



# 69<sup>th</sup> International Congress of Aviation and Space Medicine

Under the auspices of the International Academy of Aviation and Space Medicine



## Development of a brief **MENTAL HEALTH** SCREENING CHECK-LIST

*LTC Pierpaolo Calanna, CPT Christian Piazza, CPT Raffaele Erario  
Italian Air Force - Aerospace Medicine Institute · Milan*





# 01. Introduction

- **Aviation personnel are responsible for the safe carriage of thousands of people each day** and need to be physically and mentally fit to perform the job.
- It is important to **regularly evaluate the mental health of aviation personnel** due to the stressors they face that can increase the risk of developing a mental health disorder.
- Currently, **Aeromedical Centers (AeMCs) and aeromedical examiners (AMEs)** hold the responsibility of identifying cognitive and emotional issues in aviation personnel.

## 02. Introduction

- Performing **extensive psychiatric evaluations** as a regular part of aeromedical assessments is **neither productive nor cost-effective**.
- However, it is recommended that AMEs **pay more attention to common mental health disorders (CMDs)** as well as life stressors that can affect flight performance and flight safety.
- The use of **minimally intrusive, easy-to-use mental health check-lists** may help AMEs in the decision making process.

### 03. Objective of the present study

- Develop a **Mental Health Screening Checklist (MHSC)** to be used by AMEs as a brief screening tool.
- Devise an **automated strategy** to that can **identify** individuals with **moderate-to-high risk profiles** who may require professional help from mental health experts.

## 04. MHSC › development principles

- Should be **short**, yet exhaustive in the coverage of CMDs  
*max 3 minutes to complete*
- Should use a **simple and direct** language  
*reduce misunderstandings, increase accountability of responses*
- Should use a **limited number** of response options  
*decrease the cognitive burden of respondents' decision making*

## 05. MHSC › how we used the checklist

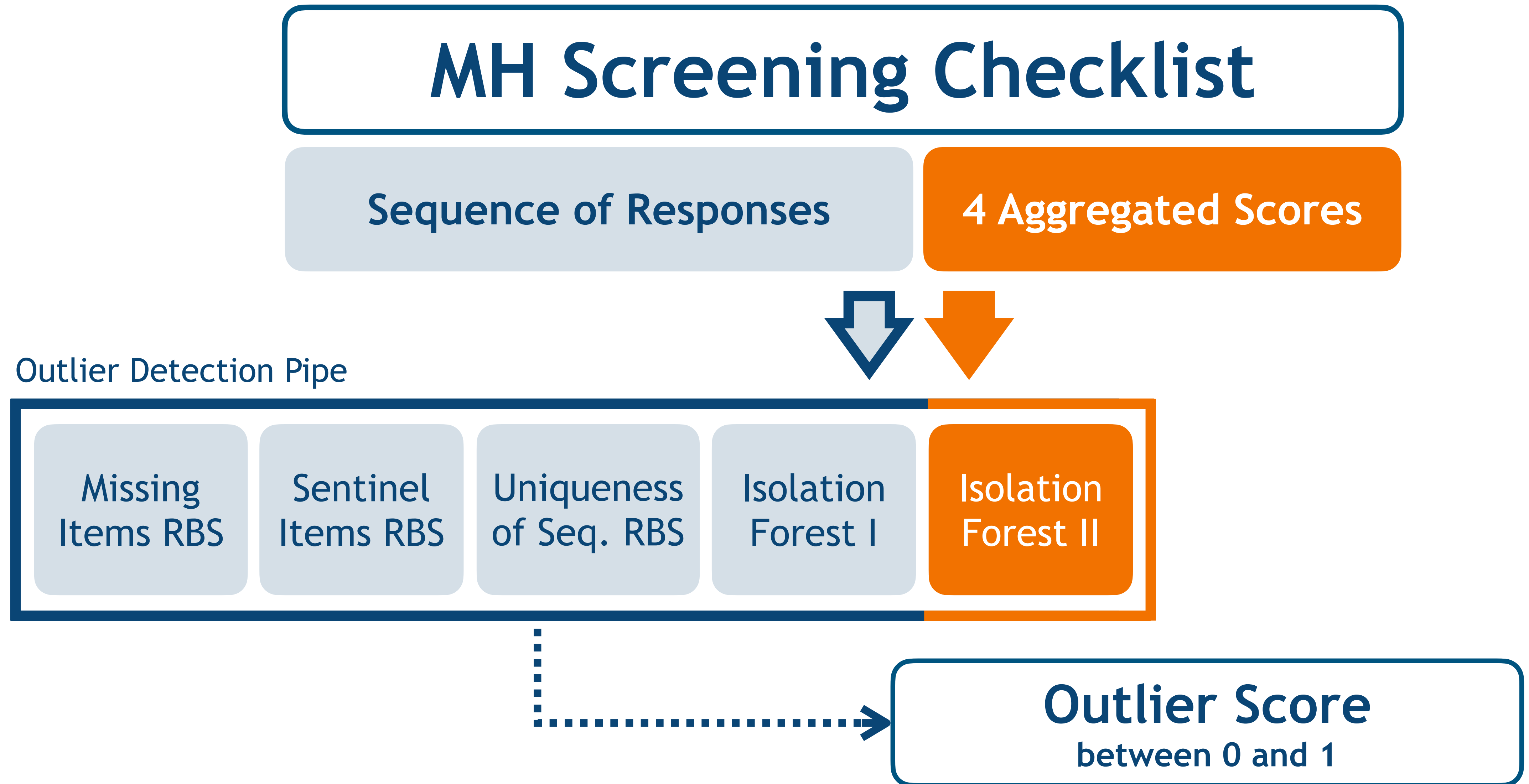
- We developed and administered our checklist to the research sample.
- We implemented an automated “outlier detection pipe” in order to identify those profiles that significantly departed from the majority of the other ones.
  - An outlier profile contains responses that fall outside the typical range.
  - Individuals with an outlier profile may be referred to a mental health specialist.

