to be away from everything, or is he thinking about methods to end his life? If so, has he done research on the internet? Or did he already make preparations, or a last will? (De Rooy 2019).

The quality of the contact is high if the patient is open, can reflect on his feelings, can reflect on the remarks of the examiner, if mood and affect are in line, and if someone can make realistic plans for the near future. It is low when answers are difficult to understand, extremely short, the examiner feels that answers are not reflecting genuine emotions, and mood and affect are not in line.

If one or more of the above things is not the case, there is an increased risk. On the other hand, there are epidemiological risk factors. The most important one is previous suicidal behaviour, but there are several more. Some important risk factors for suicide are depicted below. Especially in aviation, negative life-events seem to be important. (Mulder & De Rooy, 2018). It is a matter of clinical experience to combine the quality of the contact with the amount of clinical risk factors to make an assessment of the risk. This is a clinical judgement based on experience, not a mathematical prediction.

Aggressive behaviour may be predicted by asking questions like “Do you easily get angry?”, and ‘What do you usually do when you get angry?’, “Do you sometimes consider attacking someone?’ There are questionnaires to predict aggressive behaviour, but these have been developed in forensic populations. (Hengeveld 2020). Some risk factors for aggressive behaviour are (Hengeveld 2020):

- Previous aggressive behaviour
- Conduct problems before the age of 12
- Being a victim of violence during youth
- Antisocial or impulsive behaviour
- Substance abuse
- Lack of intimate relationships
- Lack of social abilities
- Lack of coping mechanisms
- Non-compliance with therapy or treatments

Also, these risk factors should always be combined with the clinical impression of the examiner, which is a matter of experience.

Risk factors for suicide

The following factors indicate an increased risk for suicide. (Van Hemert et al, 2012). Of course, the presence of a single risk factor does in itself mean that someone has an increased risk of committing suicide. However, if several factors are present at the same time, and especially also the quality of the contact is low, the risk may be considered to be increased.

Epidemiological factors:

- Previous suicide attempt and self-harm/ self-destructive behaviour
- Lethality of the attempt
- Suicidal thoughts and intentions, any preparations made for a suicide attempt
- Means available for suicide attempt
- Older age
- Male gender

Mental disorders:

- Mood disorders
- Anxiety disorders
- Schizophrenia and psychotic disorders
- Substance abuse and dependency
- Eating disorders
- Personality disorders
- Sleeping disorders (especially in the elderly)
- Family history of suicide

Psychological factors:

- A feeling of entrapment
- A feeling to be a burden to others
- Anxiety
- Agitation and/or aggression
- Impulsivity
- Low quality of contact during mental examination

Psychosocial factors:

- Loss of friends and relatives; bereavement
- Negative life-events
- Somatic disease and pain
- Unemployment
- Detention

Protective factors:

- Good social support
- Having responsibilities towards others
- Active involvement in religious community
- Good therapeutic relationship

4.5 Relevance of the diagnostic measures and the frequency required for the proper monitoring of certain mental pathologies

After having made a diagnosis and having decided about a suitable treatment plan, one of the greatest challenges for psychiatrists and psychotherapists is to decide how often to see a patient during the treatment phase, how long to continue the treatment, and when to stop it. Most therapists will stop treatment after a remission or at least a stable phase has been achieved, but there may be good arguments for following-up patients for a longer time. Relapse prevention is a mandatory element in most treatments of mental disorders.

Although some general remarks can be made, the duration of the treatment and frequency of follow-up measures is a highly individual decision which depends on the characteristics of the patient (e.g., previous mental disorders, availability of a good support system), the characteristics of the disorder (severity, risks, comorbidity), the treatment (long-term CBT is highly uncommon, long term pharmacotherapy is not) and the personal preferences of the patient and the psychiatrist/psychotherapist. Finally, in many countries, financial

impediments (if only a certain amount of treatment sessions is being reimbursed by the healthcare insurance) or the limited availability of mental healthcare limit the availability and duration of treatments.

Frequency of appointments and monitoring of the patient

It is impossible to give a general frequency of visits needed. In patients in an outpatient therapy, a higher frequency than once weekly is uncommon. Patients in a mental crisis, for example because they have a severe depressive disorder or are psychotic, may need more frequent treatment sessions. It is not uncommon in these cases also to provide home treatment, meaning that a nurse will visit the patient at home. Often, the most severe patients are admitted to a mental hospital. A clinical need to visit mental health service providers more often than once weekly will in the far majority of cases not be compatible with a medical certification, as these patients will have a to high chance to be or become suicidal, psychotic or by other means in a mental crisis. In practice, most psychotherapies will have weekly or two-weekly appointments in the early treatment phases, some will continue this frequency for the whole therapy, others will go to a lower frequency (e.g. monthly) towards the end of treatment. Psychiatrists will often see a patient weekly or every two weeks in the early treatment phase or when the patient has severe complaints, but soon go to a frequency of monthly or less (in some cases once every three months or less). In stable patients that need to be followed for a longer time, often once every six months or once per year can be enough.

It is a good practice to monitor the treatment not only be means of discussing patients' complaints, but also by assessing their social functioning (eg did someone return to work, did someone meet again with friends?), and to use questionnaires (preferably the same over time, so that results can be compared).

Ending treatment

The decision to end a treatment is usually made together with the patients and depends on whether the treatment goals have been achieved, but also whether the patient is still making improvements or not. Ideally, all treatment goals have been completed and the patient suffers no complaints anymore, but in the more complex cases, unfortunately that is not always a realistic goal, and for some patients, improvement may mean that they can accept their life and their shortcomings as they are (Van Oenen 2019). Relapse prevention is important (Batelaan et al 2017, Zhang et al 2018). It can be done by discussing the weaknesses of the patient and early signs of a possible relapse. Often, a plan to prevent a relapse is made in written by the patient or therapist, with a copy for the patient and a scan in the medical record.

Follow-up or not

For some patients, long-term follow-up is mandatory, for example in the case of lithium or antipsychotics use. In some countries, due to lack of financing or a too small capacity of mental healthcare, these patients are referred to the general practitioner for long follow-up, which sometimes goes well, but it can also lead to dramatic outcomes if the general practitioner has too little experience with specific drugs or diseases. Unfortunately, each year patients develop kidney failure because their General Practitioner (GP) forgets to monitor blood levels and renal function when using lithium or get a relapse of a psychosis because their GP tapers an antipsychotic too fast.

Other patients do not necessarily need long-term follow-up or can be followed up safely by their GP (e.g., in the case of stable long-term SSRI use). Some psychotherapists think that long term follow-up makes the patient dependent and will try to avoid this at all times. However, the significant relapse rates that are found in almost all mental disorders provides a sound argument for longer-term follow-up, just as is usual for example in cardiology or oncology. This is especially the case for those working in an aviation environment.

4.6 Review of (neuro-) cognitive tests on the subject of the incapacitation risk related to mild cognitive decline (irrespective of its cause) and their validity to predict safe flying performance

Preamble

- The current age limitations for commercial air transport (CAT) pilots required by Regulation (EU) No 1178/2011 were taken over from ICAO Annex 1. For single-pilot CAT operations the limiting threshold is the age of 60 and in multi-pilot CAT operations, pilots can continue to operate until the age of 65. At the request of a number of member states, EASA is presently considering an extension of the age limit for single-pilot HEMS operations (and later possibly for all single pilot CAT operations) to 65 years of age. For multi-pilot CAT operations there is –and was- discussion about extending the age limit to some years beyond the age of 65.
- For ATCOs there is no European regulation requiring a uniform age limit. According to ICAO the maximum age is left for individual States to decide. Therefore, age limits for Air Traffic Control (ATC) differ by member state or by Air Navigation Service Provider (ANSP). The ATCO retirement age ranges from 50, 52.5 and 53 (Armenia, Moldova, Estonia) to 67 years of age (Greece, Netherlands), while the retirement age is 56 years at Eurocontrol. In the US (FAA) the retirement age is 56 years, while UK and New Zealand have no compulsory retirement age.
- There is convincing evidence that the risk of mild cognitive impairment increases with age. Cognitive decline begins from 40 years of age and its course varies greatly across individuals. Although the prevalence of functionally significant mild cognitive impairment (MCI) is assumed to be low in the age ranges of active pilots and ATCOs, it should be taken into account that some of them might become unfit for their aviation duties due to MCI.
- Neuro-cognitive tests for assessing (subtle) incapacitation risks of pilots or ATCOs should have both high positive and negative predictive values to predict unsafe functioning of pilots or ATCOs.

4.6.1. Mild Cognitive Impairment (MCI)

Mild cognitive impairment (MCI) refers to the transitional state between the cognitive changes of normal aging and very early dementia (Petersen & Negash, 2008). MCI is a heterogenous clinical syndrome reflecting a change in cognitive function and deficits on neuropsychological testing but relatively intact activities of daily living. Controversy exists about the definition of MCI. According to the International Working Group on Mild Cognitive Impairment specific recommendations for the general MCI criteria include the following: (i) the person is neither normal nor demented; (ii) there is evidence of cognitive deterioration shown by either objectively measured decline over time and/or subjective report of decline by self and/or informant in conjunction with objective cognitive deficits; and (iii) activities of daily living are preserved and complex instrumental functions are either intact or minimally impaired (Winblad et al., 2004).

MCI is considered a risk state for further cognitive and functional decline with 5–15% of people developing dementia per year. However, around 50% remain stable at 5 years and in a minority, symptoms resolve over time (Dunne et al., 2021). The clinical application of neuropsychological tests for MCI is to predict a future dementia risk in patients with some evidence or suspicion of cognitive deterioration. However, the rationale of an aeromedical examination is not to predict future dementia but to predict whether the applicant's cognitive abilities are sufficient to perform safety-sensitive aviation tasks. In that context, MCI might be operationally defined by an impairment of cognitive functioning that leads to an unacceptable aviation safety risk. For

aeromedical purposes it might be recommendable to rename the term MCI into Operationally Significant Cognitive Impairment (OSCI).

The prevalence of MCI is dependent on the sensitivity and specificity of the tests used, cut-off values, population norms and estimates of premorbid cognitive functioning. Prevalence data for age groups younger than 65 years are very scarce, because most studies of the prevalence per age group only include individuals over 65 years of age. A study by the COSMIC collaboration group (Sachdev et al., 2015) found a prevalence of 4.5% among 60–69 year-olds and a significant increase of the prevalence beyond 69 year of age. The authors applied uniform criteria to harmonized data from 11 studies from USA, Europe, Asia, and Australia, and determined MCI prevalence estimates defining cognitive impairment as performance in the bottom 6.681% (equivalent of impairment more than 1.5 SDs below the mean of the total sample of 24,888 persons). As this study concerned only individuals older than 60 years, the applicability of the results is limited for pilots and ATCOs (see age limits in above preamble).

Many epidemiological studies of the prevalence of MCI define MCI as a neuro-cognitive performance score that is 1.5 standard deviations (SD) lower than the population mean. Using a 1.5 SD cut-off is more sensitive to decline than a 2 SD cut-off, but inevitably less specific. Any such cut-off is arbitrary, and there will be individuals (7% at the 1.5 SD cut-off value) who score and have always scored lower than their age-matched peers. Many of these people have stable, normal cognitive function (Dunne et al., 2021). In larger epidemiological studies MCI is often classified using the four generally accepted criteria: absence of dementia; no or minimal functional impairment; subjective memory/cognitive complaint or concern; and objective cognitive impairment

When (self-) perceived cognitive impairment (CI), defined as “confusion or memory loss that is happening more often or is getting worse during the past 12 months” was assessed in a civilian, non-institutionalized population, Centers for Disease Control and Prevention (BRFSS, 2009) found that the percentage of adults aged 18-49 years with perceived cognitive impairment ranged from approximately 4% to 8% whereas the percentage of adults aged 50 or older with perceived cognitive impairment ranged from 9% to 15%.

A study by Cornelis et al. (2019) about cognitive decline in the UK Biobank population (100,352 to 468,534 participants aged 38–73 years) showed that Fluid Intelligence scores were significantly higher between ages 55 and 64 and significantly lower at 65+ compared to age <45 (used as reference). The number of errors made on the Pairs Matching Test and Symbol Digit Substitution tests was increasingly higher with older age groups. Reaction Time and time taken to complete the Trail Making tests were also increasingly higher with older age. The odds of completing the Prospective Memory (PM) Test correctly on the first attempt were significantly lower with older age.

The International Working Group on Mild Cognitive Impairment does not recommend screening at population level for MCI because there is insufficient evidence for sensitive and specific tools (such as cognitive tests, imaging techniques, or biomarkers) that have both high positive and negative predictive values for use in the general population (Winblad et al., 2004). It is considered that this will also apply to screening asymptomatic pilots or ATCOs. At this screening level, AMEs should pay attention to subjective cognitive complaints, operational reports, and verify cognitive deterioration by state-of-the-art history taking.

Conclusion

Data support the generally accepted opinion that the risk of mild cognitive impairment increases with age. The findings of the study by Cornelis et al. (2019) about cognitive decline in the UK Biobank population suggest that declines in cognitive abilities between the end of the fourth decade and age 65 are small. There are no MCI prevalence studies that provide data relevant for ATCOs and pilots below 65 years of age. There are no sufficiently sensitive and specific cognitive tests that warrant routine testing of pilots and ATCOs on MCI. In the context of aeromedical screening of asymptomatic pilots and ATCOs, it is recommended to define MCI

operationally by an impairment of cognitive functioning that may lead to an unacceptable aviation safety risk (Operationally Significant Cognitive Impairment - OSCI).

4.6.2. Young onset Dementia

Global prevalence of young-onset dementia

Counting persons with dementia in a community who are younger than 65 years is more challenging than in older persons because the rarity of prevalent dementia in younger patients.

Findings In the recent systematic review of Hendriks et al. (2021) in which 74 studies with 2 760 379 unique patients were included in the meta-analysis showed that the overall global age-standardized prevalence of young-onset dementia was 119.0 per 100 000 population aged 30 to 64 years. Estimates increased from 1.1 per 100 000 population aged 30 to 34 years to 77.4 per 100 000 population aged 60 to 64 years. For the age range 60 to 64 years, Hendriks et al. estimated the prevalence of all-cause dementia to be 0.84 per 100 persons, which is similar to estimates made by other studies. In that age range, examining 1000 persons would be necessary to find approximately 8 cases. For the age range 55 to 59 years, Hendriks et al. estimated the prevalence of dementia to be approximately 5 times lower, meaning that screening of 5000 persons would be needed for the same yield of cases. Although the prevalence in pilots and ATCOs below 65 years of age is likely to be low, the AME has to be vigilant for any clue to early dementia and even when in doubt refer the applicant to expert neuropsychological evaluation to exclude early dementia.

4.6.3. Other diseases causing cognitive impairment

- **Brain:** All space-occupying processes in the cranium can impair cognitive and/or sensory functioning. These include benign and malignant brain tumours, metastatic growths, and haemorrhages (in particular chronic subdural hematomas). Impaired cognitive functioning may also be a first symptom of Parkinson, Alzheimer, Pick's disease and Huntington's chorea, vascular diseases, and infectious diseases (Creutzfeldt-Jacob's disease and HIV (AIDS)).
- **Metabolic:** Impairment of cognitive functioning can be a first symptom of diseases involving a metabolic disorder, such as thyroid diseases (hyperthyroidism and hypothyroidism), kidney diseases, diabetes, liver diseases, depression, vitamin B12 and folate deficiency, and chronic alcohol abuse.
- **Chronic fatigue** may cause cognitive impairment, which may result in subtle incapacitation.

