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## RESEARCH ARTICLE

## THE COVID-19 PANDEMIC AND THE INCIDENCE OF ACUTE CORONARY SYNDROMES AT A GENERAL HOSPITAL

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**Abstract**

**Background:** Although deaths from Acute Coronary Syndromes (ACS) are the most prevalent globally, during the outbreak of the new SARS-CoV-2 coronavirus pandemic, there was a declining trend in hospital admissions for ACS patients. Inevitably a reduction of invasive procedures in cardiac catheterization laboratories was observed. Moreover, an increase in sudden out-of-hospital cardiac deaths was recorded. On the other hand, patients that eventually treated in the hospital had a much worse outcome in terms of cardiac function. Inadequate treatment of acute myocardial infarction resulted in a further increase in mortality due to coronary artery disease.

The **aim** of our study was the comparison of admissions of the patients with ACS before and during the COVID-19 pandemic.

**Methods:** A retrospective single center study was conducted. We recorded all admissions with ACS underwent invasive interventions during the period of lockdown due to COVID-19 pandemic, in Greece, from 16 March 2020 to 1 May 2020 (study period A), as well as in the period of gradual withdraw of restrictions from 2 May 2020 to 1 June 2020 (study period B). The data were compared with those of the periods of 2019 (control period A and B).

**Results:** One hundred thirty eight patients were the group of study period and 158 were the group of the control period. The reduction rate was 12.7% in study period. The largest decrease in admissions concerned with elderly patients over 75 years old, as well as females (by 52% - 53% respectively). The severity of the restrictions but also the fear of the spread of the coronavirus may be relevant to the insufficient seek of help for these groups of patients.

**Conclusion:** Our study showed that during the pandemic period, the invasive interventions were fewer than those of 2019. However, the expected reduction of catheterizations during this two and a half months period was mitigated by the increase of inter-hospital transfers of patients with ACS from neighboring hospitals, without a catheterization laboratory.

**Keywords:** Acute coronary syndromes, cardiac catheterizations, COVID-19 pandemic, hospitalizations.

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## INTRODUCTION

Deaths from Acute Coronary Syndromes (ACS) are the most prevalent globally. It is well known that delay minimization in the therapy of ACS is crucial, especially in cases of STEMI (ST-elevation myocardial infarction) where the on-time reperfusion is associated with favorable results.<sup>1,2</sup> The same applies to other severe conditions, such as Ischemic Strokes. The National Health Care System organization is structured to deal with such emergencies, with centers in charge of the attendance and initial treatment of such incidents, usually Primary Health Care structures, but also Secondary General Hospitals, and subsequently their referral to Tertiary Hospitals for further specialized management.

During the pandemic of the new coronavirus SARS-CoV-2 and especially during the period of mandatory quarantine (lock-down) of the general population, it was reported a decrease in the attendance of patients with acute pathological conditions, according to the literature, due to fear of spreading the new disease.<sup>3,4</sup> As a consequence of the reduced presence of patients in the emergency department of hospitals, there was also observed a decrease in the number of patients admitted to cardiology departments with the diagnosis of ACS<sup>5</sup>. On the other hand, the Tertiary Hospitals were tasked with dealing with the enormous volume of severe respiratory cases due to the COVID-19 infection, practically turning them into single-disease hospitals. This condition resulted in a dramatic reduction in the number of interventions for reperfusion in ACS, with the adverse consequence of increasing patient mortality and heart failure incidence for those who survived.

The General Hospital of Veroia although a Secondary General Hospital, has a catheterization laboratory which performs reperfusion operations in ACS for almost a decade. During the crisis period of the pandemic, this Secondary Hospital was called upon to cover the needs of emergency cardiology for the Central and Western Macedonia Region, serving a population area of over 600,000 inhabitants.

Our study aimed to compare the ACS admissions during the COVID-19 pandemic in 2020 with the pre-pandemic ACS admissions, as well as highlighting the role of utilization of General Hospitals, especially in times of crisis.

