

# Screening of Cardiac Surgery Patients - Polish Validation 4AT Tool

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## Research

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# Abstract

## Introduction

Delirium is a phenomenon which affects patients with various disorders and representing various age groups. Screening instruments make it possible to diagnose the condition at an early stage and to prevent its development. The article presents validation of the 4AT instrument, i.e. a two-minute test used to identify delirium.

## Objectives

The aim of the present study was to examine the reliability and validity of the Polish version of the 4AT (Pol4-AT) for use by nurses working in intensive care units.

## Patients and Methods

The 4AT test was used to assess 444 patients at a cardiac surgery ward, on their sixth day in hospital, and the third day following a surgery. The patients were selected at random (in sequence any patient returning from a surgery and staying in hospital for six days). The conditions for entering the study included the subjects' informed consent and age >18 years.

## Results

The current findings show that the 4AT scale can effectively be used in Poland, not only in geriatric patients but also at surgical wards and at ICUs. The study showed Cronbach's alpha amounting to 0.843.

## Conclusions

There is currently no validation tool in Poland that can be used in the diagnosis and screening of delirium. The CAM and CAM ICU scales, despite the fact that they have been translated into Polish, are not a standard used in practice in Poland

## Introduction

Delirium, which generally is triggered by underlying medical conditions, is an acute and fluctuating disorder associated with attention and cognitive defects, and frequently accompanied by excessive arousal and perception-related problems [1]. Neurocognitive impairment and dementia which has a slowly progressive character, represents the strongest risk factor for delirium. Delirium may lead to a variety of complications, e.g. cognitive impairments and can, if untreated, accelerate the pace of eventual underlying cognitive decline or dementia. Mortality rates in patients with delirium are mainly related to the duration of the condition. Furthermore, patients with delirium generate high costs of hospital care because of their prolonged stay at Intensive Care Units (ICU) [2-5]. Development of delirium is promoted

by both anaesthesia and pain [6]. Patients subjected to cardiac surgeries are at risk of delirium due to such factors as extracorporeal circulation applied during the intervention and various cardiovascular complications [7]. Rapid identification of the problem may help eliminate avoidable complications which can be prevented at an early stage. There are a number of factors which may predispose for incidence of delirium, i.e. arterial hypertension, history of cognitive disorders, , use of drains, tubes and catheters, psychoactive medication, sedation, eventual mechanical ventilation, smoking and frequent alcohol consumption. Likewise, a history of induced coma may contribute to incidence of delirium at a later time [8-10].

In the literature we can encounter a number of instruments enabling assessment of patients, related to incidence and symptoms of delirium. Few of these tools, however, may effectively be used at ICUs. The most commonly applied instruments related to delirium are presented below.

### ***Confusion Assessment Method (CAM)***

This is the most popular instrument applied in assessment of delirium. It may be used both in clinical settings and for research related purposes. It is also helpful in management of delirium [23].

### ***Clock Drawing Test***

The patient is to draw a clock face with the digits. He/she is asked to correctly draw the hands of the clock to represent the time given by the examiner. The greater the distortion of the picture the more indicative it is of delirium. A study by Adamis et al. showed that the test is more effective in detecting cognitive impairments than delirium alone [22].

### ***Bedside Confusion Scale (BCS)***

The instrument involves observation of the level of consciousness in patients. This is a short 2-minute test. It is frequently used in combination with the Confusion Assessment Method (CAM) [23].

### ***Cognitive Test for Delirium (CTD)***

The test measures five factors, i.e. attention, orientation, memory, vigilance and comprehension. The score may range from 0 to 30 points. The higher the score the better the cognitive function. The tool is designed for use at ICUs [23].

### ***Delirium Assessment Scale (DAS)***

The scale is designed to assess intensity of delirium. A drawback of the scale is the fact that it cannot distinguish between delirium and dementia [23].

### ***Delirium Index (DI)***

The tool is designed to measure severity of delirium symptoms. It is not used as a standalone scale. The first research was conducted in combination with CAM. Based on subsequent research, DI was recognised as a reliable tool for identifying delirium [23].

### ***Delirium Observation Screening Scale (DOS)***

This is a 25-item tool designed for identifying delirium in screening examinations. The tool is mainly used in nursing care [23].

### ***Memorial Delirium Assessment Scale (MDAS)***

The tool was designed to enable multiple assessment of delirium over a short time span. The scale is mainly used in patients with cancer receiving opioid infusions [23].

### ***Nursing Delirium Screening Scale (Nu-DESC)***

The tool enables nursing personnel to perform screening tests in order to diagnose delirium. The tool assesses such factors as behaviour, orientation, communication, psychomotor disability and hallucinations. The result may be given following 24-hour observation [23].

The aim of the present study was to examine the reliability and validity of the Polish version of the 4AT (Pol4-AT) for use by nurses working in intensive care units.

## **Patients And Methods**

Based on the 4AT tool (see [www.the4AT.com](http://www.the4AT.com)), the Pol4-AT questionnaire consists of 4 items assessing four aspects of delirium. The first item involves observational assessment of the patient's alertness. The next two items focus on the cognitive functions. Item 2, based on the Abbreviated Mental Test-4 (AMT4), asks the patient to specify his/her age and birth date, the current year and his/her current location. Item 3, focusing on the patient's attention, applies the months backwards test, i.e. the patient is asked to recite the months of the year in reverse order, starting from December. Items 1–3 are filled in at the bedside, and they typically take less than 2 minutes. Item 4 is designed to assess acute changes in the patient's mental status, constituting a core diagnostic feature of delirium. In accordance with the tool design, the questionnaire was filled in by nursing staff of the cardiac surgery ward [11].