4.6.4. Screening for Mild Cognitive Impairment (MCI), dementia, or cognitive impairment caused by other brain diseases

The majority of studies of the sensitivity and specificity of screening tests for MCI have been performed among highly aged study populations with considerable prevalence of dementia and MCI, such as –e.g. - the Drivers Aged 80 and Over study (Traffic Injury Research Foundation, 2013) and studies comparing patients with established dementia, proven MCI, and those who had no cognitive impairment (Dong et al.2012).In these high prevalence groups the predictive value will be high and the false positive rate will be low. However, in the asymptomatic under-65 pilot or ATCO screening populations, prevalence of MCI and early dementia is assumed to be low, resulting in a low specificity of the tests and higher false-positive rates, in particular when the cut-off values are set towards high sensitivity. A high false-positivity rate and a low predictive value are important disadvantages for a screening tool that is intended to be used to determine that someone may be unfit for a highly sensitive job.

The most frequently used clinical instrument, the Mini-Mental State Examination (MMSE), has good sensitivity and specificity to detect dementia. It performs less well in detecting MCI because the instrument is not sufficiently sensitive to detect subtle impairment due to MCI (Sabe et al., 1993). The MMSE is a brief cognitive test that assesses several cognitive domains, such as orientation, attention, concentration, memory, language, and constructional abilities. In a meta-analysis of 34 dementia studies and 5 MCI studies it was found that the MMSE offered modest accuracy with best value for ruling-out a diagnosis of dementia in community and primary care. For all other uses (i.e., MCI) it was recommended to combine it with or replace it by other methods (Mitchell, 2009).

The MoCA (Montreal Cognitive Assessment) is considered more efficient in screening for MCI with 90% sensitivity and 97% specificity for MCI according to a validation study by Nasreddine et al. (2005). However, this study used 94 patients meeting MCI clinical criteria supported by psychometric measures, 93 patients with established mild Alzheimer's disease (AD), and 90 healthy elderly controls and it should be considered that the sensitivity of this test might be lower when screening an asymptomatic pilot or ATCO population with only a small risk of MCI.

The MoCA is a paper and pencil test evaluating different types of cognitive abilities including: orientation; short-term memory/delayed recall; executive function/visuospatial ability; language abilities; abstraction; fluency; attention; and Clock-drawing test. The test takes 10 minutes and should be done in the patient's first language to be accurate.

The CAA Australia (CASA) knows no age limits for pilots and uses extra examinations that commence at age 65, and are repeated at age 67, 69, and 71 (annually thereafter). Cognition is assessed by a MoCA paper and pencil test AND a flight test, and the two assessed together.

CASA uses the MoCA after the age of 65 and it may be not recommendable to apply the MoCA test in regular aeromedical examinations of asymptomatic pilots and ATCOs under 65 years of age, because of the rarity of MCI and dementia in individuals who are younger than 65 years. It may, however, be suited in the context of a neuropsychological examination of a younger applicant of whom the AME has identified signs or symptoms of dementia, e.g., caused by a brain disorder. It should be considered that this test, as well as most other neurocognitive tests, is freely available on internet and can thus easily be trained prior to an aeromedical examination.

Alzheimer's disease biomarkers: predictive value?

According to the criteria of National Institute on Aging–Alzheimer's Association (NIA-AA) amyloid β and tau are needed for the diagnosis of Alzheimer's disease (AD), while neurodegeneration is used to stage disease severity. Individuals who have abnormal levels of amyloid β plus abnormal tau can be considered to have biological AD, even if they do not have cognitive symptoms. However, the clinical significance of biologically defined AD in individuals without cognitive impairment is debated, because 20% of older adults without cognitive impairment are known to have abnormal levels of amyloid β and tau. Although a study by Strikwerda-Brown et al. (2022) of subjects aged 67-76 years showed that hazard ratios for progression to MCI in the group with abnormal levels of amyloid β plus tau compared with normal biomarker groups were all 5 or greater, assessment of these biomarkers is currently not recommendable to predict 1-5 years MCI risks in the context of an aeromedical exam. In their discussion about the possible value of AD biomarkers as tool for the FAA pilot screening, Lawrence and Arias (2019) concluded that "when AD biomarker status is known, it should trigger heightened scrutiny of first-class airline pilots but that requiring testing for biomarkers is not justified at this time." Currently amyloid β and tau assessments are only used in some clinical settings to confirm clinical diagnoses of AD.

Conclusion

It is not recommended to use neurocognitive tests or to use amyloid β and tau biomarkers to identify MCI in the context of aeromedical risk assessment of asymptomatic pilots or ATCOs. It seems more appropriate that the AME should try and identify Red Flags which could indicate neurocognitive decline or brain diseases irrespective of the cause. The AME interview should therefore be aimed at building up of a picture of the pilot's or ATCO's job and work environment (including results of proficiency and line checks) and family life. Answers that give clues to potential problems should be followed by an in-depth interview (Hudson & Herbert, 2017). In case of any Red Flag or doubt the pilot or ATCO should be referred for specialized diagnostic evaluation (neurologist, clinical psychologist, neuropsychological testing). AMEs should preferably have contact with examiners of proficiency and line checks, who might –with explicit informed consent of the applicant – inform the AME about any suspicion for MCI that may emerge from the results of proficiency and line checks. In such cases the AME should consider specialized diagnostic evaluation (see section 4.1.2.6).

4.6.5. How to test the applicant's cognitive ability to safely execute all safety-sensitive aviation tasks?

Most concerns about a decline of cognitive abilities by increasing age are related to the question whether or not an aging pilot or ATCO is able to safely execute all safety-sensitive tasks. This is for the largest part an operational problem because the applicant's age is causing doubt whether s/he can still function safely. The obvious solution would then be to challenge the applicant to give proof that his/her functioning has a sufficiently acceptable safety risk. The AME/AeMC may - apart from excluding MCI, dementia, or brain diseases - only contribute a part of the solution. In that context, the contribution of the AME/AeMC can consist of referring the pilot or ATCO in question for a neuropsychological or neurocognitive evaluation after finding cause for reasonable doubt (Red Flag), which might be based on operational information (e.g., results of training, proficiency, or line checks).

Cognitive decline begins from 40 years of age and its course varies greatly across individuals. The most important changes in cognition with normal aging are declines in performance on cognitive tasks that require one to quickly process or transform information to make a decision, including measures of speed of processing, working memory, and executive cognitive function. Cumulative knowledge and experiential skills are well maintained into advanced age (Murman, 2015). Current literature on executive functions suggests that brain compensatory mechanisms may counter cognitive deterioration due to aging, at least up to certain task load levels. It is generally accepted that experience can counter cognitive decline in pilots up to a certain level. This is supported by the findings of Kay et al. (1994) that showed that recent flight time determined the risk of an accident: the greater the recent experience, the fewer the number of accidents. Pilots with over 700 hours flight time in the year before the study had the lowest number of accidents. The results of the analyses indicated that the accident risk of (private) pilots aged 60-65 did not differ significantly from that of most other age groups (Kay et al., 1994)

Cognitive abilities that are generally considered to be important for pilots are perception (e.g., instrument monitoring); memory (e.g., recalling ATC information); problem solving and decision making (e.g., in case of in-flight events, malfunctions); psychomotor coordination (e.g., flight control). Data on the effects of ageing on cognitive functions are obtained for the most part from studies in which the research population consisted of non-pilots. Only a limited quantity of literature is available on pilots. There are indications that the results of non-pilot studies cannot be extrapolated to pilots because pilots are a select population and are selected for the above-mentioned cognitive faculties. They are better educated, healthier and more intelligent than the average member of the public. Moreover, pilots frequently practice the tasks they are required to perform and older pilots have great experience of their flying tasks (Simons et al., 1996). In non-pilot populations it was found that higher age was associated with a lower performance level of problem solving and decision making tasks (Salthouse, 1985). However, this association with age has never been demonstrated in surveys of groups

of pilots (Mohler, 1981). If age does have an effect on these faculties, any diminution is probably adequately compensated by the greater experience and better judgement of the older pilots (Mohler, 1981).

In studies with pilots, Braune & Wickens (1984) found a significant correlation between tracking accuracy and experience, but not with age. The speed of information processing declines from the age of 25 onwards (Braune et al., 1985). This process occurs at every level of information processing. Many studies showed that in tasks where both speed and accuracy are important, older subjects tended to give more attention to accuracy at the expense of response time (Tsang, 1989).

4.6.6. How to test cognitive abilities of asymptomatic pilots and ATCOs?

There is no neurocognitive, neuropsychological test, or battery of tests that enables a decision to be taken on whether the cognitive capacities of an individual have diminished to such an extent that he/she should no longer be allowed to fly or perform ATC tasks. It is not possible to decide solely on the basis of the score achieved in a neuropsychological test, but the results of such a test or battery of tests can provide useful background information in the process of deciding on the medical certification of an individual who has been referred by the AME/AeMC for a specialist evaluation (Hyland et al. 1994; Hardy & Parasuraman, 1997).

When the cognitive functioning of an individual is evaluated, it is of great importance to have information about the occupational history of that person. Data that are relevant in this context are the functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses. This can alert the AME to a deterioration of functioning. After discussion with the applicant in question, the AME may then refer the applicant for detailed additional screening, which may also be in the interest of the applicant.

Neuropsychological assessment is a performance-based method to assess cognitive functioning. This method is used to examine the cognitive consequences of brain damage, brain disease, mild cognitive impairment, dementia, and mental illness. There are several specific uses of neuropsychological assessment, including collection of diagnostic information, differential diagnostic information, assessment of treatment response, and prediction of functional potential and functional recovery. Neuropsychological assessment is also an important tool for examining the effects of toxic substances and medical conditions on brain functioning.

Neuropsychological tests have generally accepted diagnostic value in patients with symptoms or a suspected history (red flags to be identified by the AME), but these tests have never been developed as a 'pass' or 'fail' instrument in the context of screening individuals for highly skilled jobs. Therefore, a meaningful interpretation of results in asymptomatic individuals is impossible as there are no validated cut-off points beyond which a safe (flying) performance can be predicted (Mackenzie Ross, 2017).

The relationship between basic domain-independent cognitive abilities and flight performance is very complex. Functions assessed in cognitive studies represent basic domain-independent cognitive abilities that are only one factor in determining flight or ATC performance. Higher order cognitive factors, including metacognitive skills and domain-specific knowledge, may play an equal or greater role in determining flight performance (Hardy & Parasuraman, 1997). Static measures of cognitive functioning typically obtained in laboratory tests may not be representative of the more complex and dynamic cognitive processes required in real-world tasks. Age-related differences in measures of pilot cognition are minimally predictive of primary measures of flight performance and there is generally a low predictive validity of laboratory cognitive measures to flight performance (e.g., Damos, 1996). Cognitive ability (including perceptual-motor skills) is only moderately associated with job proficiency (Hunter & Hunter, 1984).

Pilot flight performance is the product of domain-independent skills (basic cognitive abilities) and, to a greater extent, domain-dependent knowledge and it is concluded that the weak correlations between these two are not caused by the fact that cognition is unrelated to flight performance, but because the standard cognitive

tests are insufficient to capture the complexity and dynamism of the cognitive skills involved in flying an aircraft (Hardy & Parasuraman, 1997).

When examining age and expertise level effects in flight simulator performance, it is expected that expertise will be more likely to aid older expert pilots' performance on perceptual-motor tasks and tasks that are relatively unconstrained by time (Kennedy et al., 2010). In a flight simulator study, Taylor et al. (2007) found that experienced pilots had better flight summary scores at baseline and showed less decline over time. Even though older pilots initially performed worse than younger pilots, over time older pilots showed less decline in flight summary scores than younger pilots. Secondary analyses revealed that the oldest pilots did well over time because their traffic avoidance performance improved more as compared to the younger pilots. Taylor et al. (2007) concluded that their findings support previous cross-sectional studies in aviation as well as non-aviation domains, which demonstrated the advantageous effect of prior experience and specialized expertise on older adults' skilled cognitive performances.

The majority of studies of the relationship between cognitive abilities and performance of safety-sensitive tasks in aviation involved performance of flying tasks. Although pilots and ATCOs have different tasks and working conditions, it is assumed that both groups need a similar set of cognitive abilities to safely execute their tasks, albeit that the order of importance of the specific cognitive functions needed to perform these tasks might differ and ATC work is especially characterised by cognitive complexity (e.g., Inoue et al., 2012). Based on this reasoning, it is assumed the above-mentioned results of Taylor et al. (2007) and the conceptual postulates of Hardy and Parasuraman (1997) also apply for ATC performance.

4.6.7. Cognitive performance tests for all Class 1 and Class 3 examinations?

Several EASA member states that thus far have applied for an exemption concerning age limits have a requirement of an "extended psychological test including cognitive skills and performance performed by a certified aviation psychologist" or by a psychiatrist at the "first examination after reaching the age of 60." The concrete type or content of the required "psychological test" is often not mentioned.

When requiring cognitive testing for asymptomatic pilots or ATCOs, one should consider the following:

- Many studies of the predictive value of Cognitive Tests used subjects with MCI or dementia, resulting in higher predictive values.
- When using screening tests for asymptomatic individuals, the cut-off is set towards high sensitivity, therefore in a population of pilots or ATCOs, where the prevalence of significant cognitive deficiencies is considered to be low, many of the positive results may be false positives.
- Cognitive decline begins from 40 years of age and its course varies greatly across individuals. Cut-off values for prediction of safe flying or ATC performance are not known and will be difficult to determine. Normative reference data are based on sample of "normal" individuals. For large-scale population research 1.5 standard deviations (SD) lower than the population mean is often used as cut-off value. However, this is not applicable for testing of individual cases: should we disqualify a pilot or ATCO because his/her score is 1.5 SD lower than the mean of the general pilot or ATCO population?
- Some colleagues suggested doing neurocognitive baseline tests and comparing later test results with baseline values in order to identify cognitive decline over time. Even if that would be achievable, it will remain difficult to judge what level of decline would lead to an unacceptable safety risk.

- Cognitive tests may provide an indication for further evaluation, but should not be relied upon for diagnosing brain disease or when making major decisions about a pilot's or ATCO's competency and ability to fly or perform ATC tasks (Mackenzie Ross , 2017).
- Cognitive function tests for pilots and ATCOs are designed to ensure pilots or ATCOs have the necessary basic cognitive skills to function as a pilot or ATCO: aim is selection of the right people (select-in).
- Standard cognitive tests are insufficient to capture the complexity and dynamism of the cognitive skills involved in flying an aircraft [Hardy & Parasuraman, 1997].
- Age-related differences in measures of pilot cognition are minimally predictive of primary measures of flight performance and there is generally a low predictive validity of laboratory cognitive measures to flight performance [e.g., Damos, 1996].
- Cognitive function tests are useful for large-scale research of populations and for evaluating cognitive/sedative side-effects of medication.
- Many computerized tests are freely available on internet and can thus easily be trained prior to an aeromedical examination.

One of the popular computerized tests is CogScreen™ which tests memory, visual perceptual functions, sequencing and problem solving, attention, and information processing speed. The dedicated aviation version of this test (CogScreen-AE) is very useful for selection of “the right stuff”, or for assessing effects of interventions, such as potentially sedative medication. However, it is not designed for predicting an individual pilot's performance of flying tasks, or the individual ATCO's performance on ATC tasks. It is noteworthy that the CogScreen™ Sample Report published on internet (<https://cogscreen.com/SampleAeromedicalReport.pdf>) mentions: 1) No decisions should be based solely on CogScreen results; material from other sources should be sought before making decisions about an individual. 2) Not all brain disorders produce cognitive deficits that will be detected by CogScreen (Mackenzie Ross, 2017).