06. MHSC › areas of inquiry

Area	Items	Response Options
Fatigue, Stress	2	No · Some · A lot of problems
Maladaptive Personality	4	No · Some · A lot of problems
Life Concerns	4	No · Some · A lot of problems
Relevant Events, Conditions	5	Yes · No
NRG Drinks, Alcohol, Tobacco, Drugs	5	Never · Occasionally · Weekly · Daily
Perceived Psychological Well-Being	1	10-points scale, from low to high

**Note** items are grouped in 4 parts (I, II, III and IV)

## 07. MHSC outlier detection pipe › visual representation





## 08. MHSC outlier detection pipe › description of pipe's steps

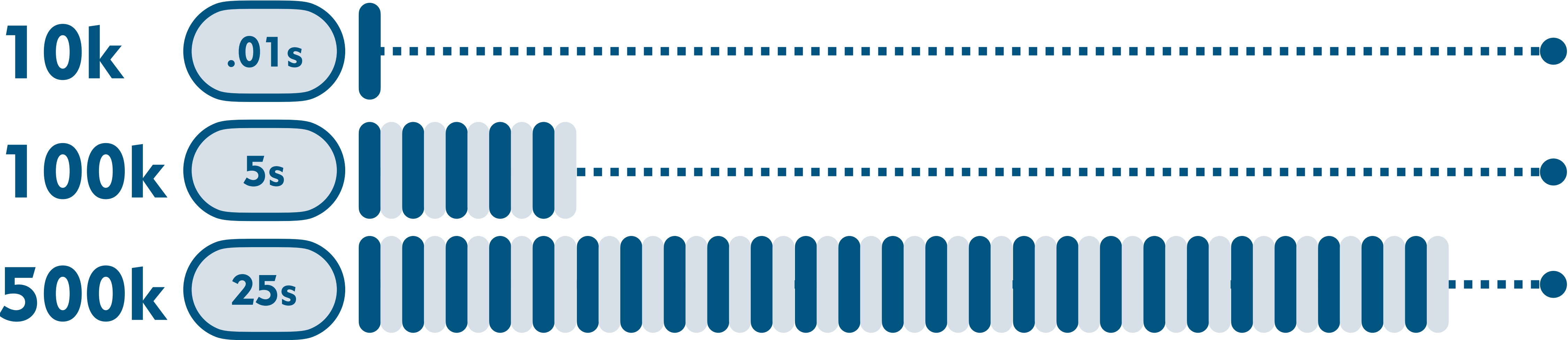
Step	Type	Description
Missing items	<b>RBS</b>	No missing items are admitted
Sentinel items	<b>RBS</b>	Negative emotionality · Aggressiveness towards others or self · Use of drugs · Psy Treatments · Legal issues
Uniqueness of sequence	<b>RBS</b>	Uniqueness of MHSC items sequence (part I & III)
Isolation forest I	<b>MLA</b>	<i>Outlierness</i> of MHSC items sequence (All parts)
Isolation forest II	<b>MLA</b>	<i>Outlierness</i> of MHSC aggregated scores

**RBS** = Rule-Based System · **MLA** = Machine Learning Algorithm

## 09. Rule-Based Systems and Isolation Forests › few explanatory words

- A **rule-based system** is a type of expert system that uses a set of **predefined rules to interact with data and make decisions**. These rules are derived from the knowledge of human experts in a particular domain.
- An **isolation forest** is an **unsupervised machine learning algorithm that uses an ensemble of binary decision trees to identify outliers**. Simplifying a bit, we can say that an isolation forest:
  - grows each tree by selecting random features and splits that act as branching rules. By using such branching rules, the algorithm isolates points in the dataset (up until the maximum allowed tree growth);
  - outliers are rapidly isolated (i.e., they need fewer splits in order to be parted from the rest and thus are — on average — closer to the root of the trees);
  - the number of splits required to isolate each point is used as an outlier score.