### **Inclusion criteria**

adult patients; conscious patient; patient consent; cardiac surgery patients

### **Exclusion criteria**

juvenile patients; unconscious patients; patient's lack of consent to participate in the study; patients from other ward than cardiac surgery

# Study participants

The study was conducted in February – June 2020. The approval of the Bioethics Committee No. 9/05/2020 at Rzeszow University was obtained. The Pol4-AT questionnaire was distributed among cardiac surgery patients from Rzeszów, Poland. A total of 444 fully completed questionnaires were accepted for analysis; 17 questionnaires were rejected (3.68%) due to incorrect completion or lack of the patient's consent.

Patients were informed about the objectives of the study and the study procedure. They were assured that participation in the study was voluntary and anonymous. The tests were forwarded to people who agreed to participate in the study. All collected questionnaires were coded anonymously.

Participants of the study included 237 females (53.4%) and 207 males (46.6%), ranging in age from 18 to 91 years. The subjects' mean age was 53 years (Table 1).

Table 1  
Gender and age of patients.

<i>Gender</i>	<b>N</b>	<b>%</b>			
Female	237	53.4			
Male	207	46.6			
Total	444	100.0			
<i>Age</i>	M	Me	SD	Min	Max
	53.9955	55.0000	16.15975	18.00	91.00

**M = mean; Me = median; SD = standard deviation; Min = minimum; Max = maximum; N = number of all participant**

## Procedure of validation

After obtaining the author's consent, the original English version of the 4AT was separately translated by 3 centres working on the validation of the Pol4-AT (University of Rzeszów, Poland; University Hospital in England; Karolinska University, Sweden). Then, three translations were compared, to be approved by the project supervisor (Karolinska University). Any doubts arising during the comparison were consulted with the English translator. As a result, one coherent version was accepted and translated back into English. The questionnaire was distributed in a convenient sample of 20 patients to examine the validity of the face. Vague words and statements were changed, and the final version translated into Polish (online supplementary material, Annex 1) was created. The Pol4-AT was tested for internal consistency and reliability. The questionnaire was distributed among a convenient sample of 461 patients. 17 responses were rejected due to incorrect completion. Finally, 444 subjects were included in the validation procedure.

The patients were assessed on the third day following a surgery (6th day in hospital). The study involved adult patients only ( $\geq 18$  years of age). Every patient returning from the Intensive Care Unit (ICU) was examined for incidence of delirium symptoms.

The examinations were performed by a team of nurses working at the cardiac surgery ward, who had been adequately trained before start of the study. The assessments started on 17 February 2020 and ended on 20 June 2020 (four months). After the scale completed for a given patient was submitted, the study coordinator entered the raw data to Excel spreadsheet. A validation procedure was initiated via statistical calculations. Recruitment to the study group and exclusions are shown in Graph 1.

## Statistical analysis

The internal consistency was assessed using the Cronbach's  $\alpha$ . Values exceeding 0.7 were deemed acceptable. Construct validity was tested using the principal component analysis (PCA) with varimax rotation with Kaiser normalization. Eigenvalues exceeding 1.0 and item loadings of 0.5 or more were applied as the criteria for factor assessment (Kaiser criterion). The discriminatory power of positions was determined. The relationships between the variables were identified using Pearson's Correlation Coefficient and chi-square test. The data were entered into Microsoft Excel (Microsoft Corporation, Redmond, Washington, United States), and then subjected to statistical analysis in IBM SPSS Statistics for Windows (IBM Corporation, Armonk, New York, United States). The minimum number of respondents according to the generally accepted 10 x question according to methodology. The study was scheduled from February to June 2020, and everyone who were in inclusion criteria for the study was qualified.

## Results

The internal consistency was examined using the Cronbach's  $\alpha$ . The  $\alpha$  value for the full sample was 0.843. After removing individual items on the scale, the Cronbach's  $\alpha$  values ranged from 0.791 to 0.801. The discriminatory power of positions ranged from 0.691 to 0.851. The value of ICCs (intraclass correlation coefficient) was 0.824 (95% confidence interval, 0.778–0.859;  $P < 0.001$ ). Construct validity was assessed by the principal component analysis (PCA) with a varimax rotation with Kaiser normalization. Eigenvalues greater than 1.0 and item loadings equal to or greater than 0.5 were the criteria for factor assessment (Kaiser criterion). The value of the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.816. The Bartlett test of sphericity was statistically significant ( $X^2 = 1426.033$ ;  $P < 0.001$ ). These findings indicated the lack of correlations between variables. One factor was identified, with an eigenvalue of 3.205 and the percentage of explained variance of 80.126%. The loadings of items ranged from 0.824 to 0.936, respectively. To assess the validity of the scale, the Cattell's scree test was also applied (Graph 1, Table 2).

Graph 1. The Cattell's screen test.

Table 2  
Descriptive statistics for Items and Global Pol4AT Score

Pol4-AT	M	Me	SD	Min	Max
[1] Alertness	0.7140	0.0000	1.53122	0.00	4.00
[2] AMT4 – Short mental test	0.7658	1.0000	0.74464	0.00	2.00
[3] Attention	0.8243	1.0000	0.80391	0.00	2.00
[4] Acute change or fluctuating course	1.4505	0.0000	1.92519	0.00	4.00
Pol4AT Score	3.7568	2.0000	4.44219	0.00	12.00
<i>M = mean; Me = median; SD = standard deviation; Min = minimum; Max = maximum; N = number of all participant</i>					

The Cronbach's  $\alpha$  was used to assess the internal consistency. Values greater than 0.7 were considered acceptable.

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Table 3  
Reliability analysis of the Pol4-AT.