Taylor et al. (2000) studied aviators performing aviation tasks in a Frasca model 141 flight simulator and the CogScreen-AE battery. The majority of the 97 participants (age range 50-69 yr) were FAA medically certified as Airman Class III (52%), 40% were Class II, and 8% were certified as Class I. Pilots who had ever flown for major air carriers were excluded from participating. A multiple regression analysis indicated that four CogScreen variables could explain 45% of the variance in flight summary scores. Predictors were: Speed/ Working Memory scores, Visual Associative Memory, Motor Coordination, and Tracking. Pilot age was found to significantly improve prediction beyond that which could be predicted by the four cognitive variables. Cockpit monitoring performance was not found to be associated with any of the CogScreen predictors tested in the study.

When job performance is to be predicted on an individual basis, it is useful to consider the basic order of the predictors of flight or ATC performance as has been postulated by Hyland et al. (1994) and Hardy and Parasuraman (1997) who classified the predictors as: a) domain-independent cognitive and motor skills, such as those assessable with CogScreen; b) domain-dependent (aviation) knowledge; c) pilot or ATCO characteristics such as age, cardiovascular status, drug dependency, agreeableness; and d) stressors, such as difficult work conditions, fatigue, and interpersonal conflicts. The predictive value of these different variables depends on the criterion of interest. In this context, a study involving airline pilots by Hoffmann et al. (1998) showed that domain-dependent knowledge predicted training success but not line-check ratings of aircraft control, while conversely CogScreen Manikin and Symbol Digit scores predicted aircraft control, but not training success. CogScreen Dual Task and Divided Attention scores predicted training and compliance with procedures but not aircraft control (Hoffmann et al. (1998). The above-mentioned prediction study of Taylor et al. (2000)

found that age still accounted for a significant amount of variance beyond that predicted by CogScreen performance. This could well indicate the possibility that other age-associated pilot characteristics might predict flight performance or bear a risk for in-flight incapacitation.

4.6.8. Neuropsychological assessment in cases that have raised suspicion

- A neuropsychological assessment may be indicated by the AME who has identified signs and/or symptoms of mild cognitive impairment or brain dysfunction. The neuropsychological assessment is indicated to find evidence for brain dysfunction, mild cognitive decline, or dementia and covers a wide range of cognitive domains: enabling a differential diagnosis. A neuropsychological assessment has generally accepted diagnostic value in patients with symptoms or suspected history (Red Flags).
- A study by Klekociuk et al. (2014) showed that the rate of false positive MCI diagnoses, found with brief cognitive tests, can be significantly reduced through the use of sensitive and specific neuropsychological measures of memory and non-memory functions.
- Neuropsychological assessment has never been developed as a 'pass' / 'fail' instrument to screen individuals for highly skilled jobs. Meaningful interpretation of results in asymptomatic individuals is difficult due to lack of validated cut-off points that predict safe flying or ATC performance (Mackenzie Ross, 2017).
- Neuropsychological assessment is to assess brain function or dysfunction and is not designed to predict pilot or ATCO performance (Mackenzie Ross, 2017).

Conclusion

Although cognitive test batteries, such as CogScreen are useful as select-in tests (determine whether a candidate has the cognitive abilities to become a good pilot or ATCO), there are currently no cognitive tests available that are suited to predict flight or ATC performance or to identify subtle impairments in cognitive functioning of asymptomatic pilots or ATCOs (select-out). It is emphasized that neurocognitive or neuropsychological tests performed as a routine measure without indication (Red Flag) or clinical question will not provide useful results in the context of determining pilot's or ATCO's cognitive abilities to safely execute all tasks: without a question (indication), there will be no relevant answer! The AME/AeMC in collaboration with operational examiners should provide the clinical question for neuropsychological assessment by the neuropsychologist, neurologist, or psychiatrist to whom they refer a pilot or ATCO with suspected neurocognitive decline.

Currently, it is considered that simulator checks, line checks, and peer review provide the best opportunities to detect below standard performance that may be caused by mental problems or neuro-cognitive impairment. It is therefore important that the AME is informed about the results of the simulator, line, and ATC checks. This information can be provided by the applicant or by the operational examiner. Instructors, operational examiners, and proficiency check officers should be trained to identify impaired cognitive performance and to discuss their concerns with the pilot or ATCO in question in order to stimulate the pilot or ATCO to self-report the problems to the AME/AeMC, or Peer Support Programme, or get the pilot's or ATCO's approval to share the concerns with the AME/AeMC, while guaranteeing strict confidentiality. To detect possible neurocognitive shortcomings, essential cognitive factors of flight or ATC performance should be incorporated in the regular mandatory License Proficiency Checks or Operator Proficiency Checks. Attention should be focused on abilities to function under highly stressful demands, such as high time pressure.

4.6.9. Conclusions and recommendations

Scientific data support the generally accepted opinion that the risk of mild cognitive impairment increases with age, although there is good evidence suggesting that declines in cognitive abilities between the end of the fourth decade and age 65 are small.

It is not recommended to use neurocognitive tests to identify MCI for the aeromedical screening of asymptomatic pilots and ATCOs. It seems more appropriate that in via extensive history taking in which personal life factors and job factors are discussed, the AME should try and identify Red Flags which could indicate neurocognitive decline or brain diseases irrespective of the cause. In case of any Red Flag or reasonable doubt the pilot or ATCO should be referred for specialized diagnostic evaluation (neurologist, clinical psychologist, neuropsychological testing). Red Flags for MCI may also emerge from the results of proficiency and line checks and should lead to specialized diagnostic evaluation.

How to test cognitive abilities of asymptomatic pilots or ATCOs?

Most concerns about a decline of cognitive abilities by increasing age are related to the question whether or not an aging pilot or ATCO is able to safely execute all safety-sensitive tasks. This is for the largest part an operational problem where the AME/AeMC - apart from excluding MCI, dementia, or brain diseases - may only contribute a part of the solution. If there is no suspicion found by the AME, the operational solution is to challenge the applicant to give proof that his/her functioning has a sufficiently acceptable safety risk. Such challenge can be provided by training and the regular mandatory operational checks each pilot or ATCO has to undergo.

There are currently no useful tests available to identify subtle impairments in cognitive functioning of asymptomatic pilots or ATCOs that are suited to predict flight or ATC performance. It is emphasized that neurocognitive or neuropsychological tests performed as a routine measure without indication (reasonable cause, Red Flag) or clinical question will not provide meaningful results in the context of determining someone's cognitive abilities to safely execute all flying or ATC tasks. The AME/AeMC, in collaboration with operational examiners (OPC/LPC) or peers, should formulate a clear referral question for neuropsychological assessment by a neuropsychologist, neurologist, or psychiatrist.

Recommendation

To detect possible neurocognitive shortcomings the recommended aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses.

1. AME history taking (Hudson & Herbert, 2017; EASA, 2022)

The AME should try to build an trustful alliance with the applicant and take sufficient time to discuss the applicant's job: type of flying, or ATC work; employer details; length of service in current employment; full-time/part-time; type of contract; total flying hours; hours flown since last medical; roster pattern: long-, medium-, short-haul; number of sectors flown in a duty period; for ATCOs: details and fairness of rosters; fatigue; job satisfaction/; attitude towards job; aspirations for future career development; difficulties with operational crew resource management (CRM); any difficulties with employer and/or other colleagues and managers; is there company peer support?

Further questions should involve the applicant's role and attitude in accidents or incidents, problems in training or proficiency checks, behaviour or knowledge relevant to the safe exercise of aviation tasks relevant for their class of licence; coping strategies under periods of psychological stress or pressure in the past, including seeking advice from others; family arrangements: married, single; relationship; ages of children; child care; family life;

health issues family; partner employment; holidays; hobbies; financial concerns (debts; overtime work, second job) and interpersonal and relationship issues, including difficulties with relatives, friends, and work colleagues.

This should be followed by a structured medical history taking concerning health, illness, symptoms, organ systems (functioning, complaints); sleep: quality and amount (at home and on stopovers; snoring; hypnotics); jet lag / shift work; rest arrangements prior to duty; medication (prescribed; over-the-counter; via internet); exercise/diet: activities; diet (food during work); and drugs/alcohol/smoking habits (alcohol type/amount/binge drinking, suggested bottle to throttle time, social / party drugs, legal highs, driving license offences).

As mentioned by EASA in AMC1 MED.B.055 Mental health (EASA, 2022), the following aspects should also be taken into consideration when conducting the mental health examination: Appearance; Attitude; Behaviour; Mood; Speech; Thoughts process and content; Perception; Cognition; Insight; and Judgement.

Answers to above questions and observations can provide the AME with a complete picture of the applicant's life and functioning and may give clues to potential problems. When suspicion of cognitive dysfunction emerges, the applicant should be referred to a neuropsychological or neurological expert.

2. Operational information

Occupational history and functioning of the pilot or ATCO in the event of incidents and accidents can be provided by the applicant or – with explicit consent of the pilot- by occupational physicians, peers, or head of flight department. Information of functioning during simulator sessions, proficiency checks and training courses can be provided – with explicit consent of the pilot- by instructors and examiners. Essential cognitive factors of flight or ATC performance should be incorporated in the regular mandatory checks or operator checks. Attention should be focused on abilities to function under highly stressful demands, such as high time pressure.

The information obtained using the above two pillars of examination can alert the AME to a deterioration of functioning. After discussion with the applicant in question, the AME should then refer the applicant for detailed additional neuropsychological or neurological screening.

All information gathered in the above described procedure, will enable taking a reasonable decision in which the consequences for the applicant are weighted against the safety consequences.

4.7 Take-away messages

Although tests questionnaires are essential in mental healthcare, psychodiagnostic tests taken as standalone tools do not enable a psychological diagnosis.

Besides, using them in the medical screening of aviation professionals is difficult. On the one side there is the risk of false-positive findings when the wrong questionnaire is being used (for example a questionnaire on personality traits for detecting a depressive disorder), on the other side is the risk of false-negative findings due to underreporting of mental complaints. Very few dedicated and validated tests and questionnaires for pilots, ATCO's and other aviation professionals exist. Valid pilot and ATCS norms are available for the MMPI-2. Still tests and questionnaires might be useful to support the part of the interview addressing mental complaints. Developments with regards to smartphone and wearable technology are worth to be followed critically.

The duration of the treatment and frequency of follow-up measures is a highly individual decision which depends on the characteristics of the patient (e.g., previous mental disorders, availability of a good support system), the characteristics of the disorder (severity, risks, comorbidity), the treatment (long-term CBT is highly uncommon, long term pharmacotherapy is not) and the personal preferences of the patient and the psychiatrist/psychotherapist.

Scientific data support the generally accepted opinion that the risk of mild cognitive impairment increases with age, although there is good evidence suggesting that declines in cognitive abilities between the end of the fourth decade and age 65 are small. There are currently no cognitive tests available that are suited to predict flight or ATC performance or to identify subtle impairments in cognitive functioning of asymptomatic pilots or ATCOs.

It is not recommended to use neurocognitive tests to identify MCI for the aeromedical screening of asymptomatic pilots and ATCOs. To detect possible neurocognitive shortcomings the recommended aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses. It is therefore important that the AME is informed about the results of the simulator, line, and ATC checks. Data protection constraints actually represent a challenge in implementing this: in the next tasks of the MESAFE project it will be discussed how to derive suitable recommendations to get this done. To achieve this, relevant stakeholders, including pilots and ATCOs, will be involved. Considering that privacy laws prevailing in many countries might disallow the exchange of such information, methods to obtain this necessary information are currently still to be developed. In that context, pilots or ATCOs might be mandated to self-report the results of their checks to the AME or submit the examiner’s report to the AME or Competent Authority of the pilot. Or examiners and trainers might –with explicit informed consent of the applicant– inform the AME or the medical assessor of the Competent Authority of the pilot about any suspicion for MCI that may emerge from the results of proficiency and line checks.

For the scope of MESAFE, the following take-aways can be taken into consideration:

Take away ID	Take away message
4.1	Psychodiagnostic tests taken as standalone assessment measures do not enable a psychological diagnosis. Still tests and questionnaires might be useful to support the part of the interview addressing mental complaints.
4.2	Very few dedicated and validated tests and questionnaires for pilots, ATCO’s and other aviation professionals exist. Valid pilot and ATCS norms are available for the MMPI-2.
4.3	Personality tests cannot be used for diagnosing mental disorders.
4.4	Tests and questionnaires hardly predict the mental health status in between two medical examinations.
4.5	Assessing the risk of suicide and other risky behaviours is generally assumed to be based on two major principles: the clinical impression and quality of the contact with the patient, and epidemiological risk factors.
4.6	It is not possible to assess the mild cognitive decline solely on the basis of the score achieved in a neuropsychological test, but the results of such a test or battery of tests can provide useful background information in the process of deciding on the medical certification of an individual who has been referred by the AME/AeMC for a specialist evaluation.
4.7	To detect possible neurocognitive shortcomings the recommended aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses.

Table 8 - Take-away messages on assessing mental health

5. Overview of mental health assessment methods and options currently used in aviation

5.4 Review of existing evidence and procedures for assessing mental health in EASA and ICAO

5.4.1 Regulations and guidance material for examinations for Pilots and ATCOs.

ICAO regulation and guidelines

The International Civil Aviation Organisation (ICAO) publishes Annex 1 (personnel licensing). This document contains medical standards for contracting states (which include EASA states) – and is updated regularly by the Aviation Medicine Section of ICAO. The most recent version is the 14th edition and was published July 2022.

Annex 1 states requirements for medical assessment intervals in Chapter 1, with validity of different licenses. It also states that the Designated medical examiner (in Europe: Aeromedical examiner - AME) shall have training in Aviation Medicine.

A requirement for health promotion is mentioned in Chapter 1:

1.2.4.3 The Licensing Authority shall implement appropriate aviation-related health promotion for licence holders subject to a Medical Assessment to reduce future medical risks to flight safety.

Annex 1 does not go into the methodological issues regarding getting a good history from a pilot or ATCO in the particular circumstances, but does state reactions to any false declaration:

1.2.4.7.1 Any false declaration to a medical examiner made by an applicant for a licence or rating shall be reported to the Licensing Authority of the issuing State for such action as may be considered appropriate.

Specifically regarding mental requirements, Chapter 6 has a list of mental disorders which might render the applicant unable to safely exercise the privileges of the license applied for or held.

The ICAO manual of Aviation Medicine contains supplementary guidance for examinations, and was last updated in 2012. It gives guidance on evaluation of the different conditions.

The following is included as a general advice in the manual, page III-9-2:

9.1.5 In order to control an aircraft, aircrew members need:

- a) to know their position in space, which requires adequate sensory input (sight, hearing, balance, proprioception, etc.);*
- b) to evaluate flight conditions and to choose a safe course to ensure the aircraft arrives safely at its destination, which requires the capacity to acquire information, process the information, and make relevant decisions;*
- c) the physical capacity and the mental desire to carry out the chosen course of action*

9.1.6 Psychiatric conditions can cause an aircrew member to become incapacitated, which may be obvious or subtle, and the task of the medical examiner is to detect this or the likelihood thereof on the basis of the regulatory examination.