10. MHSC outlier detection pipe › training time with different sized datasets



Macbook Pro M2, RAM 16Gb

Python 3.10.6 · Numpy 1.23.5 · Pandas 2.01 · Scikit-Learn 1.2.2 · PyOD 1.0.9

## 11. MHSC research › sample

**73**  
**PILOTS**

**25**  
**CREW**

**46**  
**APPL**

124 males • 20 females

67 between 17-30 • 49 between 31-50 • 28 over 50



12. MHSC research › items endorsement rates › fatigue, stress

%	Rank			Item
	P	C	A	
9	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	Fatigue, difficulties in recovering from fatigue
9	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	Stress, feeling of being overwhelmed

P = Pilots · C = Cabin Crew · A = Applicants

13. MHSC research › items endorsement rates › maladaptive personality

%	Rank			Item
	P	C	A	
1				Difficulties in controlling impulses
6				Negative emotionality
1				Aggressiveness towards others or self
3				Difficulties in interpersonal relationships

P = Pilots · C = Cabin Crew · A = Applicants

14. MHSC research › items endorsement rates › life concerns

%	Rank			Item
	P	C	A	
10	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	Concerns about private life
10	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	Concerns about job
5	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	Health concerns
5	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	Financial concerns

P = Pilots · C = Cabin Crew · A = Applicants

15. MHSC research › items endorsement rates › lifestyle

%	Rank			Item
	P	C	A	
83	●	●	●	Energizing beverages (coffee, tea, energy drinks, etc.)
63	●	●	●	Alcoholic beverages
21	●	●	●	Tobacco or tobacco-related products
0	●	●	●	Light drugs (e.g., marijuana)
0	●	●	●	Other drugs