Pol4-AT	Mean of scale after item removal	Scale variance after item removal	Total item correlation	Alfa Cronbach' Alfa after item removal
[1] Alertness	3.0405	10.536	0.690	0.801
[2] AMT4 – Short mental test	2.9887	14.381	0.850	0.801
[3] Attention	2.9302	13.979	0.851	0.791
[4] Acute change or fluctuating course	2.3041	7.833	0.761	0.821

Construct validity was assessed by the principal component analysis (PCA) with a varimax rotation with Kaiser normalization. Eigenvalues greater than 1.0 and item loadings equal to or greater than 0.5 were the criteria for factor assessment (Kaiser criterion). The value of the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.816. The Bartlett test of sphericity was statistically significant ( $X^2 = 1426.033$ ;  $P < 0.001$ ). These findings indicated the lack of correlations between the variables. One factor was identified, with an eigenvalue of 3.205 and the percentage of explained variance of 80.126%. The loadings of items ranged from 0.824 to 0.936, respectively (Table 4).

Table 4  
The values of loadings for Items.

Pol4-AT	Value of loadings
[1] Alertness	.824
[2] AMT4 – Short mental test	.936
[3] Attention	.936
[4] Acute change or fluctuating course	.880

Correlation between Pol4-AT and age, Pearson's  $r$  0.856;  $p < 0.001$ . Higher age corresponds to higher Pol4AT Score. The correlation is very strong.

## Graph 2. The relationships between age and Global Pol4AT Score

The analysis showed that in 187 subjects (42.1%) delirium or severe cognitive impairment were unlikely (but delirium still possible if information is incomplete). Possible cognitive impairment was identified in 95 subjects (21.4%). The findings showed that 162 subjects (36.5%) presented possible delirium or/and cognitive impairment (Graph 3).

### Scoring clarification

0 point = delirium or severe cognitive impairment unlikely (but delirium still possible if information incomplete)

1–3 points = possible cognitive impairment

4–12 points = possible delirium +/- cognitive impairment

Table 5  
Percentage distribution  
of delirium in the study  
group

Score	N	%
0	187	42.1
1–3	95	21.4
4–12	162	36.5
Total	444	100.0

**N = number of all participant**

## Graph 3. Characteristics of delirium incidence in the relevant population

The results of the examinations were divided into two groups: females and males. In 49.4% of the females, delirium or severe cognitive impairment was unlikely (but delirium still possible if information is incomplete). The same result is presented by 33.8%. Possible cognitive impairment was identified in 26.2% of the females and in 15.9% of the males. Possible delirium or/and cognitive impairment was presented by 24.5% of the females and 50.2% of the males (Graph 4).

Table 6  
Percentage distribution of delirium by gender

Score	Female		Male	
	N	%	N	%
0	117	49.4	70	33.8
1–3	62	26.2	33	15.9
4–12	58	24.5	104	50.2
Total	237	100.0	207	100.0
Chi-square = 31.846; p < 0.001				

## Graph 4. Pol4AT results in the groups of females and males

### Discussion

Despite the fact that delirium is a very big problem which patients and personnel have to cope with, it is rarely assessed with the use of specialist tools [12, 13]. Krupa & Ozga in their publication emphasise that delirium is an important issue. The related pharmacotherapy and preventive treatments are frequently overlooked or they are prescribed incorrectly because of the lack of an effective tool making it possible to detect delirium [14]. Chester et al. point out that hospitalised patients who have not been diagnosed with a coma may be at a high risk of delirium [15]. Similarly, in elderly patients presenting no signs of dementia, an episode of delirium is a significant predictor of future risk of dementia [16]. Increasing traffic of visitors has been observed at [www.the4AT.com](http://www.the4AT.com), and the 4AT tool has been translated into a number of languages. Furthermore, the 4AT has also been listed as a recommended instrument in a number of national and international guidelines and position statements. It has already been assessed in several validation studies but it still requires further testing in large populations. It is also necessary to determine its effectiveness in identifying other types of cognitive impairment, its relationship to future outcomes and its economic impact in public health systems [17–21].

In a study carried out by Bellelli et al., it was shown that the 4AT presented very good specificity. It was also demonstrated that the tool is sensitive to delirium in patients with dementia. The result of Cronbach's test showing internal consistency amounted to 0.80 [24]. According to Saller et al., a study showed that in a German population sensitivity of the 4AT scale amounted to 93.3% (95% CI: 68.1–99.9), and its specificity to 99.2% (95% CI: 95.7–100.0) [25]. In another study, Bellelli et al. applied the 4AT tool in a group of 1867 elderly patients hospitalised in Italy. The authors describe groups of patients distinguished according to the type of delirium. The highest prevalence of delirium was identified in neurology and geriatric departments and the lowest at rehabilitation wards. The study took into account correlations and such factors as malnutrition, antipsychotic medication as well as feeding tubes [26]. In a study by Shenkin et al., the 4AT scale was validated in a group of patients hospitalised in Edinburgh, Bradford and Sheffield. The study was continued for 18 months. The findings showed 100% sensitivity and 90% specificity of the tool [27]. Gagne et al. in their study reported sensitivity and specificity of 4AT amounting to 68.4%, and 73.2%, respectively, for delirium. As for cognitive impairment, the same authors found the tool presented sensitivity of 50% and specificity of 87% [28]. Another study, conducted in Edinburgh, aimed to determine whether or not 4AT tool could be introduced to replace CAM scale, which is commonly used worldwide. According to its authors, i.e. Baird et al., the 4AT may effectively be used during admission of patients to a ward. As a result of this study the so-called 'Delirium Checklist' was created. Thanks to implementation of staff education at the wards the 4AT scale can be used as a replacement. It is important because this is a short and rapid tool, which definitely makes work at the ward easier [29].

The current findings show that the 4AT scale can effectively be used in Poland, not only in geriatric patients but also at surgical wards and at ICUs. The study showed Cronbach's alpha amounting to 0.843. Owing to the study it is possible to create a new tool which is the only and the first one in Poland to be used to identify delirium [30].

## Conclusions

There is currently no validation tool in Poland that can be used in the diagnosis and screening of delirium. The CAM and CAM ICU scales, despite the fact that they have been translated into Polish, are not a standard used in practice in Poland.