This is the basic requirement that has to be met, and how mental health issues may hamper the fulfilment of the requirement. In addition to this, the manual gives a comprehensive overview over different mental disorders, and how to evaluate them. It does not give any particular methodological guidance as to how such conditions may be picked up, unless the pilot or ATCO herself voluntarily convey the symptoms. It does, however, refer to a simple cognitive mental status test, and gives some references to articles about screening

questions for common mental problems in primary care, screening for depression and questionnaires for depression and anxiety. It also gives reference to evaluation of antidepressant treatment.

EASA regulations and guidance

Part ATCO.MED with AMC (Acceptable Means of Compliance) has a similar layout to ICAO documents, in that it gives an outline of disorders that might be a problem for certification as well as some, but limited guidance of evaluation protocols. However, there is little information on how the AME may perform screening for mental health problems.

The EASA regulation for Class 1 pilots (Part-MED AMC1.MED.B.055) Mental health dates from 2019 and includes updates and changes after the Germanwings crash.

The guidance for assessment of different diagnoses is very similar to ICAO Annex 1 and guidance material, utilizing specialist competence.

However, regarding screening for mental health problems, the new EASA regulations and guidelines take a clear step forward in requiring a larger activity and minimum specific questions on the part of the AME to uncover possible problems.

For initial class 1 aeromedical examinations, the following steps are required: (Applies to Aeromedical centres, AeMC)

(a) Mental health assessment as part of the initial class 1 aero-medical examination

(1) A comprehensive mental health assessment should be conducted and recorded taking into account social, environmental and cultural contexts.

(2) The applicant's history and symptoms of disorders that might pose a threat to flight safety should be identified and recorded.

(3) The mental health assessment should include assessment and documentation of:

(i) general attitudes to mental health, including understanding possible indications of reduced mental health in themselves and others;

(ii) coping strategies under periods of psychological stress or pressure in the past, including seeking advice from others;

(iii) childhood behavioural problems;

(iv) interpersonal and relationship issues;

(v) current work and life stressors; and

(vi) overt personality disorders.

A similar list exists for renewal of certification, but then taking into consideration employment and work issues, including interpersonal relationships and coping strategies.

There is also included a psychoactive substance testing requirement for initial examinations for Class1, which is performed in Aeromedical centres (AeMC)

Discussion

ICAO regulation and guidelines give concrete guidance on what the requirements for a pilot or ATCO are relating to flight safety. There is also a clause on prevention, albeit not necessarily applied to the individual medical

examination. These points help the Aeromedical examiner to be aware of the importance of mental health issues. There is also a comprehensive list of different diagnoses and their evaluation.

However, there is little guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable. There is a requirement that the medical examiner reports pilots who make false declarations to the competent authority, showing the issue of non-reporting or false declaration is clearly recognized. Although there is some limited reference to tests for some psychological disorders, these are not validated for aircrew or in a similar situation.

The screening regimes of most states, also EASA before 2019, consist of simple questionnaires where pilots and ATCOs answer “yes” or “no” regarding previous mental disease. It is then up to the AME to decide whether he/she would probe further. Anecdotally, it is common for AMEs to discuss working conditions and general life conditions with Pilots or ATCOs, but most AMEs are not trained to interview in such a way as to pick up mental problems in an effective way. AMEs around the world, including Europe, are usually situated in small practices (except for initial examinations performed by Aeromedical Centres – AeMC), and in such situations psychological or psychiatric evaluation is usually only available by referral. Access, waiting times, and lack of knowledge of aviation on the part of many psychologists or psychiatrists, may affect the usage of specialist evaluations except when indications are very clear.

It may be argued that the mental health examination requirements give a list of unwanted conditions, a reason to avoid them, but no clear tools to find them in an environment where non-reporting of symptoms is probable. This is an issue also regarding physical disorders, of course, as the diagnosis on most conditions relies on a good history. However, physical disorders like cardiac or pulmonary conditions will commonly show some physical signs at some stage, while mental disorders may to a greater extent be kept “under the radar” of the aeromedical examiner who has no good tools of diagnosing such conditions.

The EASA regulations from 2019 form a definite step in a direction with more explicit screening methods. In many countries, psychologists or psychiatrists are used closer to the assessment process, at least for initial examinations at Aeromedical centres (AeMCs). There is, however, a large variation in how this is done. A survey was performed to understand the way the mental health examination is currently performed around Europe. The results are found in section 5.4.4.

There is, to our knowledge, no empirical study to assess the effect of mental health screening for aviation personnel, as the relationship between AME and Pilot/ATCO is different from a “normal” doctor-patient relationship. We have reason to believe that non-reporting is a substantial problem, specifically regarding mental health. Still, there is some basis to assume that a greater awareness of mental issues- and that it might be “normal” to have mental health issues sometime during life events – might lower the threshold to discuss this – even with the AME. The medical history taking by the AME should include questions related to common life stressors such as work-related problems, financial worries, health concerns, bereavement issues, relationship / family difficulties, separation from family, and social demands.

As such, the new EASA guidelines are probably a step forward, if AMEs receive the competence to use these guidelines in a clinical setting. However, there is a need for clinical studies to assess mental health screening for pilots and ATCOs in the certification process.

5.4.2 Problems AMEs’ face when trying to identify mental health problems

Problems which the AMEs face when trying to identify mental health problems, may stem from AME functioning and characteristics of the applicant pilots and ATCOs, as well as the system in which these examinations take place. It should be considered that the aim of a mandatory examination in the context of obtaining or renewing a pilot or ATCO licence is completely different from a clinical examination where a patient

seeks guidance or treatment for a medical problem. In the clinical setting patients are likely to disclose their problems to a doctor and are likely to be cooperative in order to get help. In the mandatory medical examination setting, the aim of pilots and ATCOs is to be declared fit and it is likely that they might be reluctant to disclose any health problem that might lead to an unfitness decision by the AME, or medical assessor. It is also likely that any disclosed symptoms may be understated on the part of the pilot or ATCO, consciously or unconsciously, in order to avoid the AME reacting in a manner restricting license privileges.

AMEs

- AMEs might have insufficient knowledge of psychological and psychiatric signs and symptoms.
- AMEs might have insufficient experience with, or training in, psychological or psychiatric interview techniques.
- Some AMEs do not take sufficient time for the aeromedical interview, or treat the aeromedical examination as a “box ticking” exercise.
- For the mental health examination, some AMEs rely completely on questionnaires to be filled in by the applicants and do not realise the methodological limitations of the questionnaires and the unreliability of the answers given by the applicants.

Applicants

Applicant pilots and ATCOs may hide their mental health problems because:

- They might feel ashamed and guilty of showing vulnerability in front of others, that might be particularly frequent in male applicants with a former military background
- They might perceive AMEs as a higher authority with the power to end their career, to the extent they would not trust AMEs.
- There is a lack of awareness on the part of pilots/aviation personnel (and also some AMEs) regarding the importance of mental health in aviation, and is to some extent a part of the general trend in society.
- They fear that they would lose their licence if they mention or admit to have psychological and psychiatric problems.
- There is a stigma concerning psychiatric or psychological disorders. This stigma is widespread among all social classes. This stigma is likely very prevalent among pilots and ATCOs.
- People with psychological problems or life stress often think that their problems will have no effect on the quality of their job performance and, therefore would downplay during a job-related medical examination.

Context

- Even if the Applicants may trust their AME, the final decision of unfitness is often made by a medical assessor whom the applicant does not know.
- The exact decision-making process for unfitness is not known to the pilot or ATCO, and is often not known to the AME either.

The procedure for an appeal is often unknown or unclear for the AME and the applicant, often might involve legal action and take time, and the possibility for success is not high.

An AvWeb Online Survey among US commercial pilots showed that 46% (of 567 responses) ever had a medical condition for which the respondent did not seek treatment for fear that disclosure might jeopardize their flying job. Of 563 responses 32% admitted that they have had a medically treated condition and failed to disclose this on their FAA medical application for fear that disclosure might jeopardize their flying career. Of 561 responses 21% took medication about which they have not told the FAA (<http://www.avweb.com/news/aeromed/181888-1.html?redirected=1>). Although the methodology of this study is unclear and the response rate is unknown, the results give an indication that a considerable number of pilots do not disclose medical conditions or medication that potentially affects safety.

The above-mentioned survey results are in agreement with a recent study of Strand et al. (2022) among 1616 respondents of a Norwegian sample consisting of commercial pilots (45%), private pilots (28%), ATCOs (17%) and other aeromedically certificated personnel (10%). A total of 188 individuals (12%) admitted having under-reported information related to one or more categories, including mental (3%) or physical health (4%), medications (2%), and drug use, including alcohol use (5%). Among these, 21 participants believed their own under-reporting “to some” or “to a high extent” affected flight safety. In total 50% of non-initial applicants reported that they knew colleagues who had under-reported information. Analyses revealed that being a commercial pilot showed a higher risk for under-reporting compared with other classes. Among these, 21 participants believed their own under-reporting “to some” or “to a high extent” affected flight safety. In total 50% of non-initial applicants reported that they knew colleagues who had under-reported information. Analyses revealed that being a commercial pilot showed a higher risk for under-reporting compared with other classes. It was also found that respondents believed that a supportive or authoritative role of aeromedical examiners would reduce the risk.

To reduce the risks for AMEs to miss symptoms and signs of mental health problems, AMEs should receive additional training in aviation mental health issues. According to the AsMA Pilot Mental Health Working Group recommendations (AsMA, 2016) this should be emphasized as part of the initial and periodic aeromedical examiner training programs and this training should also include guidance for when an aeromedical examiner should consult/refer to a mental health specialist provider or other aeromedical resource.

AMEs and safety trainers should educate pilots and ATCOs on the following principles:

- Self-reporting of addiction or mental health problems will improve flight safety
- One can recover from addiction and/or mental health problems and can resume aviation duties after recovery
- Self-reporting can be the start of regaining a healthy and safe pilot career.
- AMEs, pilots, and ATCOs share the same aim: to keep you healthy and working safely.

The most important recommendation is that AMEs should utilize methods to build rapport and trust with the pilot in a nonthreatening environment (AsMA, 2016). Considerations regarding trust and alliance between applicants and AMEs will be further discussed in section 5.4.3.

5.4.3 Trust and alliance between applicants and AMEs, and organizational context.

As discussed in section 5.4.2, mistrust is a major barrier affecting a frank discussion of mental health issues between an AME and a pilot or ATCO. While the sources of mistrust, indicated in section 5.1.7, are quite clear, a direct solution does not seem easy. Professionalism, honesty and trust are the building blocks of a good

working relationship between an AME and a pilot or ATCO. This does not happen overnight. It requires work from both parties. AMEs and pilots/ATCOs together should foster a culture where disclosure by the pilot or ATCO of potentially career threatening medical problems is likely. When it exists, the pilot can expect a supportive response to his problems and then both can work together towards a shared goal of a long and safe career in aviation (ECA-ESAM-EAAP, 2015). An ongoing relationship between the pilot or ATCO and the AME provides a firm basis for building up trust, enabling health promotion and facilitating better communication both during, and between, examinations. Most medical problems arise between medicals. The mandatory medical itself helps to identify and discuss, and thus prevent such problems.

To achieve a trustful relationship, pilots and ATCOs should learn about the aims of the AME job and the methods that AMEs use to achieve optimal safety. Pilots and ATCOs should know what they can expect from their AME. On the other hand AMEs should learn that flight safety and a healthy and fulfilling career are the number one and two top priorities for a professional pilot or ATCO. Therefore, AMEs should clarify that this is also something that the AME works for together with the pilot or ATCO. AMEs should know current developments in the aviation industry and the environment in which their applicants work. AMEs should show genuine interest in their examinees. They should be interested in the professional and social life of their applicant and should know what the applicant expects from them. AMEs should make their applicants feel comfortable in a nonthreatening environment and explain the aim and contents of the examination. They should use a personalized approach, listen carefully and give and ask feedback. The AME should have a frank and open approach and be honest about probable safety risks of the disclosed (mental) health problems and discuss next steps concerning referral, treatment, and prognosis in relation to health and professional career. The AME should make clear that if the applicant identifies any areas for which s/he would like to have further support, the AME can recommend ways to address these problems outside of the medical, in order to prevent them becoming an issue that could impact the applicant's fitness for flying or ATC work in the future. This might include Peer Support Programmes, specialised counseling, or support from a professional association. Anything that does not directly impact the aviation safety risk should remain confidential between the applicant and the AME (ECA-ESAM-EAAP, 2015).

Detailed guidelines for the AME medical interview are provided in paragraph 4.6.9. Questions and interview techniques can be used to assess mental health that will have a minor impact on the examination and should not prove burdensome for the pilot or examining physician. Asking questions regarding mood, quality of sleep, current sources of stress (such as work, fatigue, financial, home and family), alcohol and/or substance use are recommended. These questions should be woven into the conversation with the pilot during the aeromedical examination as part of a general health promotion discussion that addresses a variety of health issues, both mental and physical (AsMA, 2016).

Prerequisites for the above approach are sufficiently trained and dedicated AMEs, the existence or availability of Peer Support Programmes (safe zones) and a no-blame culture.

A trustful alliance between the AME and the pilot or ATCO is a crucial basis for making the Aviation medical interview work as a tool for flight safety. However, there will always be a trust issue that cannot be solved – this is a systemic and organizational challenge. Even if the Applicants may trust their AME, the final decision of unfitness is often made by a medical assessor whom the applicant does not know. The exact decision-making process for unfitness is not known to the pilot or ATCO, and is often not completely understood for the AME either. In addition, the procedure for a complaint is often unknown or unclear for the AME and the applicant, often might involve legal action and take time, and the possibility for success is not high. More transparent decision-making processes, also on the level above the AME, must be devised to improve predictability for the pilot and ATCO and trust in the system itself. The basis of valuation of many mental health issues in Pilots and ATCOs is often not diagnosis itself, but an analysis of flight safety implications. Pilots and ATCOs are usually resourceful people who have thoughts about flight safety consequences of a given condition or problem, and

the process must include the pilot's or ATCO's own viewpoints on as well as diagnostic conclusions. Some countries have ways of letting the pilot or ATCO make a statement of suitability despite not conforming to medical standards such as the FAA's "statement of demonstrated ability". Other countries are working on solutions for process which gives the pilot or ATCO a better chance of having her or his case re-evaluated without using the legal system, such as an Ombudsman-system (CAA, UK). Different ways of achieving better process should be explored in order to improve the contextual distrust in aviation medical systems that exists with many Pilots and ATCOs.

5.4.4 Current gaps and needs

An online survey named "Mental Health assessment: a survey to collect the AMEs and aeromedical assessors' point of view" has been developed to understand current gaps and needs with respect to the mental fitness assessment process from the point of view of AMEs and aeromedical assessors.



The main objectives of this survey were to:

- Identify misalignments between the knowledge, skills and competencies obtained during education/training and the knowledge, skills and competencies required for a satisfactory aeromedical examination.
- Determine the factors that obstruct or facilitate the assessment of the mental health of applicants.

The Medical Expert Group (MEG) was identified as target and was contacted by EASA. The MEG is composed of medical assessors of the European National Competent Authorities and medical representatives of aviation industry representing, among others, pilot associations, airlines representatives, ATCO associations, etc. Some of the MEG members activate themselves as AMEs or aeromedical staff working in AeMCs.

The survey was administered using google forms, to ensure the widest and most usable distribution. The survey contained a total of 23 questions (21 mandatory and 2 optional). The survey consisted mostly of 5-point Likert scale rating questions and closed ended questions. However, open-ended questions were also asked to deepen some concepts and, where necessary, the option "other" was always available. Thus, the survey produced both quantitative and qualitative data. The participation to the study was fully voluntary and the collected data has been anonymized from the beginning and treated confidentially.