## METHODS

A retrospective single-center comparison study was conducted. Data were collected from the archives of the Cardiology Department and the Cardiac Catheterization Laboratory of the General Hospital of Veroia. All patients admitted with ACS (acute ST-elevation myocardial infarction - STEMI, non-ST-segment elevation myocardial infarction - NSTEMI, and unstable angina) during the period of imposition of strict measures, from 16 March 2020 to 1 May 2020 (study period A), and also at the period of their gradual withdrawal from 2 May 2020 until 1 June 2020 (study period B) were included in the study. The control group consisted of the patients admitted with ACS the corresponding periods of 2019, i.e. from 16 March 2019 to 1 May 2019 (control period A), and from 2 May 2019 to 1 June 2019 (control period B). They were classified according to their gender (men/women) and their age which was categorized into three groups (group A: under 50 years old, group B: between 51-74 years old, and group C: over 75 years old). Additionally, cardiac catheterization laboratory activations were distinguished between merely invasive coronary angiographies and percutaneous coronary interventions (PCI).

### Statistical analysis

Continuous variables are presented with mean and standard deviation and were compared using a t-test. Quantitative variables are presented with absolute and relative frequencies. For the comparison of proportions chi-square tests was used. All p values reported are two-tailed. Probability  $p < 0.05$  was considered statistically significant. All analyses were conducted using IBM SPSS statistical software (version 19.0).

## Declarations

The manuscript was approved by the Scientific Committee of the Hospital (Number 87/2020) according to the Helsinki Declaration, and written consent was obtained from the patients. The datasets during and/or analyzed during the current description is available from the corresponding author on reasonable request.

The authors report no conflict of interests and no funding.

## RESULTS

A total of 138 catheterizations had performed in 2020 (study periods A and B), versus 158 in control periods A and B of 2019 with a reduction rate of 12.7%. The number of catheterizations, the type, patient gender, and age distribution, in both periods is shown in Table 1. During the study period A, 74 procedures were carried out in the Cardiac Catheterization Laboratory; 39 diagnostic coronary angiographies (52.7%) and 35 therapeutic percutaneous interventions (47.3%). In the control period A of 2019, 90 procedures had performed; 48 coronary angiographies (53.3%) and 42 PCIs (46.7%). The overall percentage of reduction for angiographic procedures between these two periods was 17.8% ( $p=0.4$ ).

During the study period B, it was observed a slight decrease in admissions. More accurately, 64 catheterizations had performed; 33 diagnostic coronary angiographies (51.6%) and 31 PCI (48.4%), while during the control period B, 68 procedures had taken place; 39 diagnostic coronary angiographies (57.4%) and 29 PCI (42.6%) ( $p=0.4$ ). The catheterization data per each period is presented in Figure 1.

Specifically, there were no significant differences in patients' characteristics (gender, age, epidemiological data) and the volume of cardiovascular hospitalizations was similar between the two periods. Data regarding gender and age distribution for study and control periods A is presented in Figures 2, 3, 4. The corresponding data concerning the study and control periods B is presented in Figures 5, 6, 7.

Regarding patients' demographics, there was no significant difference in the number of males that had catheterized for ACS. On the contrary, it was observed a clear reduction in the number of female patients who presented with ACS during the COVID-19 outbreak period. The catheterization processes that took place in the study periods A and B were half of those in the corresponding period of 2019 for females (26 in 2020 vs. 50 in 2019).

As for the age distribution of the patients who had catheterized in the study periods A and B, it turned out that the vast majority of them belonged in group B. However, it is remarkable that during the same period of 2020, the number of invasive procedures for ACS was almost reduced by half for older patients of group

C, compared to control periods A and B (18 in 2020 vs. 34 procedures in 2019).