## Declarations

### **Ethics approval and consent to participate**

Bioethical Commission 9/05/2020 at the Rzeszow University

**Consent for publication:** No need

**Availability of data and materials:** All materials are available in author Sabina Krupa

**Competing interests:** No

**Funding:** No

**Authors' contributions:**

design of the work; SK, DO, DR

the acquisition, SK, DO

analysis, KJ

interpretation of data; SK, DO, KJ, MA

the creation of new software used in the work; SK, DO, TT, DR

have drafted the work or substantively revised it: DR, LT, MA

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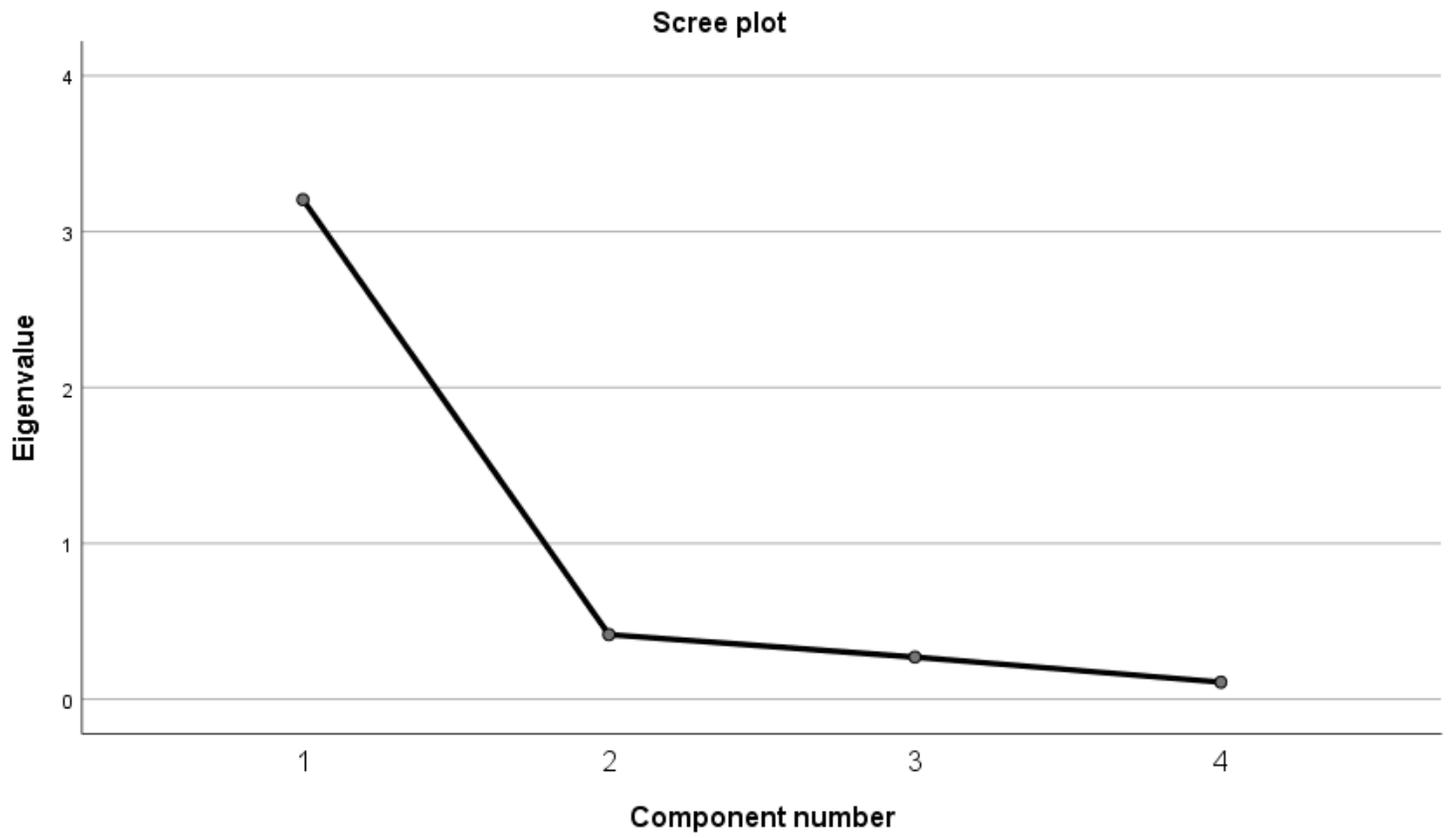
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## Figures



**Figure 1**

The Cattell's screen test.