The questions were divided in 4 sections:

1. Background information: where participants were asked to indicate their nation, years of experience as AMEs and the class application they assess;
2. Individual experience with the mental health assessment: in terms of who performs the assessment, how it is performed (methods and instruments), if there are differences between initial and revalidation/renewal assessments, how often applications are referred to mental health specialists for examination and/or treatment, how often the AME consult both mental health specialists and peer support groups;
3. Gaps and needs: easiness to assess mental incapacitation risk level, to collect information about mental health during the examination, to access psychosocial history, to detect signs and symptoms of mental illness, to decide whether call for a mental health specialist advice; opinion on joint work with Peers and mental health specialists; the level of training received on mental illnesses' signs and symptoms knowledge and psychoactive knowledge;
4. Final remarks: two open-ended questions where participants were asked to identify challenges and improvements/recommendations for the mental health fitness assessment process.

The full questionnaire is available for consultation in **Annex 1**.

BACKGROUND (Section 1)

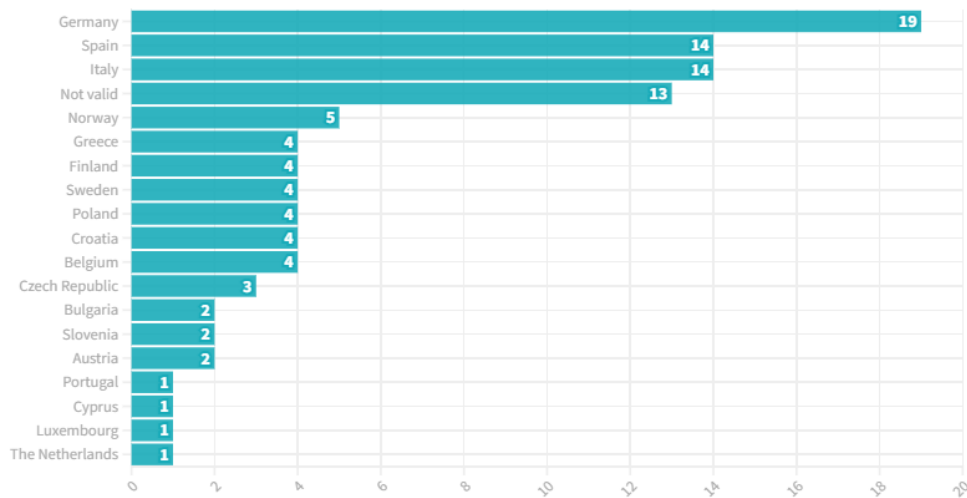
Nation (Q1)

A total of 102 individuals answered the survey. The main represented nations were Germany (N=19; 18.6%), Italy (N=14; 13.7%) and Spain (N=14; 13.7%). 13 answers were considered not valid answers since the nations was not specified (12.7%).

Nation	Frequency	Percentage
Italy	14	13.7%
Spain	14	13.7%
Greece	4	3.9%
Slovenia	2	2%
Belgium	4	3.9%
Portugal	1	1%
Cyprus	1	1%
Croatia	4	3.9%
Czech Republic	3	2.9%
Bulgaria	2	2%
Germany	19	18.6%
Austria	2	2%
Norway	5	4.9%
Sweden	4	3.9%
Finland	4	3.9%

Luxembourg	1	1%
Poland	4	3.9%
The Netherlands	1	1%
Not valid	13	12.7%
Total	102	100%

MESAFE - AMEs' Nation Frequency

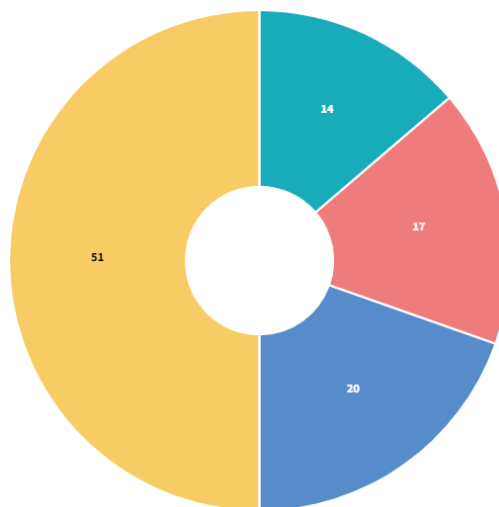


Years of experience (Q2)

Within the sample, the majority of AMEs have at least 15 years of experience (N=51; 50%), followed by those with 10-15 years of experience (N=20; 19.6%), between 5 and 10 years of experience (N=17; 16.7%) and less than 5 years of experience (N=14; 13.7%).

MESAFE- AMEs' years of experience

- Less than 5 years
- Between 5 and 10 years
- Between 10 and 15 years
- More than 15 years

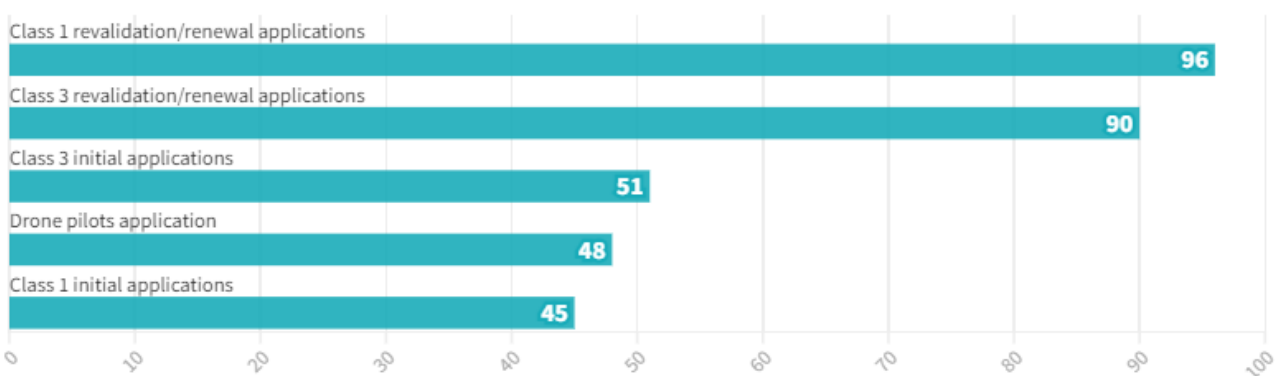


Classes assessed (Q3)

Of all the AMEs sample (N=102), 45 perform Class 1 initial applications, 51 perform Class 3 initial applications, 96 perform Class 1 revalidation/renewal applications, 90 Class 3 revalidation/renewal applications, and 48 perform Drone pilots' applications.

Although the participants are not representative of all the AMEs in the EU member states, major and relevant insights can be derived from their answers thanks to their valuable years of experience.

MESAFE - Class assessed by AMEs Frequency



INDIVIDUAL EXPERIENCE WITH THE MENTAL HEALTH ASSESSMENT (Section 2)

This section collected AMEs' individual experiences with the mental health assessment, both for initials and revalidation/renewals. Main findings as follows:

- AMEs' most used procedure is to assess mental fitness independently
- High heterogeneity in tests used both for the initial and revalidation/renewal assessments
- Most AMEs make use of MHS for psychopathological evaluation only if specific needs arise
- Almost no AMEs refer applicants to MHS for the treatment of any temporary or permanent psychological distress
- A considerable percentage of AMEs (36%) have never consulted peer support groups, and in general just over half of them have consulted them.

The following sections present these results in detail.

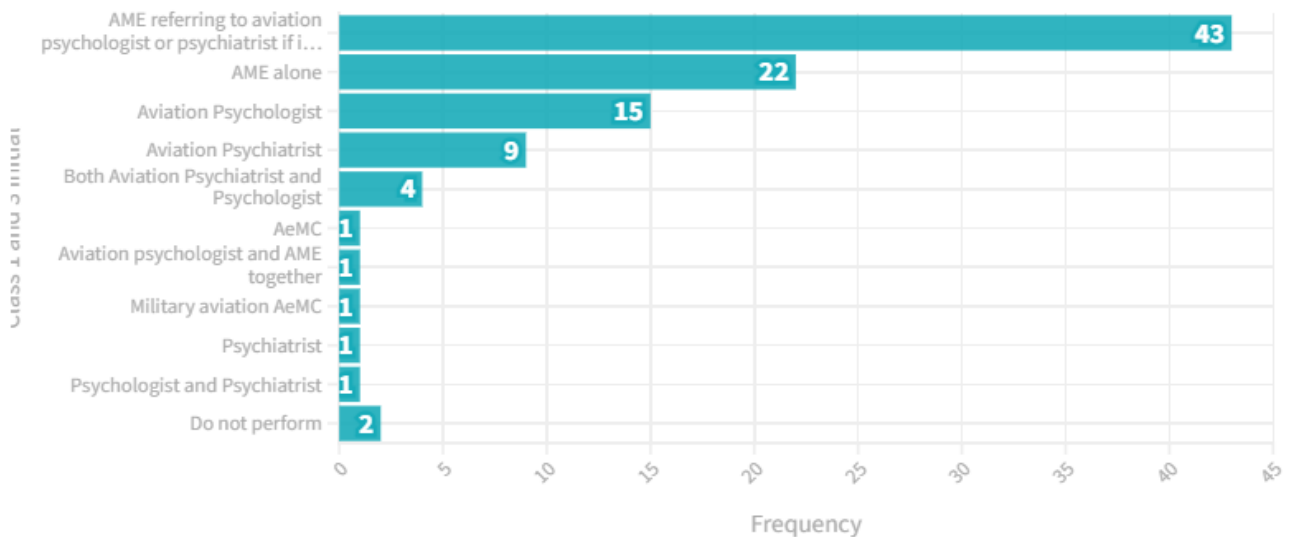
Who performs the mental health assessment for class 1 and 3 initial applications (Q4)

For the initial application, the most adopted procedure by AME is to refer to aviation psychologists or psychiatrists only if indicated (N=43; 42.2%), followed by the AME alone (N=22; 21.6%), the Aviation Psychologist (N=15; 14.7%), and the Aviation Psychiatrist (N=9; 8.8%). The remaining 13 subjects (12.9%) indicated both aviation psychiatrist and psychologist (N=4), AeMCs (N=1), Military aviation AeMCs (N=1), Aviation psychologist and AME together (N=1), psychiatrist (N=1), psychologist and psychiatrist (N=1) or do not perform it (N=2).

AMEs alone and those who consult psychologists and psychiatrists only if indicated represent 63.8% of the sample (N=65) and they would not refer to an aviation psychologist or psychiatrist on a normal basis.

The question does not allow to understand which criteria AMEs use for a consultation or for a referral to the mental health specialist. This data shows that AMEs diagnose mental health on their own, most of the time. Moreover, these results show an absence of standardized procedures to assess mental health and that mental health specialists are not yet properly involved in the assessments.

MESAFE - Mental health assessment class 1 and 3 initial ■ Frequency

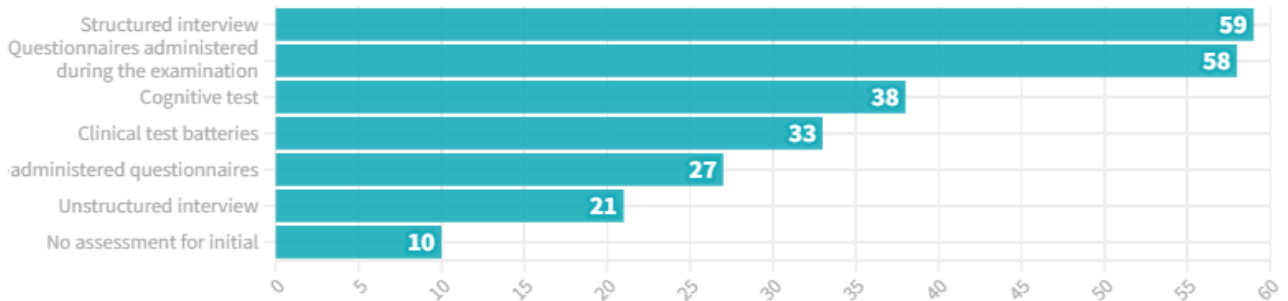


Mental health assessment for class 1 and 3 initial applications (Q5, Q5a)

This multiple answer question showed that the most common used techniques to assess the mental health at initial class assessments are structured interviews (N=59), followed by questionnaires administered during the examination (N=58), Cognitive tests (N=38), clinical test batteries (N=33), self-administered questionnaires (N=27) and unstructured interviews (N=21). 10 subjects claim not to assess mental health at initials.

This result shows the high variability in the assessments and how there are no standardized and sound techniques to be used. In fact, in question 5a, when asked to indicate the clinical test batteries used, a total of 39 different tests were indicated. The most frequently cited were the Minnesota Multiphasic Personality Inventory (MMPI, N=10), the *Evaluación Factorial de las Aptitudes Intelectuales* (EFAI-4; N=5), the Personality Assessment Inventory (PAI; N=4), the *Cuestionario Tea Clinico* (CTC; N=4), the Test of attention and concentration (D2; N=5), the *Aptitudes Mentales Primarias* (PMA-R; N=3), and the *Inventario de Respuestas de Afrontamiento* (CRI-A; N=3). The high frequency of Spanish questionnaires immediately catches the eye, suggesting their predisposition to the use of clinical test batteries, and that for AMEs native language is an important aspect that deserves to be investigated. The MMPI remains the most used.

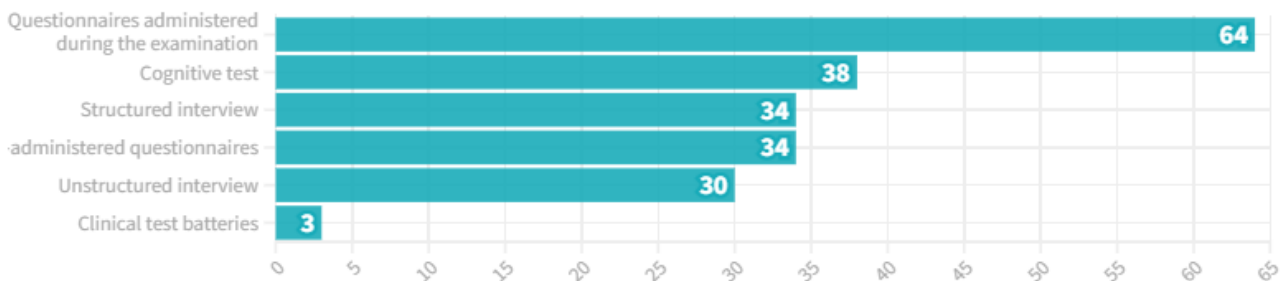
MESAFE - techniques to assess mental health - initial Frequency



Mental health assessment for class 1 and 3 revalidation/renewal applications (Q6, Q6a)

For what renewal and revalidation is concerned, AMEs as for the initial assessment mostly use non-validated questionnaires administered during the examination (N=64). Self-administered questionnaires (N=34), Structured (N=34) and unstructured (N=30) interviews are the other adopted options. Clinical test batteries are used only by 3 AMEs. This result confirms what has been found in Q5, to such an extent that the only cited test in question Q6a is, again, the MMPI. While to AMEs refer to use a questionnaire of the German LBA federal aviation agency.