P = Pilots · C = Cabin Crew · A = Applicants

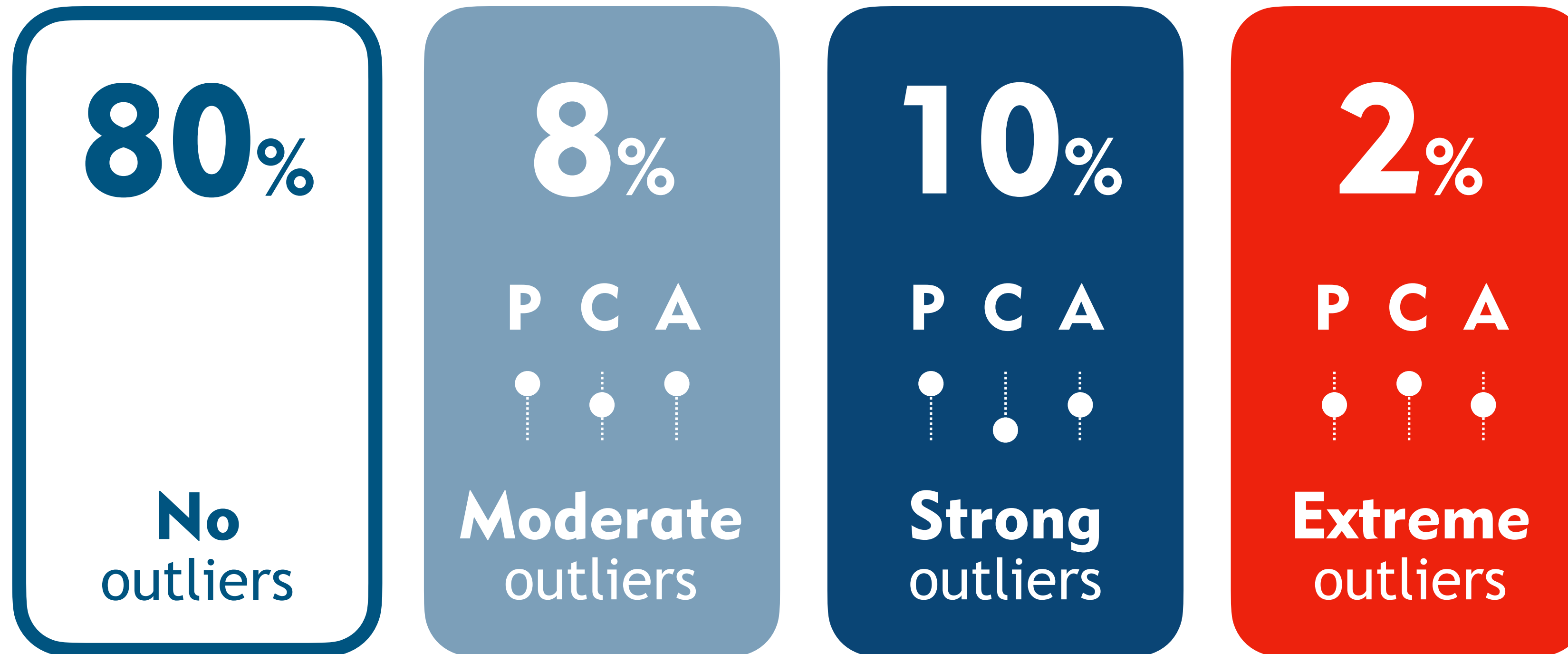


16. MHSC research › items endorsement rates › significant events and conditions

%	Rank			Item
	P	C	A	
2	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	Psychiatric or psychological treatments
0	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	Access to corporate services dedicated to worker support
3	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	Inconveniences, dangerous events, accidents in the workplace
4	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	Other significant/relevant events
2	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	Judicial/quasi-judicial/disciplinary proceedings

P = Pilots · C = Cabin Crew · A = Applicants

## 17. MHSC research › outlier detection pipe › results › by level of outlieriness



P = Pilots · C = Cabin Crew · A = Applicants

29 outliers out of 144 profiles

18. MHSC research › outlier detection pipe › results › by pipeline step

Outliers captured by pipeline step	%
Missing items step <i>only</i>	0
Sentinel items step <i>only</i>	10
ISOFs on responses and scores steps <i>only</i>	10
Uniqueness of sequence step <i>only</i>	17
<b>Any combination of steps</b>	<b>63</b>