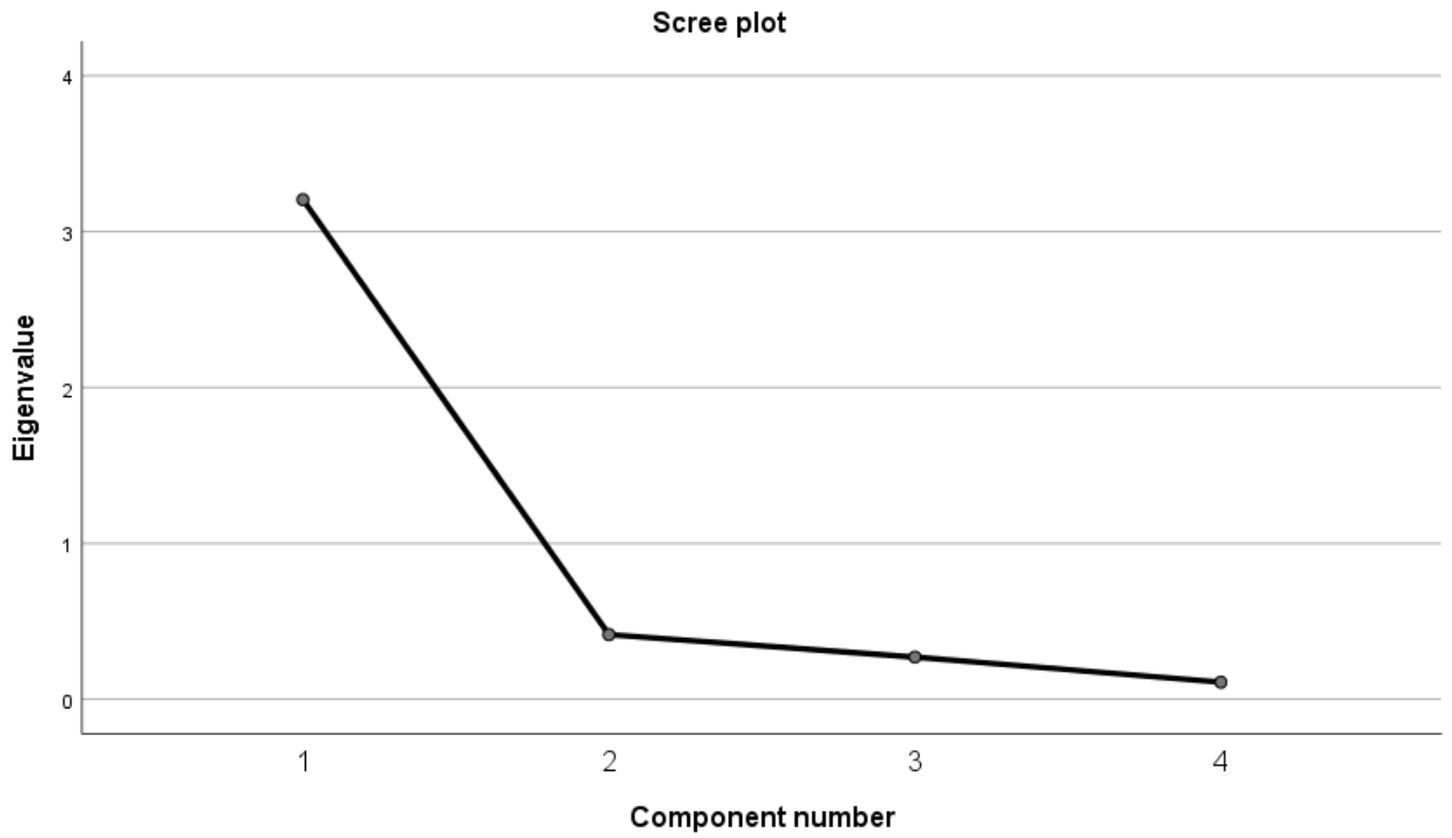
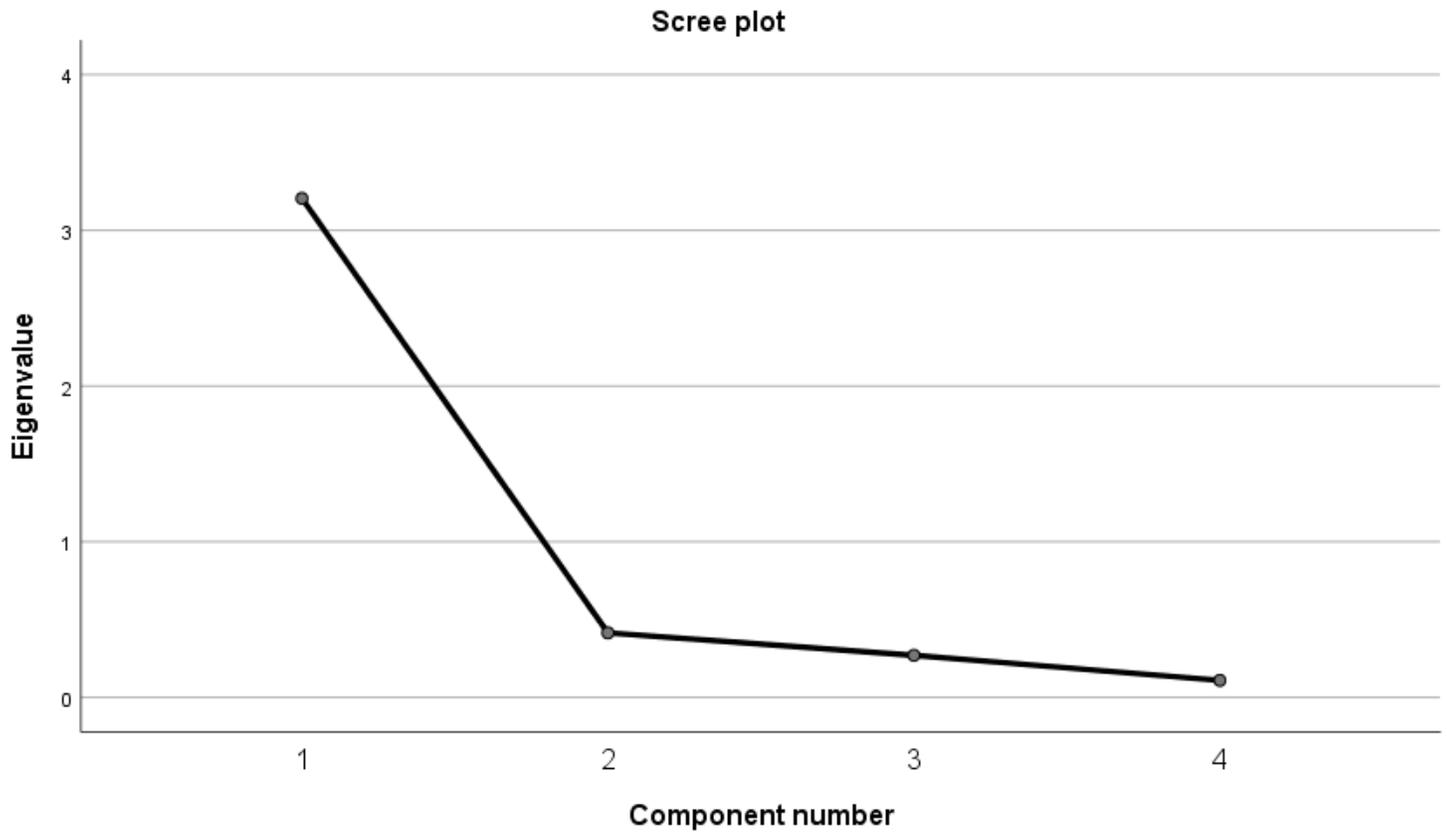