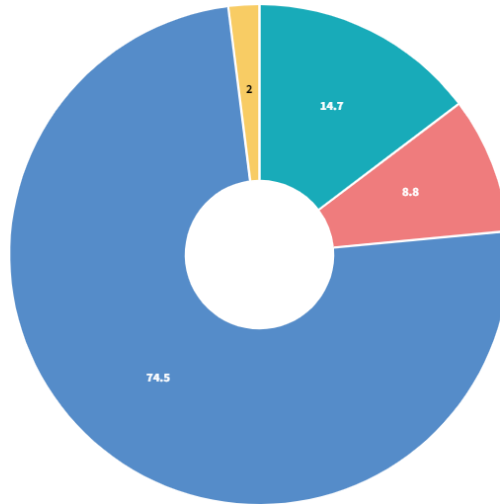
MESAFE - techniques to assess mental health - revalidation/renewal Frequency



Refer applicants to mental health specialists for a mental examination (Q7)

MESAFE - percentage of referral to MHS for mental examination

- At least once a month
- At least once a year
- Only whenever a particular need arises
- Never



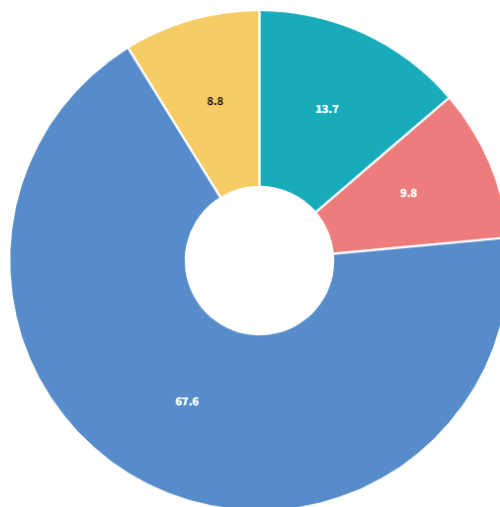
The majority of AMEs (N=76; 74.5%) refer mental health specialists to patients only when a particular need arises. 14.7% of AMEs (N=15) refer applicants at least once a month, 8.8% (N=9) of participants once a year, and 2% (N=2) never refer applicants.

Since 75% of the AMEs refer only when a particular need arises, there is a need to get insights on what “particular need” means for the AMEs and what conditions they consider referring applicants to mental health specialists.

Consult a mental health specialist for advice without referring the applicant (Q8)

MESAFE - percentage of consultation with a MHS for advice

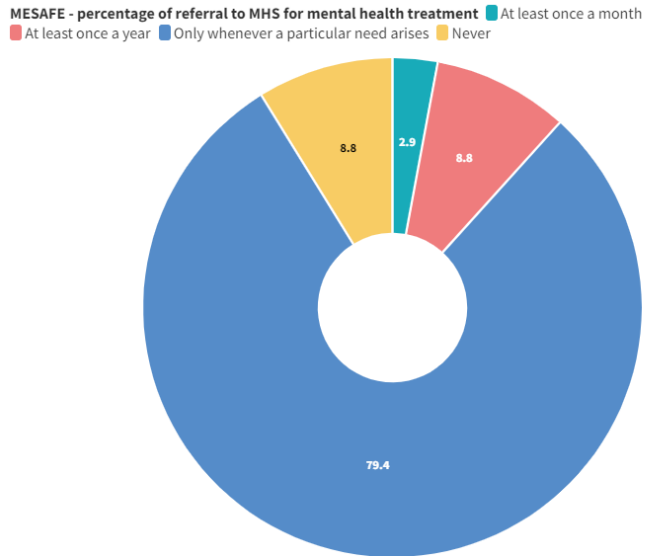
- At least once a month
- At least once a year
- Only whenever a particular need arises
- Never



The majority of AMEs (N=69; 67.6%) consult with mental health specialist only when a particular need arises, while 13.7% (N=14) at least once a month and 9.8% (N=10) once a year. The 8.8% (N=9) of AMEs never consult

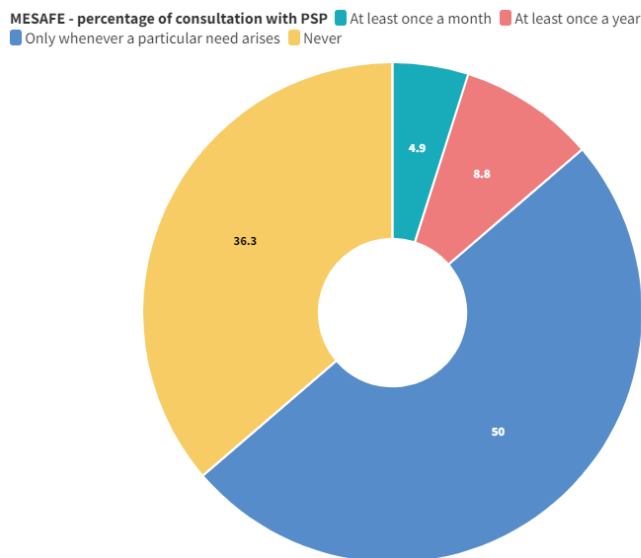
with mental health specialists. Again, clarifications would be needed regarding the “particular need” AMEs could face when assessing mental health.

Refer applicants to mental health specialists for a mental health treatment (Q9)



Regarding treatments, consistently with the previous answers, 79.4% of AMEs refer applicants to a mental health specialist only when a specific need arises (N=81), 2.9% once a month (N=3), 8.8% at least once a year (N=9) and 8.8% never (N=9).

Consult with peer support groups (Q10)



When it comes to peer support groups, the majority of AMEs either consult them only when a particular need arises (N=51; 50%) or never (N=37; 36.3%). Few AMEs consult them at least once a month (N=5; 4.9%) or at least once a year (N=9; 8.8%). Peer-to-peer is one of the main topics that will be addressed in MESAFE as one among the relevant safety nets to detect mental health issues, other than offering support and paths towards treatment.

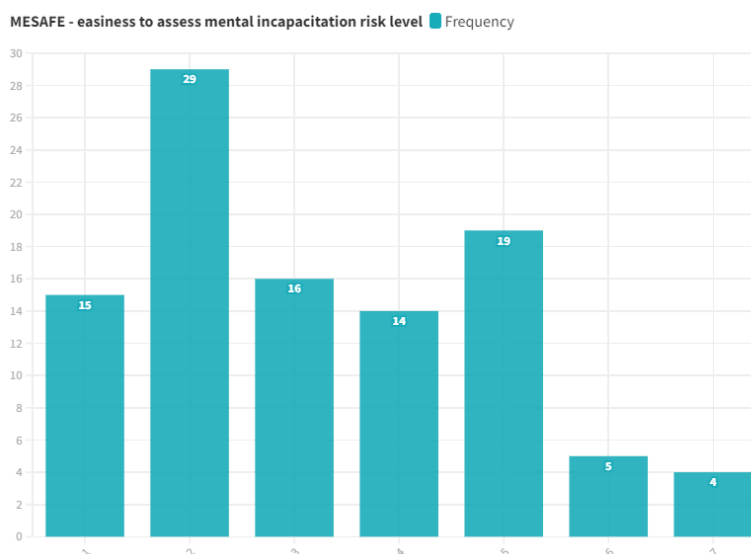
GAPS AND NEEDS (Section 3)

The questions of this section allowed to complement the results obtained in the previous questions. In particular, they allow to further investigate the AMEs' need to refer to mental health specialists and the need of this research to better investigate what criteria are used to call for their advice. In fact, while in question 4 AMEs declare they refer to MHS "only when indicated", only half of them find it easy to decide whether to call for a Mental Health Specialist's advice (Q11e). Main findings as follows:

- More than half of the respondents find it very difficult to assess the mental incapacitation risk level, based on medical records
- Only the 20% of the respondents find it easy to collect information about mental health during the aeromedical examination, and a considerable percentage (26%) doesn't have any opinion on how easy this is.
- almost half of the respondents don't have usable and effective criteria to decide whether to refer to the mental health specialists
- almost all the respondents agree that AMEs should work closely with MHS and Peer support groups

The following sections presents these results in detail.

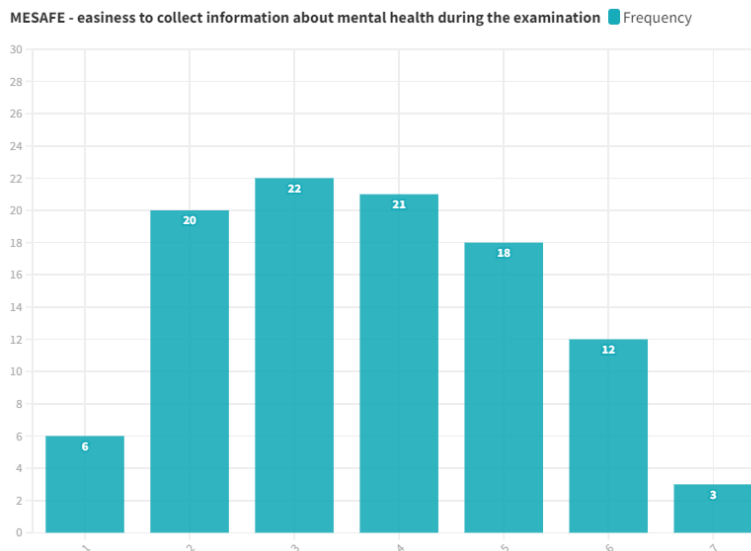
Easiness to assess the mental incapacitation risk level, based on medical records of a reported mental illness, without experts' advice (Q11a)



Putting together the Likert-point 1, 2 and 3, the majority of respondents find difficult to assess the mental incapacitation risk level, based on medical records of a reported mental illness, without experts' advice (N=60; 58.8%). The 13.7% neither agree or disagree, while, putting together the Likert-point 5, 6 and 7, the 27.4% of AMEs find the mental incapacitation risk level easy to assess (N=28).

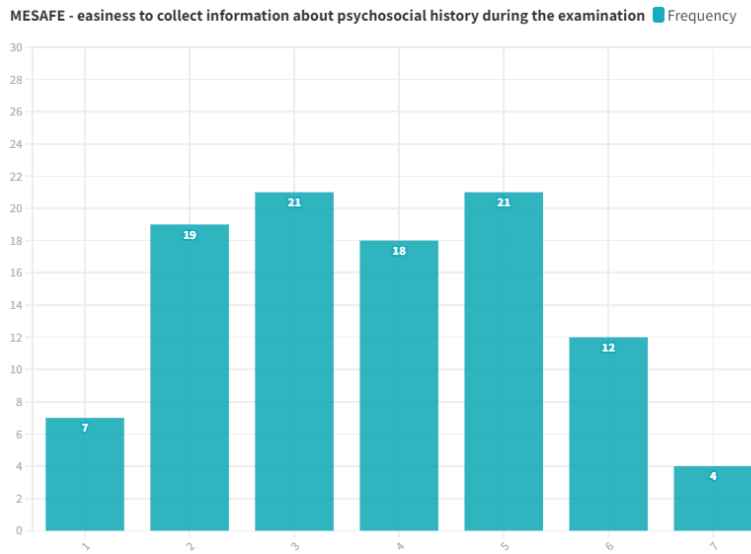
The incapacitation risk level results in being a hard concept to be assessed and individual misperception could influence its assessment. There is a concrete need to define the concept of incapacitation risk level based on mental health conditions and work characteristics proper to the individual (i.e., pilot, ATCO, drone pilot). Finally, this question, seen the difficulty in making an incapacitation risk assessment, complement and deepen the need for MHS consultancies.

Easiness to collect information about mental health during the aeromedical examination (Q11b)



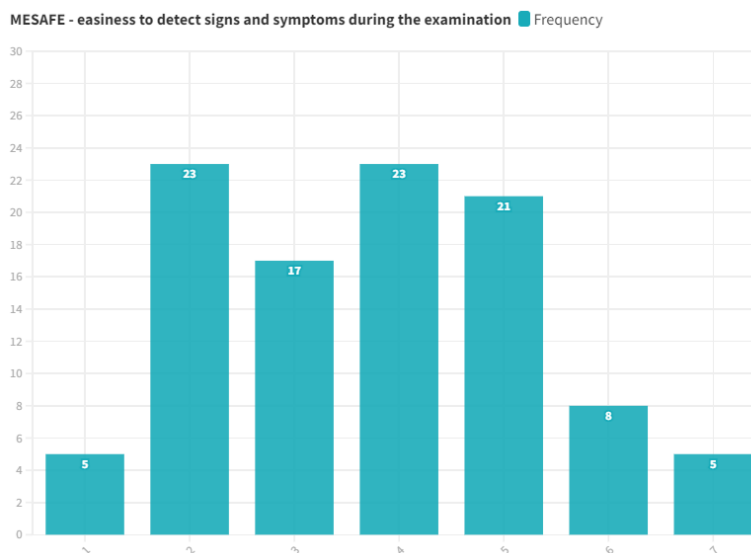
Regarding the collection of information about mental health during the aeromedical examination, 20.6% of AMEs remain neutral (N=21), while 47.1% find it difficult (N=48) and the 32.3% find it easy (N=31). This result is inconsistent with Q4 and Q8 where AMEs perceive themselves proficient and able to collect information about mental health without neither availing the mental health assessment to mental health specialists nor consulting them.

Easiness to collect information about psychosocial history during the aeromedical examination (Q11c)



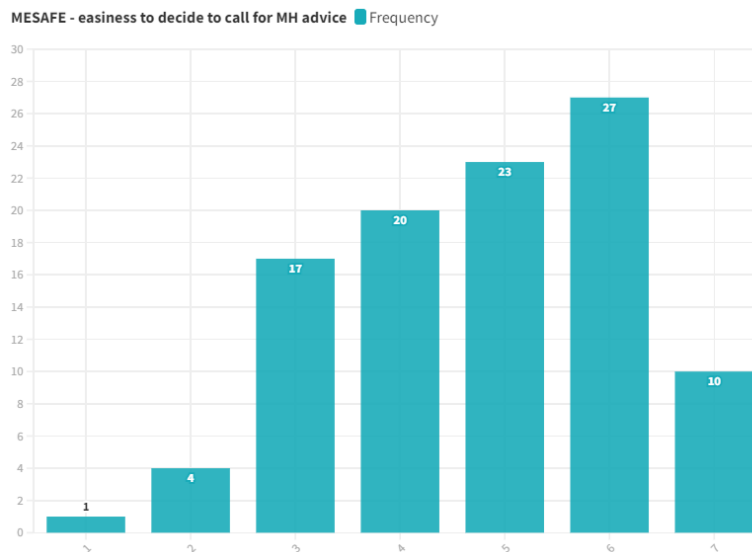
For what the collection of information about psychosocial history during the aeromedical examination is concerned, 17.6% of subjects remain neutral (N=18), while 46.1% find it difficult (N=47) and 36.3% find it easy (N=37). AMEs from different nations could have different access to medical history records and this information could explain why different AMEs have such different answers to this question. Psychosocial history information can be relevant to better contextualize the applicant history and prevent latent risks not expressed or acknowledged by the applicant.