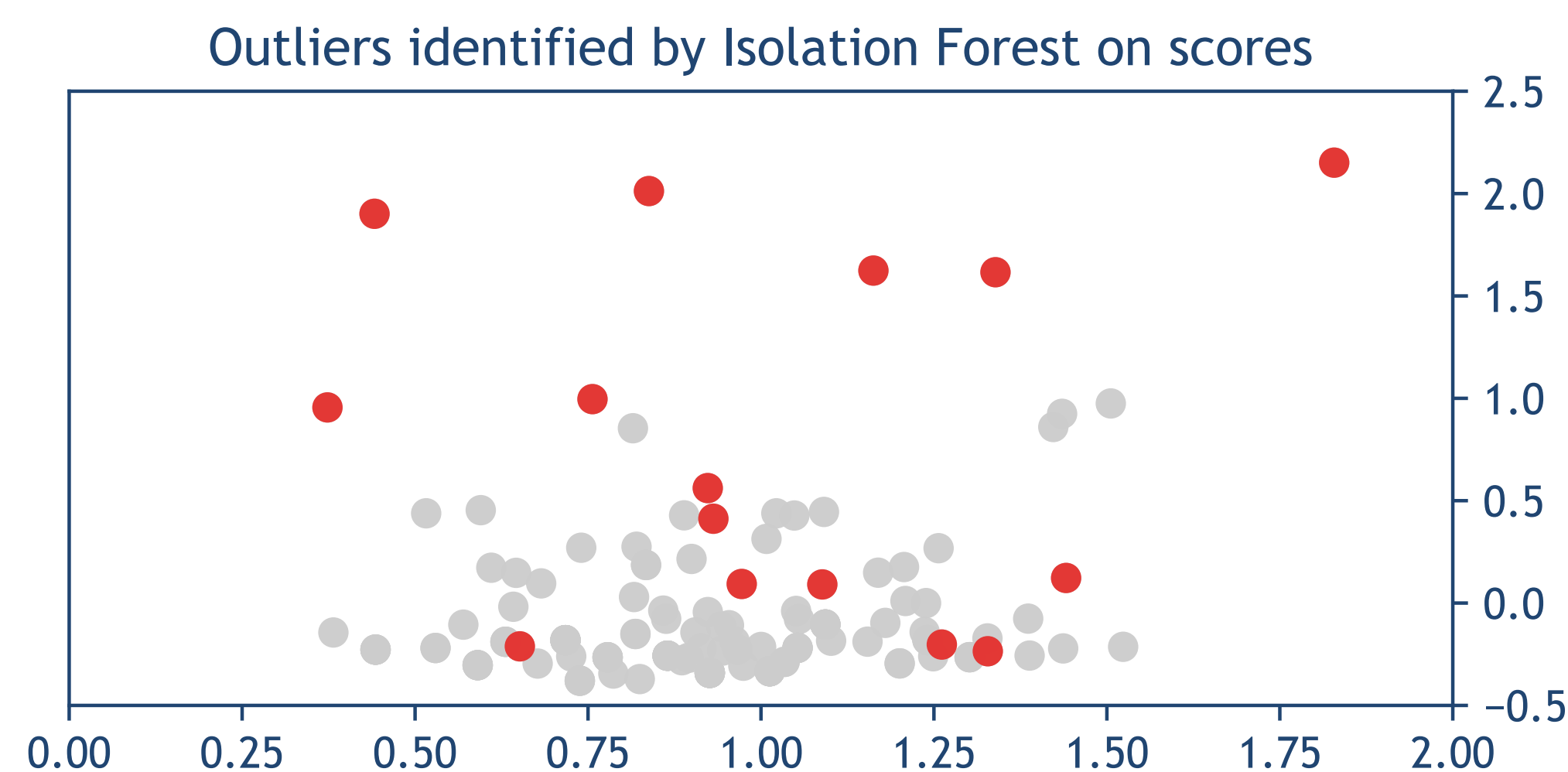
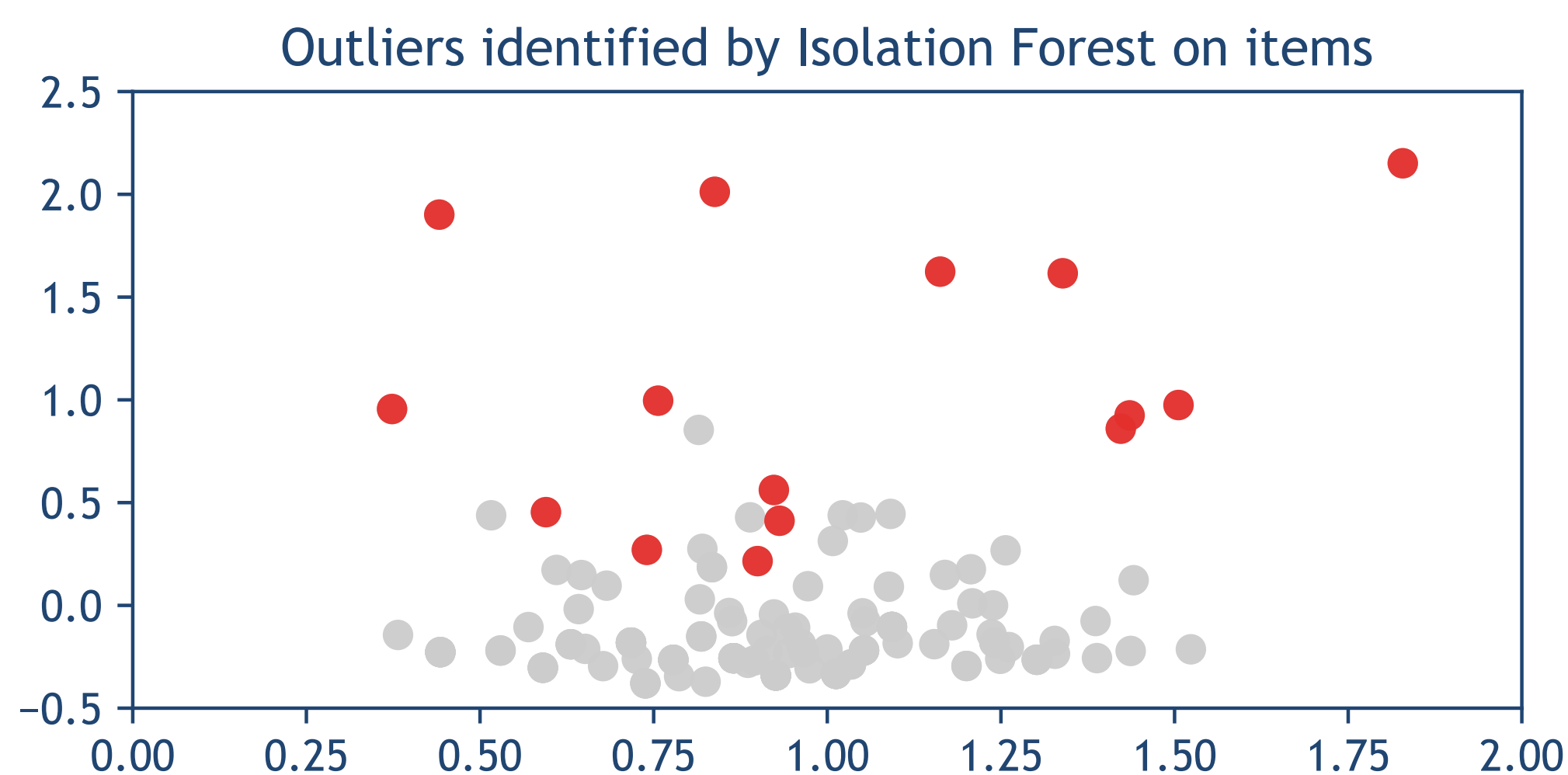