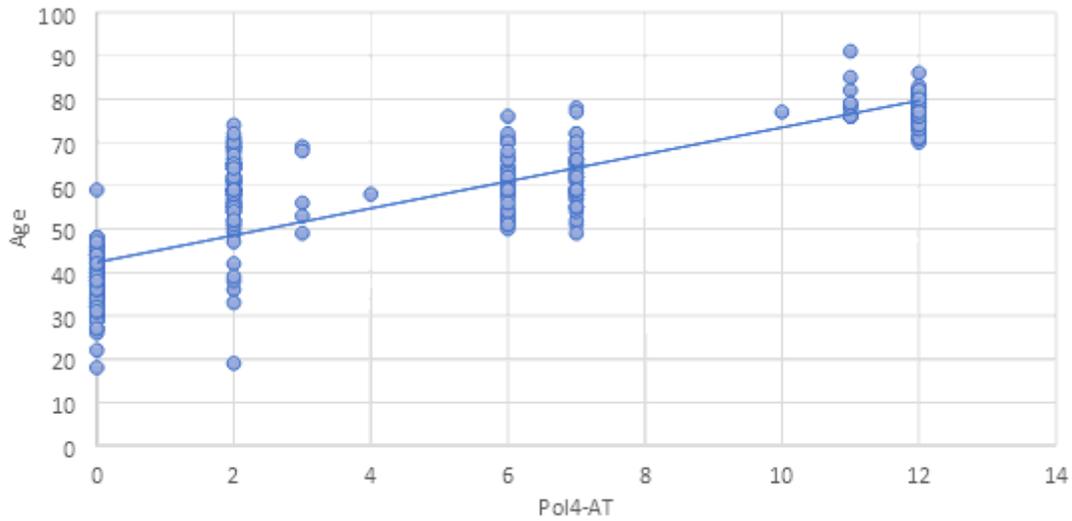
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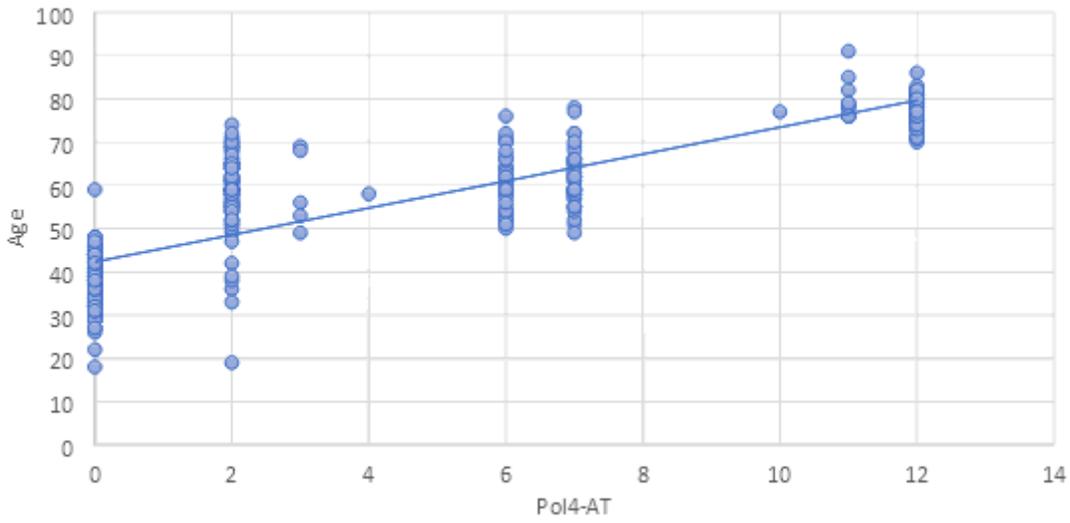
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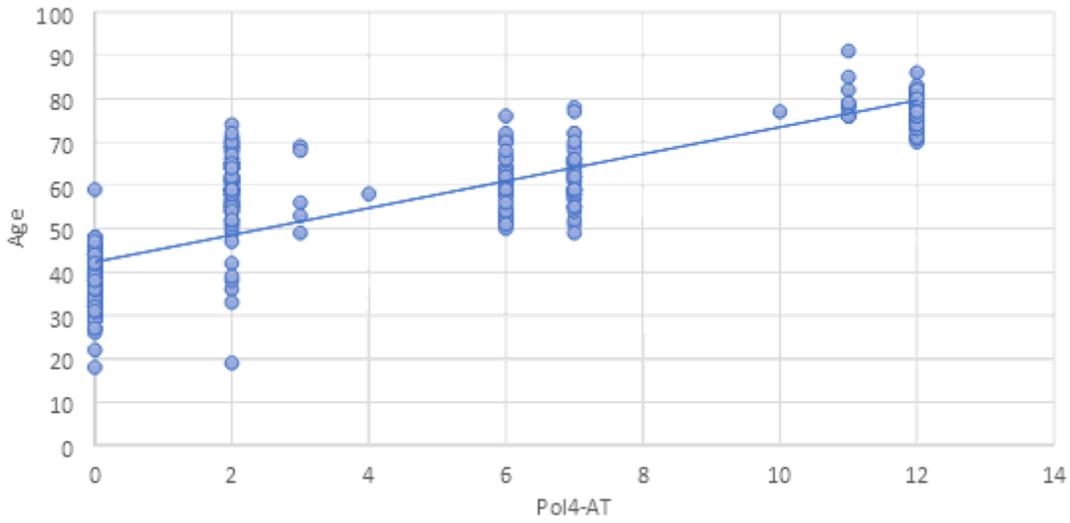
**Figure 2**