Easiness to detect signs and symptoms of mental illness during the aeromedical examination (Q11d)



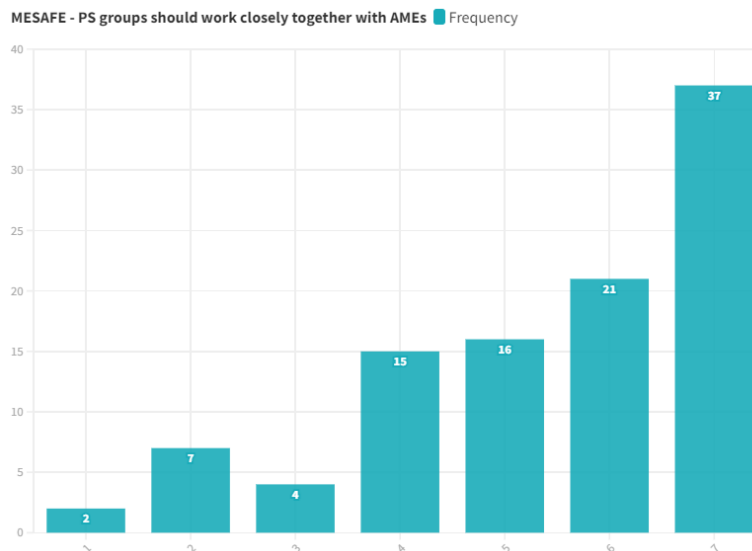
Regarding the detection of signs and symptoms of mental illness during the aeromedical examination, 22.5% of subjects remain neutral (N=23), while 44.1% find it difficult (N=45) and 33.3% find it easy (N=34).

Easiness to decide whether to call for a Mental Health Specialist’s advice (Q11e)



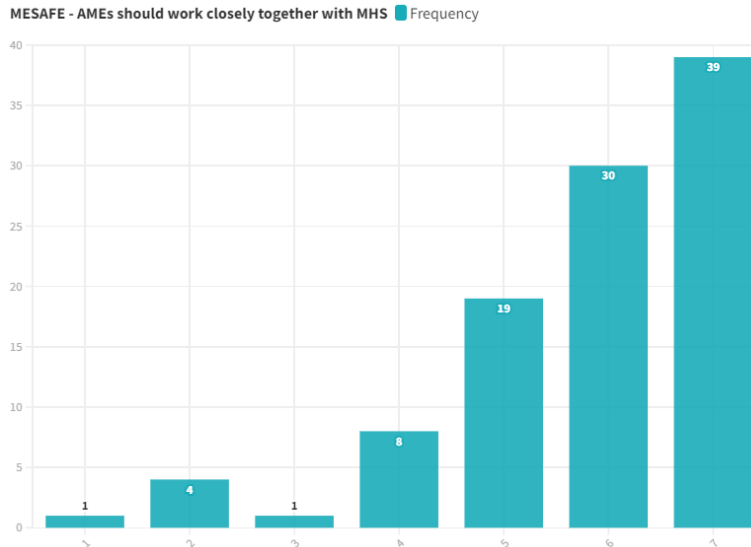
Regarding the decision to call for a mental health specialist advice, 19.6% of subjects remain neutral (N=20), few AMEs find it difficult (N=22; 21.6%) and 58.8% find it easy (N=60). Criterion that drives their decisions should be investigated, since in Q8 the majority of AMEs declared they consult mental health specialists only when necessary and thanks to this question (Q11e) it seems almost half of them do not have usable and effective criteria to decide whether to interact with the mental health specialists.

Peer support groups should work closely together with AMEs (Q11f)



Regarding the close collaboration of peer support groups with AMEs there is a large portion (N=74; 72.6%) of the sample that agrees on having a close collaboration with peers, 14.7% that remains neutral and an 12.8% that disagrees, of which just 1 subject completely disagree. The importance of peer support groups seems to be shared among almost all AMEs. In fact, from Q10, AMEs consult peer support groups only when a particular need arises (N=51; 50%) or never (N=37; 36.3%). The result from Q11f suggests the desire of AMEs to collaborate more with peers, probably because of the positive potential of this collaboration to prevent critical situations.

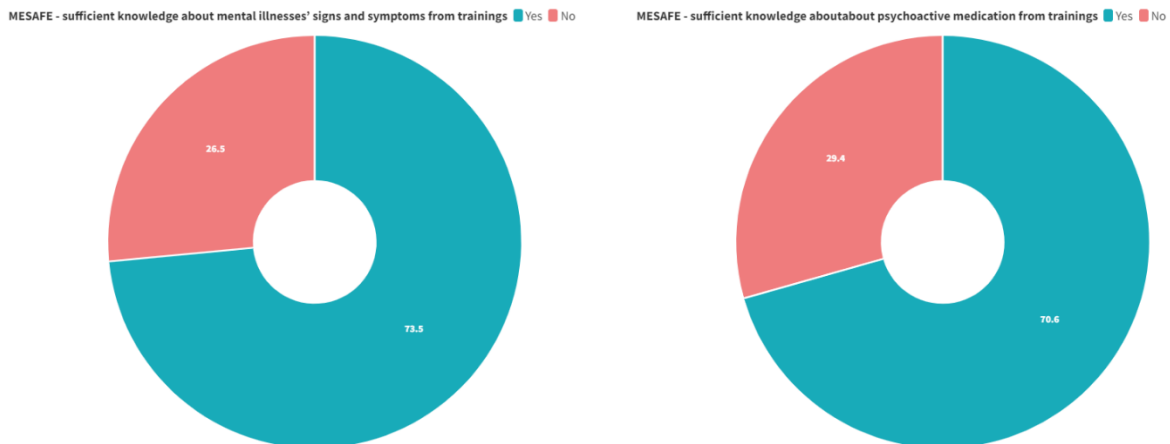
AMEs should work closely together with mental health specialists (11g)



Similarly, to the peer support groups, when it comes to work closely with mental health specialists, AMEs (86.2%) agree and completely agree in having a close collaboration with the mental health experts. With Q11f and Q11g, a relevant need to closely collaborate with other figures emerges. AMEs alone are not suited to deal and manage the mental health of applicants, since these are complex and arduous themes. Moreover, to date (Q7) AMEs (N=76; 74.5%) refer mental health specialists to patients and (Q8) they (N=69; 67.6%) consult with mental health specialist only when a particular need arises.

Training for mental illness signs and symptoms knowledge and for psychoactive medication knowledge (Q12, Q13)

When it comes to trainings, AMEs refer to have received proper knowledge both for mental illnesses' signs and symptoms (N=75; 73.5%) and psychoactive medication (N=72; 70.6%). This data is not totally in line with Q11d where 44% of AMEs found difficult to identify mental illness signs and symptoms.



FINAL REMARKS (Section 4)

Challenges in the mental fitness assessment (Q14)

AMEs were asked to identify the greatest challenges that they are facing in the mental fitness assessment both for initial applicants and revalidation/renewal applicants. More than 40 open-ended answers were collected and were categorized to obtain the following challenges:

- Applicants' opposing attitudes to disclose information
- Difficulties in identifying symptoms
- Lack of training on mental health
- Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA
- Absence of clear, robust, and validated questionnaires and interviews
- Impossibility to access the applicant psychosocial and medical history; no access to earlier AME's record
- Lack of cooperation among AMEs and mental health specialists
- Too little time allocated to assess mental fitness of applicants

Improvements to the mental fitness assessment process (Q15)

AMEs were also asked to suggest recommendations to improve the mental fitness assessment process both for initial applicants and revalidation/renewal applicants. Like Q14, almost 40 open-ended answers were collected and were synthesized to obtain the following recommendations:

- Multidisciplinary collaboration with mental health specialists and peer support groups
- Standardized questionnaires and interviews
- Possibility to access the applicant psychosocial and medical history
- Shared procedures among Member States
- Especially through EASA guidelines on how to perform the assessment
- Periodical evaluation performed by mental health specialists
- Trainings and educational material both for AMEs and mental health specialists on their collaboration

5.5. Take-away messages

ICAO regulation and guidelines give guidance on what the requirements for a pilot or ATCO are relating to flight safety. There is also a clause on prevention, albeit not necessarily applied to the individual medical examination. These points help the Aeromedical examiner to be aware of the importance of mental health issues. There is also a comprehensive list of different diagnoses and their evaluation.

However, there is little guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable. Most AMEs are not trained to interview in such a way as to pick up mental problems in an effective way. It may be argued that the mental health examination requirements give a list of unwanted conditions, a reason to avoid them, but no clear tools to find them in an environment where non-reporting of symptoms is probable.

The key challenges reported by AMEs with respect to the current procedures for the aeromedical mental fitness assessment, both for initial applicants and revalidation/renewal, are summarized as follows:

- Applicants’ opposing attitudes to disclose information
- Difficulties in identifying symptoms
- Insufficient of training on mental health
- Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA
- Absence of clear, robust, and validated questionnaires and interviews
- Impossibility to access the applicant psychosocial and medical history; no access to earlier AME’s record
- Insufficient of cooperation among AMEs and mental health specialists
- Too little time allocated to assess mental fitness of applicants

AMEs were also asked to suggest recommendations to improve the mental fitness assessment process both for initial applicants and revalidation/renewal. They are summarized as follows:

- Multidisciplinary collaboration with mental health specialists and peer support groups
- Standardized questionnaires and interviews
- Possibility to access the applicant psychosocial and medical history
- Shared procedures among Member States
- Especially through EASA guidelines on how to perform the assessment
- Periodical evaluation performed by mental health specialists
- Trainings and educational material both for AMEs and mental health specialists on their collaboration

For the scope of MESAFE, the following take-aways can be taken into consideration:

Take away ID	Take away message
5.1	There is little international guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable.
5.2	<p>The key challenges reported by AMEs with respect to the current procedures for the aeromedical mental fitness assessment, both for initial applicants and revalidation/renewal, are summarized as follows:</p> <ul style="list-style-type: none"> • Applicants’ opposing attitudes to disclose information • Difficulties in identifying symptoms • Insufficient training on mental health • Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA • Absence of clear, robust, and validated questionnaires and interviews

- Impossibility to access the applicant psychosocial and medical history; no access to earlier AME's record
- Insufficient cooperation among AMEs and mental health specialists
- Too little time allocated to assess mental fitness of applicants

5.3

Suggested recommendations to improve the mental fitness assessment process, both for initial applicants and revalidation/renewal, by AMEs:

- Multidisciplinary collaboration with mental health specialists and peer support groups
- Standardized questionnaires and interviews
- Possibility to access the applicant psychosocial and medical history
- Shared procedures among Member States
- Especially through EASA guidelines on how to perform the assessment
- Periodical evaluation performed by mental health specialists
- Trainings and educational material both for AMEs and mental health specialists on their collaboration

Table 9 - Take-away messages on the overview of mental health assessment methods and options currently used in aviation

6. Main findings

Personal factors such as fatigue, physical and mental health problems, life events and personal as well as organizational stressors may act as preconditions for unsafe acts.

Total in-flight, or on-duty, incapacitation of pilots, or ATCOs is a rare event which may, although probably infrequently, be caused by a mental health disorder.

The frequency of subtle incapacitation is unknown. However, subtle incapacitation may represent a significant threat to flight safety.

The results of studies of causes of unfitness of pilots and ATCOs provide convincing evidence that mental health disorders or problems contribute significantly to unfitness of pilots and ATCOs. Because the studies of causes of grounding of pilots include only recognized health disorders, it can be assumed that the actual prevalence of mental disorders in pilots and ATCOs may be higher, since it is unlikely that all mental disorders are diagnosed and recognized.

These conclusions emphasize that mental health disorders or problems will play an important role in aeromedical determination of pilots' and ATCO's job fitness. As not all mental health problems may be identified by AMEs/AeMCs, mental health problems can lead to total and subtle incapacitation.

Not all mental disorders are long-term, and not all mental disorders lead to loss of medical certification.

To make decisions about the certification of mental fitness, it is important to evaluate:

- The presence of a mental disorder and potential comorbidities in the history of the applicant;
- The presence of a mental disorders and potential comorbidities in the current timeframe;
- The Incapacitation risk level (including an evaluation of the impairment in performing flight duties and of the level of social dangerousness).
- Personal protective and risk factors (psychosocial circumstances, physical health, etc.)

Although questionnaires are essential in mental healthcare, using them in the medical screening of aviation professionals is difficult. On the one side there is the risk of false-positive findings when the wrong questionnaire is being used (for example a questionnaire on personality traits for detecting a depressive disorder), on the other side is the risk of false-negative findings due to underreporting of mental complaints. Very few dedicated and validated questionnaires for pilots, ATCO's and other aviation professionals exist. Valid pilot and ATCS norms are available for the MMPI-2. Still tests and questionnaires might be useful to support the part of the interview addressing mental complaints. Developments with regards to smartphone and wearable technology are worth to be followed critically.

The duration of the treatment and frequency of follow-up measures is a highly individual decision which depends on the characteristics of the patient (e.g., previous mental disorders, availability of a good support system), the characteristics of the disorder (severity, risks, comorbidity), the treatment (long-term CBT is highly uncommon, long-term pharmacotherapy is not) and the personal preferences of the patient and the psychiatrist/psychotherapist.

Scientific data support the generally accepted opinion that the risk of mild cognitive impairment increases with age, although there is good evidence suggesting that declines in cognitive abilities between the end of the fourth decade and age 65 are small. There are currently no cognitive tests available that are suited to predict flight or ATC performance or to identify subtle impairments in cognitive functioning of asymptomatic pilots or ATCOs.

It is not recommended to use neurocognitive tests to identify MCI for the aeromedical screening of asymptomatic pilots and ATCOs. To detect possible neurocognitive shortcomings the recommended

aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses. It is therefore important that the AME is informed about the results of the simulator, line, and ATC checks.

The safety assumption according to which an applicant suffering from a mental health disorder will seek help and self-declare her/his condition might fail.

ICAO regulation and guidelines give guidance on what the requirements for a pilot or ATCO are relating to flight safety. There is also a clause on prevention, albeit not necessarily applied to the individual medical examination. These points help the Aeromedical examiner to be aware of the importance of mental health issues. There is also a comprehensive list of different diagnoses and their evaluation.

However, there is little guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable. Most AMEs are not trained to interview in such a way as to pick up mental problems in an effective way. It may be argued that the mental health examination requirements give a list of unwanted conditions, a reason to avoid them, but no clear tools to find them in an environment where non-reporting of symptoms is probable.

The key challenges reported by AMEs with respect to the current procedures for the aeromedical mental fitness assessment, both for initial applicants and revalidation/renewal, are summarized as follows:

- Applicants’ opposing attitudes to disclose information
- Difficulties in identifying symptoms
- Lack of training on mental health
- Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA
- Absence of clear, robust, and validated questionnaires and interviews
- Impossibility to access the applicant psychosocial and medical history; no access to earlier AME’s record
- Lack of cooperation among AMEs and mental health specialists
- Too little time allocated to assess mental fitness of applicants

AMEs were also asked to suggest recommendations to improve the mental fitness assessment process both for initial applicants and revalidation/renewal. They are summarized as follows:

- Multidisciplinary collaboration with mental health specialists and peer support groups
- Standardized questionnaires and interviews
- Possibility to access the applicant psychosocial and medical history
- Shared procedures among Member States
- Especially through EASA guidelines on how to perform the assessment
- Periodical evaluation performed by mental health specialists
- Trainings and educational material both for AMEs and mental health specialists on their collaboration

Key take-aways are summarized in Table 10.

Take away ID	Take away message
2.1	Mental health problems can lead to total and subtle incapacitation
3.1	More than 450 mental disorders exist. They are not all the same. Not all mental disorders lead to loss of medical fitness certification.
3.2	Not all mental disorders are long-term. Many of them are short-term.
3.3	Not all mental disorders are featured by abnormal, unpredictable and deviant behaviours. Some of them are featured by maladaptive psychophysiological reactions to life changing events and stressors.