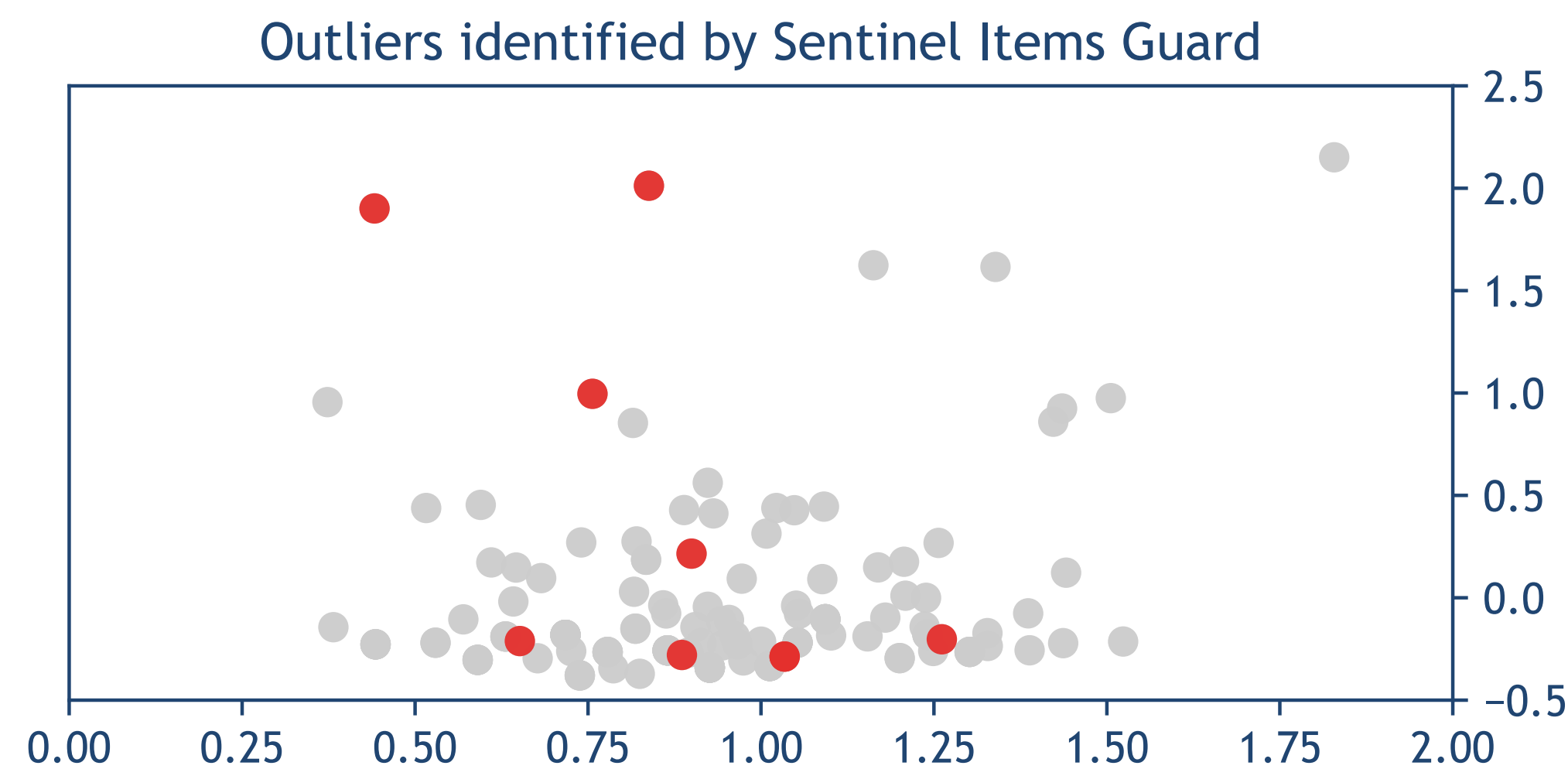