## DISCUSSION

Our study concerned the management of patients with ACS at the level of a secondary prefectural hospital, during the outbreak period of COVID-19 in Greece. According to our single-center experience, it was recorded a reduction in ACS admissions, as in studies made worldwide.<sup>6</sup> Nevertheless, the mitigation of the decline of catheterizations that was noticed in our study due to the fact that the cardiac catheterization laboratory of our hospital was serving other neighboring regions, as well. The difficulty in transporting patients from neighboring hospitals without a catheterization laboratory to tertiary hospitals, since the last ones turned into COVID-19 reference centers, was the reason for the smaller reduction of catheterization acts in our hospital; this situation was observed and in other countries.<sup>7</sup>

As aforementioned, for the entire period of two and a half months that we studied compared to last year's control period, a decrease of 12.7% was recorded in the interventions of the Cardiac Catheterization Laboratory of our department. However, this rate of reduction was not as large as was emphatically recorded in other centers because it had equilibrated by the increased number of inter-hospital patient transfers from adjacent prefectures, such as Kozani, Kastoria, Pella, and Pieria.

It is worth noting that during the severe lockdown period, these catheterization procedures involved ACS only in an emergency base. The fear of viral infection's high transmissibility, especially in countries with a high prevalence of the COVID-19, brought about the contradictory phenomenon for the patients' number that was encountered and admitted to hospitals, due to these cardiovascular diseases, since this was reduced.<sup>8,9</sup> Also, during the same period, there was an increase in out-of-hospital cardiac arrests, which further exacerbated the number of victims.<sup>10,11</sup> According to a survey by the European Society of Cardiology, the decrease in STEMI presentations to hospitals, but also the increase in delayed presentations of patients who would eventually come for medical treatment, was associated with the fear of infection, the application of full or partial country lockdown but also with the current healthcare priorities in each country.<sup>12</sup>

As far as Greece is concerned, the prevalence of COVID-19 disease and the number of deaths due to the pandemic remained at remarkably low levels. The timely implementation of the lockdown by the Greek state, in combination with the obedience shown by the vast majority of the Greek people to the suggestions of the special scientists' committee, were the two main elements for achieving this target, during the first quarter of the pandemic outbreak in our country.

Due to the small number of cases and deaths from coronavirus in Greece compared to other countries in Europe and America, during the first wave of coronavirus epidemic at the country it was not possible to carry out large-scale studies on the effect of the new virus on general mortality in the country. A very recently published survey about the impact of the pandemic on hospital management of ACS in Greece was made by Papafaklis et al.<sup>13</sup> According to this survey, despite the low incidence of coronavirus in the country, there was a decrease in ACS-related hospitalizations. The percentage of decrease was 28.4%, comparing to the corresponding period of 2019 when there was no pandemic and any application of the restrictive measures of the free movement of citizens. The reduction was proportional to all three ACS expressions; STEMI by 24.5%, NSTEMI by 26.5%, and unstable angina by 36.5%. The reduction in STEMI admissions was harmonious throughout the two and a half months of the coronavirus outbreak period, while the decrease in NSTEMI and unstable angina admissions was mainly observed during the period of tightening of social measures. Consequently, there was a proportional decrease in the number of catheterizations in these two periods, because of the reduced attendance of patients. Additionally, in this study, it was observed that during the period of the virus outbreak, there was an increase of ACS-admitted patients who presented with left ventricular systolic dysfunction by 6.7% more, compared to those in the 2019 control period (22.2% vs. 15.5%).

Finally, as recorded in our study during the COVID-19 outbreak period, the decrease of hospitalizations, and therefore catheterizations due to ACS had to do mostly with older patients (>75 years-old), and females. This reduction exceeded 50%. As for the elderly patients, the problematic management during the COVID-19 period is mainly related to the poor outcomes of this

age group, in terms of ACS. Thus, elderly patients with relatively stable ACS it was preferred to be treated conservatively, and only those who were more unstable underwent invasive therapy.<sup>14</sup>

As for the reduction rate of females, it is explained possibly by the fact that they did not seek timely aid from the health care system, due to social restrictions measures out of fear of hospital-acquired infection from SARS-CoV-2, although females appeared to be less vulnerable to infection from the new coronavirus, due to biological factors associated with the ACE receptor.<sup>15,16</sup> Surprisingly, even though the total number of hospitalized males due to ACS, was decreased during the two and a half months of the outbreak of the virus disease, it was recorded an increase in males' admission number for the same reason, specifically in the period of the gradual withdrawal of the restrictive measures, compared to the control period of 2019. Smoking, sedentary life, and lack of exercise in the quarantine period might have been the triggering factors for such kind of findings in males.<sup>17</sup>

This significant reduction that recorded for females and the vulnerable age group of patients >75 years old, by 52% and 53% respectively, can be attributed either to the fact that these patients did not seek medical help or to the fact that their management based on the treatment of thrombolysis, which came to the fore.