The relationships between age and Global Pol4AT Score



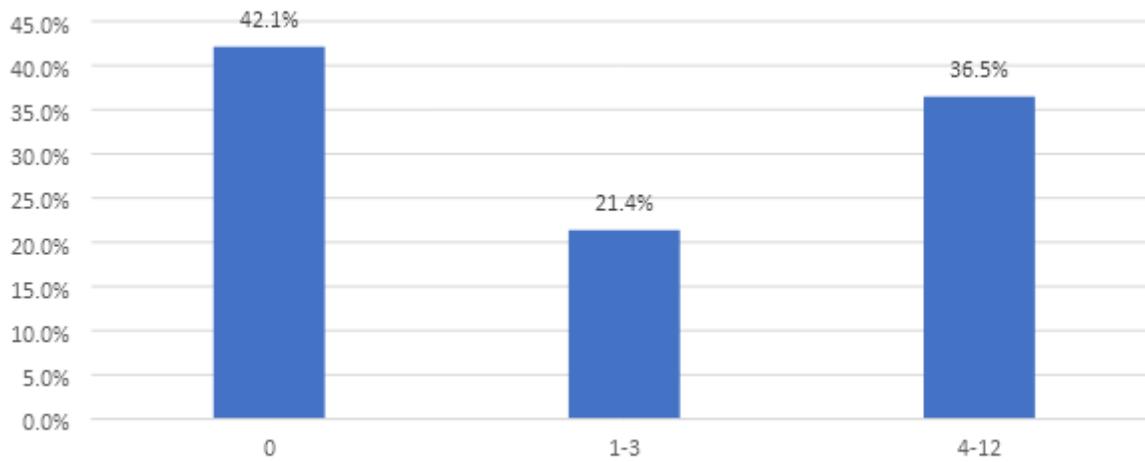
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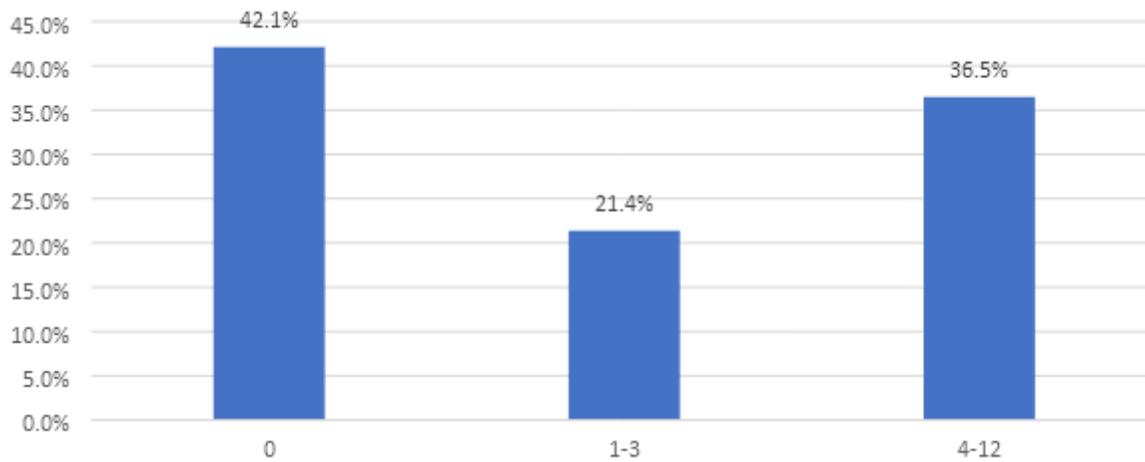
**Figure 2**