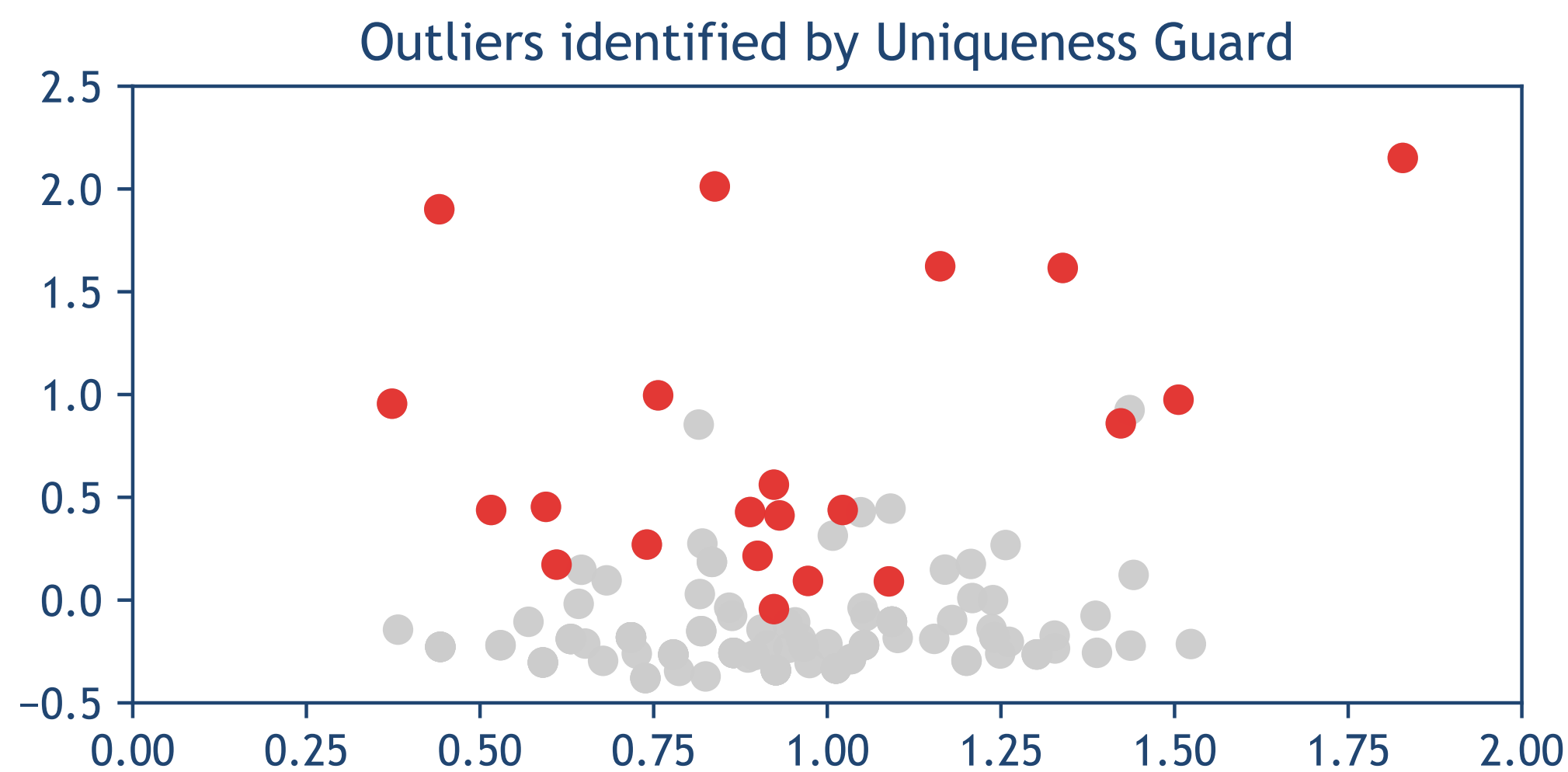
29 outliers out of 144 profiles