3.4	Life changing events and work-related stressors have an impact on mental health.
3.5	To make decisions about the certification of mental fitness in case a mental disorder is present, it is important to evaluate: <ul style="list-style-type: none"> • Comorbidities • Incapacitation risk (i.e., impairment in performing flight duties) • The level of social dangerousness associated to that condition • The presence of life changing events • Risks related to the treatment – if that leads to suicidal ideation, depression or to slow reaction times that may be a risk for flight safety even if the condition itself is not anymore. • The risk of relapse after recovery
3.6	Many mental disorders impede the ability to concentrate and cause sleeping difficulties, which is much more frequent than suicidal behaviour, and also an important risk for flight safety.
3.7	The safety assumption according to which an applicant suffering from a mental health disorder will seek help and self-declare her/his condition might fail. Indeed, for many mental disorders denial is a relatively frequent symptom leading to a reduced rate of self-declaration. Feelings of shame and guilt can also reduce the rate of self-declaration.
3.8	The cultural and organizational environment which individuals belong to have an impact on their possibility and willingness to self-declare mental health issues. A supportive and just-culture oriented environment towards mental health and psychological discomfort might help self-declaration of possible mental issues before they escalate into negative effects for safety and for the health of people suffering from them.
4.1	Psychodiagnostic tests taken as standalone assessment measures do not enable a psychological diagnosis. Still tests and questionnaires might be useful to support the part of the interview addressing mental complaints.
4.2	Very few dedicated and validated tests and questionnaires for pilots, ATCO's and other aviation professionals exist. Valid pilot and ATCS norms are available for the MMPI-2.
4.3	Personality tests cannot be used for diagnosing mental disorders.
4.4	Tests and questionnaires hardly predict the mental health status in between two medical examinations.
4.5	Assessing the risk of suicide and other risky behaviours is generally assumed to be based on two major principles: the clinical impression and quality of the contact with the patient, and epidemiological risk factors.
4.6	It is not possible to assess the mild cognitive decline solely on the basis of the score achieved in a neuropsychological test, but the results of such a test or battery of tests can provide useful background information in the process of deciding on the medical certification of an individual who has been referred by the AME/AeMC for a specialist evaluation.
4.7	To detect possible neurocognitive shortcomings the recommended aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses.
5.1	There is little international guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable.
5.2	The key challenges reported by AMEs with respect to the current procedures for the aeromedical mental fitness assessment, both for initial applicants and revalidation/renewal, are summarized as follows:

	<ul style="list-style-type: none"> • Applicants’ opposing attitudes to disclose information • Difficulties in identifying symptoms • Insufficient training on mental health • Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA • Absence of clear, robust, and validated questionnaires and interviews • Impossibility to access the applicant psychosocial and medical history; no access to earlier AME’s record • Insufficient cooperation among AMEs and mental health specialists • Too little time allocated to assess mental fitness of applicants
5.3	<p>Suggested recommendations to improve the mental fitness assessment process, both for initial applicants and revalidation/renewal, by AMEs:</p> <ul style="list-style-type: none"> • Multidisciplinary collaboration with mental health specialists and peer support groups • Standardized questionnaires and interviews • Possibility to access the applicant psychosocial and medical history • Shared procedures among Member States • Especially through EASA guidelines on how to perform the assessment • Periodical evaluation performed by mental health specialists • Trainings and educational material both for AMEs and mental health specialists on their collaboration

Table 10 - Take-away messages on the review of diagnostic measures

Take-aways will be followed up in the next tasks of MESAFE, where they will be translated into recommendations. A list of key issues that MESAFE will follow-up and translate into guidelines in the next phases of the project include, but is not limited to, the following:

Take away ID	Take away message	Key issues to follow-up in the next tasks of the MESAFE project
2.1	Mental health problems can lead to total and subtle incapacitation	Training on mental health for AMEs and peers
3.1	More than 450 mental disorders exist. They are not all the same. Not all mental disorders lead to loss of medical fitness certification.	Training on mental health for AMEs (customised training based on the needs and specialization of the AMEs?) Awareness campaign on mental health and issues Training on how AMEs work for peer support groups
3.2	Not all mental disorders are long-term. Many of them are short-term.	Training on mental health for AMEs (customised training based on the needs and specialization of the AMEs?) Awareness campaign on mental health and issues

		Training on mental issues signs and symptoms detection for peer support groups
3.3	Not all mental disorders are featured by abnormal, unpredictable and deviant behaviours. Some of them are featured by maladaptive psychophysiological reactions to life changing events and stressors.	Awareness campaign on mental health and issues Training on mental issues signs and symptoms detection for peer support groups
3.4	Life changing events and work-related stressors have an impact on mental health.	Assessment of life changing events in the aeromedical mental health examination
3.5	To make decisions about the certification of mental fitness in case a mental disorder is present, it is important to evaluate: <ul style="list-style-type: none"> • Comorbidities • Incapacitation risk (i.e., impairment in performing flight duties) • The level of social dangerousness associated to that condition • The presence of life changing events • Risks related to the treatment – if that leads to suicidal ideation, depression or to slow reaction times that may be a risk for flight safety even if the condition itself is not anymore. • The risk of relapse after recovery 	Involvement of Aviation Psychologists and Psychiatrists in the process
3.6	Many mental disorders impede the ability to concentrate and cause sleeping difficulties, which is much more frequent than suicidal behaviour, and also an important risk for flight safety.	Involvement of Aviation Psychologists and Psychiatrists in the process
3.7	The safety assumption according to which an applicant suffering from a mental health disorder will seek help and self-declare her/his condition might fail. Indeed, for many mental disorders denial in a relatively frequent symptom leading to a reduced rate of self-declaration. Feelings of shame and guilt can also reduce the rate of self-declaration.	Close cooperation AMEs/PSP/MHP Training on applicants' history taking
3.8	The cultural and organizational environment which individuals belong to have an impact on their possibility and willingness to self-declare mental health issues. A supportive and just-culture oriented environment towards mental health and psychological discomfort might help self-declaration of possible mental issues before they escalate into negative effects for safety and for the health of people suffering from them.	Awareness campaigns on mental health and issues
4.1	Psychodiagnostic tests taken as standalone assessment measures do not enable a psychological diagnosis. Still tests and questionnaires might be useful to support the part of the interview addressing mental complaints.	Development of Aviation Mental Health questionnaires and interviews (EASA level? NAA level?)
4.2	Very few dedicated and validated tests and questionnaires for pilots, ATCO's and other aviation professionals exist. Valid pilot and ATCS norms are available for the MMPI-2.	Training targeted to AMEs on how to complement the results of psychodiagnostics tests with the history taking and interview
4.3	Personality tests cannot be used for diagnosing mental disorders.	Training targeted to AMEs
4.4	Tests and questionnaires hardly predict the mental health status in between two medical examinations.	Involvement of peer support groups

		Training targeted to peers on how to detect signs and symptoms of mental health issues
4.5	Assessing the risk of suicide and other risky behaviours is generally assumed to be based on two major principles: the clinical impression and quality of the contact with the patient, and epidemiological risk factors.	Training targeted to AMEs on mental health and effective communication to build trust
4.6	It is not possible to assess the mild cognitive decline solely on the basis of the score achieved in a neuropsychological test, but the results of such a test or battery of tests can provide useful background information in the process of deciding on the medical certification of an individual who has been referred by the AME/AeMC for a specialist evaluation.	Access for AMEs to simulator and operations reports from a specific applicant
4.7	To detect possible neurocognitive shortcomings the recommended aeromedical examination should be based on the two most important pillars: 1) the AME interview (history taking), and 2) Operational information: occupational history and functioning of the pilot or ATCO in the event of incidents and accidents and during simulator sessions, proficiency checks and training courses.	Access for AMEs to simulator and operations reports from a specific applicant
5.1	There is little international guidance on how the screening examinations may be done in an environment where non-reporting of symptoms is probable.	Awareness campaign Training for AMEs on effective communication to build trust Close cooperation Ames/PSP/MHS Training for peers on how AMEs work Training for peers on how to detect signs and symptoms of mental health issues
5.2	The key challenges reported by AMEs with respect to the current procedures for the aeromedical mental fitness assessment, both for initial applicants and revalidation/renewal, are summarized as follows: <ul style="list-style-type: none"> • Applicants' opposing attitudes to disclose information • Difficulties in identifying symptoms • Insufficient training on mental health • Lack of legal definition or basis of implementation Mental Health Assessment in the different CAA • Absence of clear, robust, and validated questionnaires and interviews • Impossibility to access the applicant psychosocial and medical history; no access to earlier AME's record • Insufficient cooperation among AMEs and mental health specialists • Too little time allocated to assess mental fitness of applicants 	All the aforementioned
5.3	Suggested recommendations to improve the mental fitness assessment process, both for initial applicants and revalidation/renewal, by AMEs: <ul style="list-style-type: none"> • Multidisciplinary collaboration with mental health specialists and peer support groups • Standardized questionnaires and interviews 	All the aforementioned

- Possibility to access the applicant psychosocial and medical history
- Shared procedures among Member States
- Especially through EASA guidelines on how to perform the assessment
- Periodical evaluation performed by mental health specialists
- Trainings and educational material both for AMEs and mental health specialists on their collaboration

Table 11 - List of key issues that MESAFE will follow-up in the next phases of the project

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8. Annex 1. The questionnaire used for the online survey

30/09/22, 16:12

Mental Health assessment: a survey to collect the AMEs and aeromedical assessors' point of view

Mental Health assessment: a survey to collect the AMEs and aeromedical assessors' point of view

About the project

This survey is being conducted as part of the MESAFE project, funded by the European Union's Horizon Europe research and innovation programme and managed by EASA. MESAFE assesses new medical developments for the early diagnosis as well as treatment of mental health conditions which could pose a safety risk for aviation and would consequently lead to pilot and air traffic controller's (ATCOs) unfitness. In particular, the project is targeting AMEs, aeromedical assessors and aeromedical staff working in AeMCs. By identifying the needs of the stakeholders, MESAFE will develop evidence-based recommendations for mental health assessment methods suitable for aeromedical fitness assessments.

For more information: <https://www.easa.europa.eu/research-projects/mesafe-mental-health>

About this survey

As part of this research, the MESAFE project aims to understand current gaps and needs with respect to the mental fitness assessment process from the point of view of AMEs and aeromedical assessors. The main objectives of this survey are to:

- Identify misalignments between the knowledge, skills and competencies obtained during education/training and the knowledge, skills and competencies required for a satisfactory aeromedical examination.
- Determine the factors that obstruct or facilitate the assessment of the mental health of applicants.

The survey will take approximately 15 minutes to complete (23 questions in total).

About your participation

Your participation in this study is fully voluntary and all the collected data will be anonymized and treated confidentially. The research outputs resulting from this work will only include collated data, without the possibility for anyone to identify individual answers. The survey does not require you to provide any information that could identify you personally (e.g., your name). If, whilst completing the survey, you wish to withdraw, please just close the browser without submitting your answers.

By proceeding with this survey you confirm that you are at least 18 years old, have read and understood the above information, agree to participate in this research study and agree that your data will be included in our analysis and any research publications resulting from it.

If you have any questions or would like to hear about the MESAFE project results, please contact Paola Tomasello at paola.tomasello@dblue.it.

https://docs.google.com/forms/d/1-OCxdTbG0cs5saXkkOKZ6NDACIsaL47m_RoPcpeBg/edit

1/9



Thank you for your participation in this survey.
The MESAFE Project Team

* Required

General Information

1. 1. What member state do you work in, as AME or aeromedical assessor? *

2. 2. How many years of experience do you have as AME/aeromedical assessor? *

Mark only one oval.

- Less than 5 years
- Between 5 and 10 years
- Between 10 and 15 years
- More than 15 years

3. 3. Currently, do you assess (select all that apply): *

Check all that apply.

- class 1 initial applications
- class 3 initial applications
- class 1 revalidation/renewal applications
- class 3 revalidation/renewal applications
- drone pilots applications

Your current experience with the mental health assessment

4. 4. In your current experience, who performs the mental health assessment for class 1 and 3 initial applications: *

Mark only one oval.

- The AME alone
- The AME, referring to aviation psychologist or psychiatrist if indicated
- Aviation Psychologist
- Aviation Psychiatrist
- Other: _____

5. 5. In your current experience, how is the mental health assessment for class 1 and 3 initial applications performed (select all that apply): *

Check all that apply.

- Self-administered questionnaire(s)
- Questionnaire(s) administered during the examination
- Structured interview (whether or not using a written checklist)
- Unstructured interview
- Cognitive test(s)
- Clinical test batteries
- Other: _____

6. 5a. If you selected clinical test batteries in the previous question, please specify which ones:

7. 6. In your current experience, how is the mental health assessment for class 1 *
and 3 revalidation/renewal applications performed (select all that apply)

Check all that apply.

- Self-administered questionnaire(s)
- Questionnaire(s) administered during the examination
- Structured interview (whether or not using a written checklist)
- Unstructured interview
- Cognitive test(s)
- Clinical test batteries
- No mental health assessment is performed for class 1 and 3 revalidation/renewal applications
- Other: _____

8. 6a. If you selected clinical test batteries in the previous question, please specify which ones:

9. 7. How often do you refer applicants to mental health specialists for a mental *
examination?

Mark only one oval.

- At least once a month
- At least once a year
- Only whenever a particular need arises
- Never

10. 8. How often do you consult a mental health specialist for advice without referring the applicant? *

Mark only one oval.

- At least once a month
- At least once a year
- Only whenever a particular need arises
- Never

11. 9. How often do you refer applicants to mental health specialists for a mental health treatment? *

Mark only one oval.

- At least once a month
- At least once a year
- Only whenever a particular need arises
- Never

12. 10. How often do you consult with peer support groups? *

Mark only one oval.

- At least once a month
- At least once a year
- Only whenever a particular need arises
- Never

Gaps and needs

On a scale of 1-7, how much do you agree with the following statements?

13. 11a. It is easy to assess the mental incapacitation risk level, based on medical records of a reported mental illness, without experts' advice. *

Mark only one oval.

1 2 3 4 5 6 7

Totally disagree Completely agree

14. 11b. It is easy to collect information about mental health during the aeromedical examination. *

Mark only one oval.

1 2 3 4 5 6 7

Totally disagree Completely agree

15. 11c. It is easy to collect information about psychosocial history during the aeromedical examination. *

Mark only one oval.

1 2 3 4 5 6 7

Totally disagree Completely agree

16. 11d. It is easy to detect signs and symptoms of mental illness during the aeromedical examination. *

Mark only one oval.

1 2 3 4 5 6 7

Totally disagree Completely agree

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Mental Health assessment: a survey to collect the AMEs and aeromedical assessors' point of view

17. 11e. It is easy to decide whether to call for a Mental Health Specialist's advice. *

Mark only one oval.

	1	2	3	4	5	6	7	
Totally disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

18. 11f. Peer support groups should work closely together with AMEs. *

Mark only one oval.

	1	2	3	4	5	6	7	
Totally disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

19. 11g. AMEs should work closely together with mental health specialists. *

Mark only one oval.

	1	2	3	4	5	6	7	
Totally disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely agree

20. 12. Has the training you received provided sufficient knowledge about mental illnesses' signs and symptoms? *

Mark only one oval.

- Yes
 No

21. 13. Has the training you received provided sufficient knowledge about psychoactive medication? *

Mark only one oval.

Yes

No

Final remarks

22. 14. Currently, what are the challenges preventing a sound mental fitness assessment? *

23. 15. What would you recommend to improve the mental fitness assessment process? *

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Thanks for
your
participation!

Please click on the button below to submit your replies!

For more information about the project:

<https://www.easa.europa.eu/research-projects/mesafe-mental-health>

If you have any questions or would like to hear about the MESAFE project results, please contact Paola Tomasello at paola.tomasello@dblue.it

Thank you for your participation!
The MESAFE Project Team

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