The relationships between age and Global Pol4AT Score



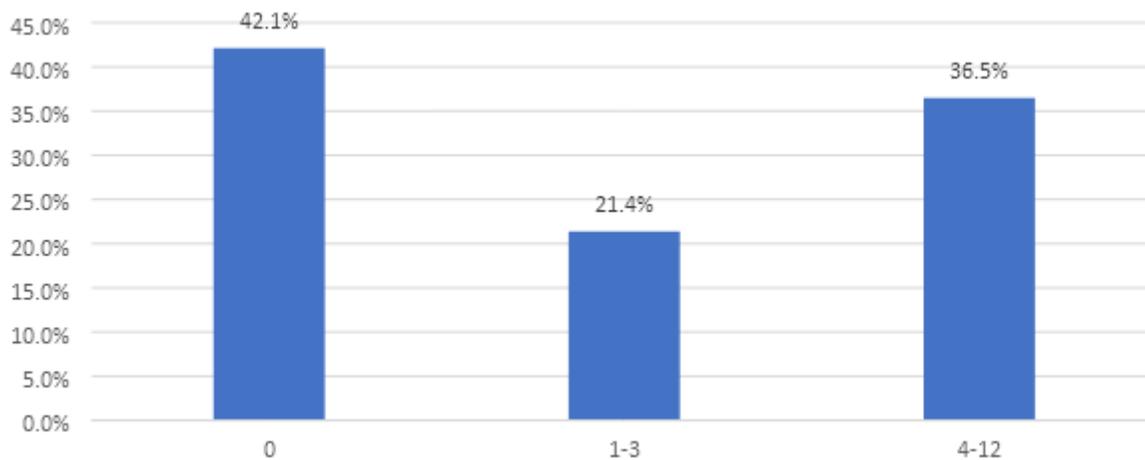
**Figure 3**

Characteristics of delirium incidence in the relevant population



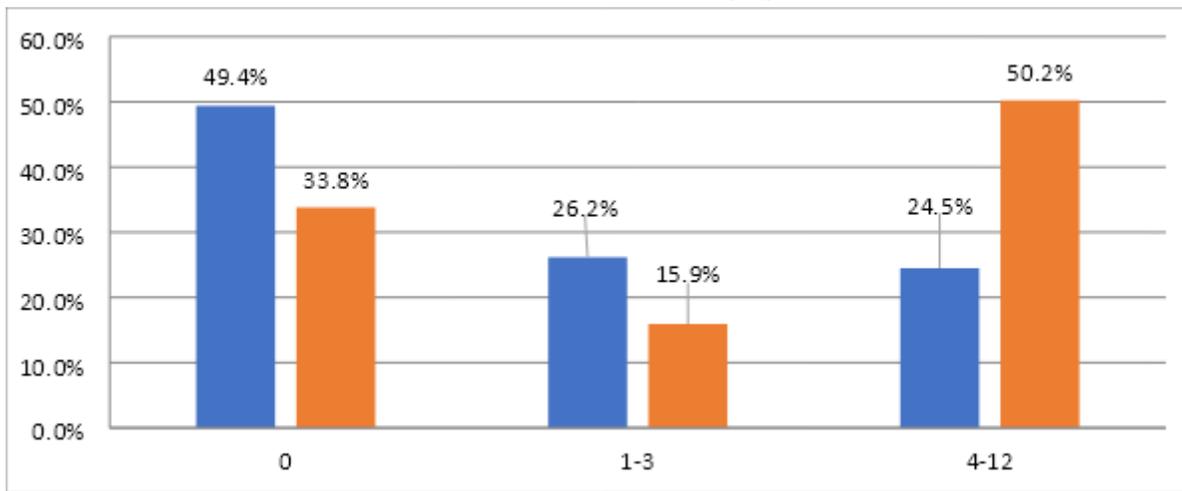
**Figure 3**

Characteristics of delirium incidence in the relevant population



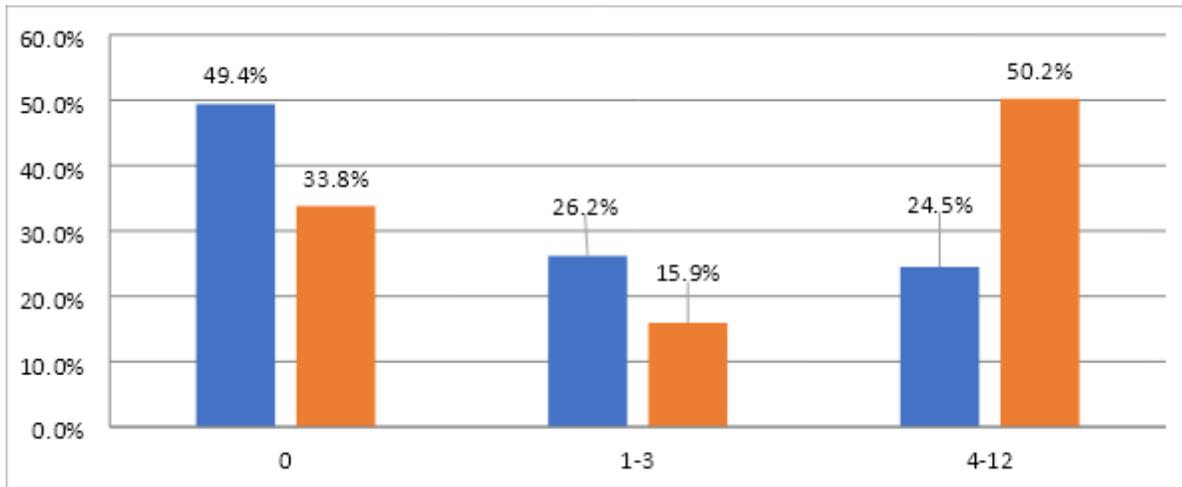
**Figure 3**

## Characteristics of delirium incidence in the relevant population



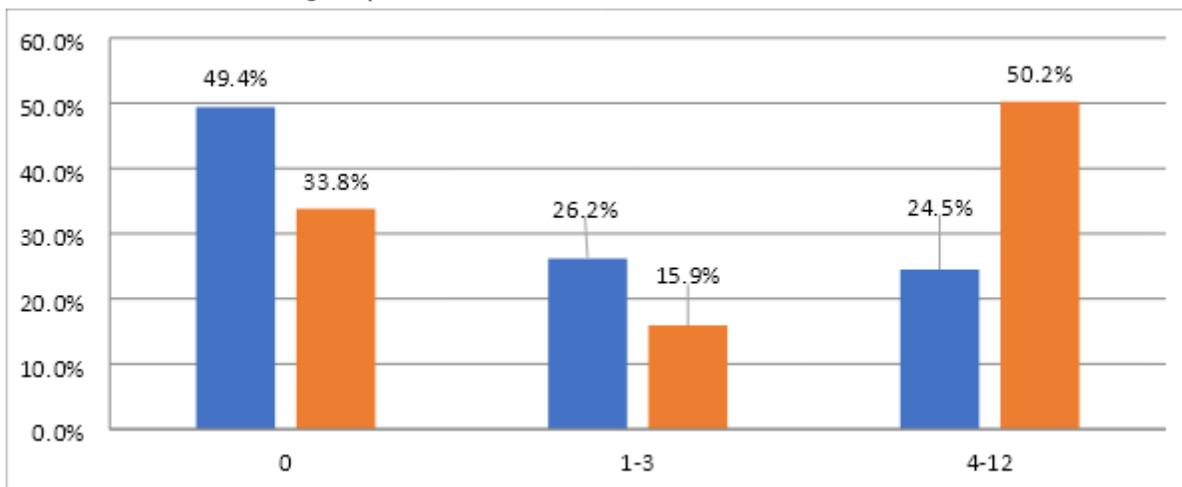
**Figure 4**

## Pol4AT results in the groups of females and males



**Figure 4**

## Pol4AT results in the groups of females and males



## Figure 4

Pol4AT results in the groups of females and males