## 19. MHSC research › outlier detection pipe › visualizing outliers › part I

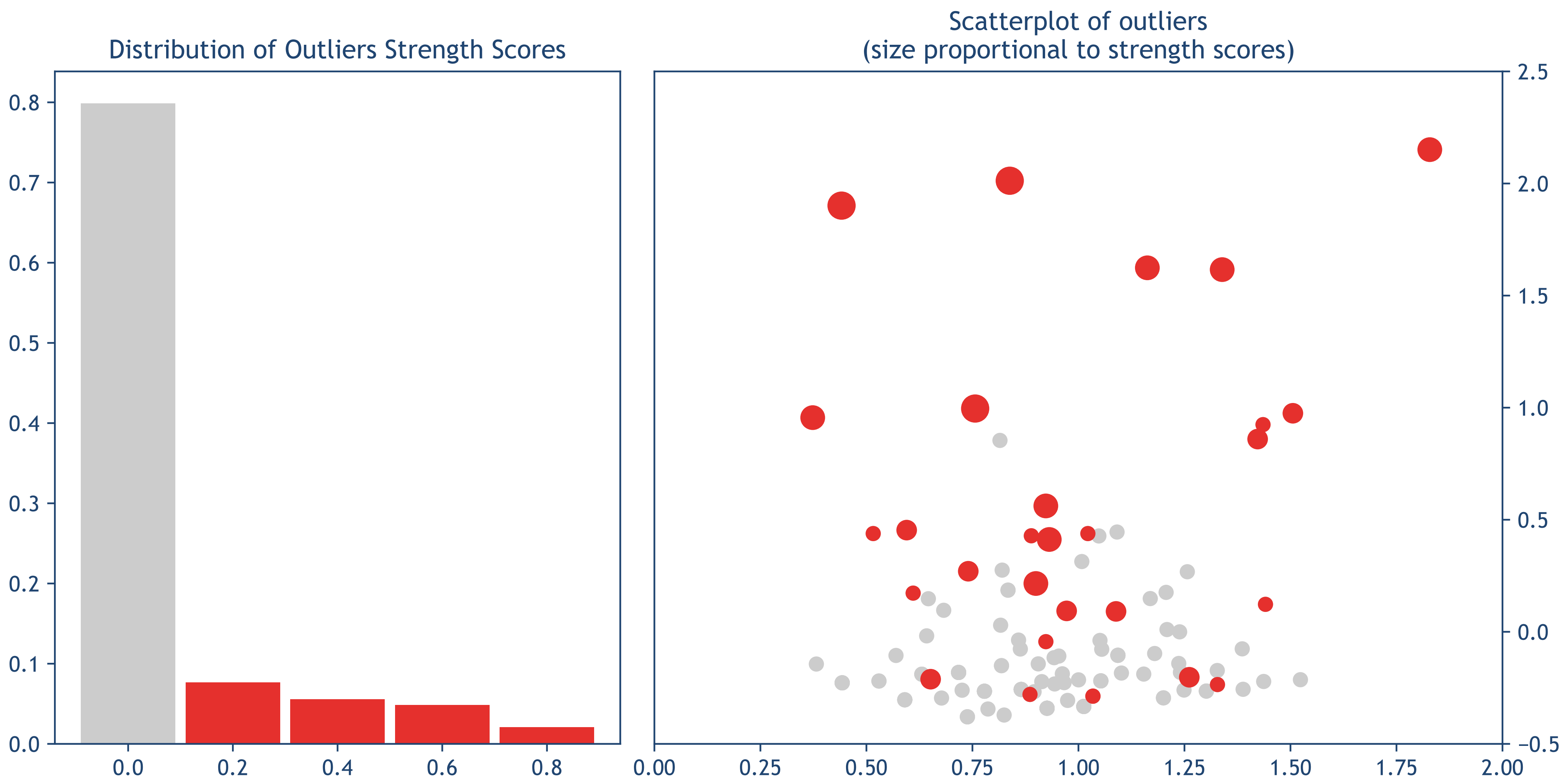
- In order to visualize the outliers identified by the pipe, we reduced the original features space to a bi-dimensional space, while preserving most of the information available.
- We employed a factorization technique called **Truncated Single Value Decomposition**, which works very well with sparse matrices like our dataset (i.e., profiles contains many zeroes).



20. MHSC research › outlier detection pipe › visualizing outliers › part II



21. MHSC research › outlier detection pipe › visualizing outliers › part III



## 22. MHSC › conclusions

- The MHSC proved to be a **fast, easy, unobtrusive way to screen** aviation workers for **mental health** issues.
- The users perceived **MHSC** quite well, the reason being that it is a “**cultural device**” **proximal to the aviation industry** mental toolset.
- The machine learning **pipeline** was a valuable tool for **automatically flagging** individuals who should be considered candidates for an in-depth clinical interview.

## 23. MHSC › limitations, future directions

- Some steps of the **MHSC outlier detection pipe** need be trained on a **sample representative of the assessed population** before being able to make predictions.
- In those working cultures where mental health issues are considered a social stigma, **under-reporting phenomena** may be an issue as the MHSC is easily fakeable.
- An **MSHC profile not flagged as outlier doesn't rule out** the presence of a **mental health condition**.
- In future versions of the MHSC outlier detection pipe, **more sophisticated ML algorithms (e.g., semantic reasoner models) will be implemented**.



## 24. MHSC › additional resources

MSHC (ita-eng) + analysis



[bit.ly/3MYTLeS](https://bit.ly/3MYTLeS)



**ITALIAN AIR FORCE**

Aerospace Medicine Institute • *Milan*