The limitations of our study are that this is a single-center study, with a small sample size, and so there is an inability to generalize results, although the findings agree with other larger studies in the literature.

## CONCLUSION

Our study showed that during the COVID-19 pandemic period, the invasive interventions in the Cardiac Catheterization Laboratory of the Cardiology Department were fewer than before pandemic. The restrictive measures in the movement of the population during the pandemic reduced the frequency of invasive operations compared to the period before the lockdown mainly affecting patients over 75 years old as well as female patients. However, the expected reduction of catheterizations was mitigated by the increase of inter-hospital transfers of patients with

ACS from neighboring hospitals, without a catheterization laboratory.

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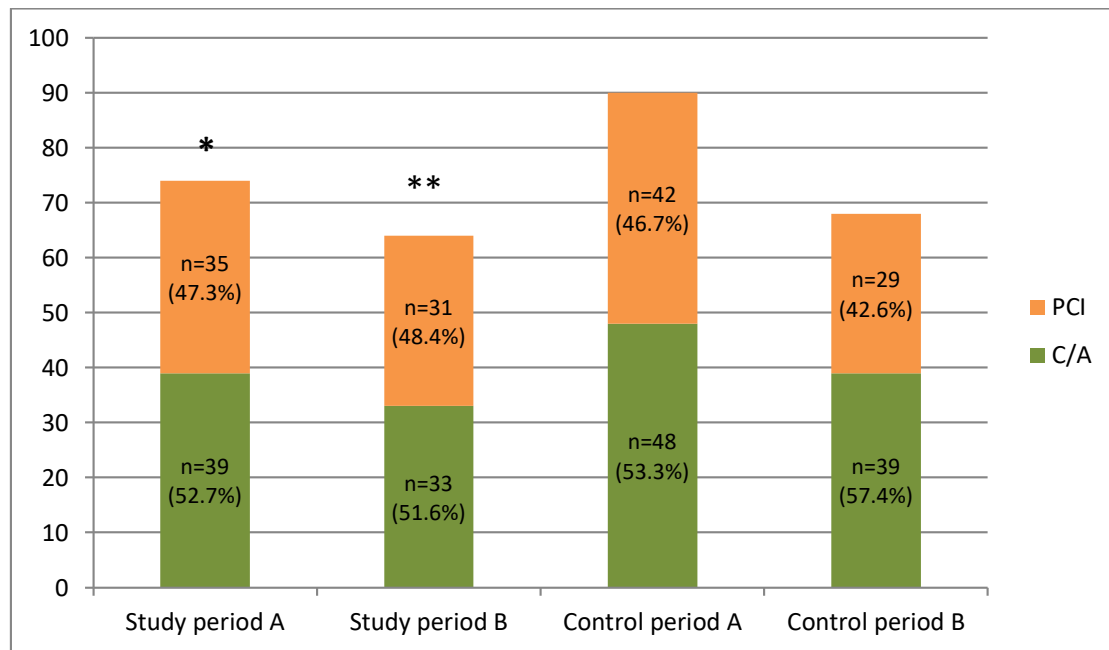
## ANNEX

**TABLE 1.** Comparison of patients admitted for Acute Coronary Syndrome (ACS) between the study and control periods.

<b>Catheterizations</b>	<b>Study period A N</b>	<b>Control period A N</b>	<b>p</b>	<b>Study period B N</b>	<b>Control period B N</b>	<b>p</b>
<b>Coronary Angiographies</b>	39	48	0.344	33	39	0.298
<b>Percutaneous Coronary Interventions</b>	35	42	0.275	31	29	0.288
<b>Males</b>	64	70	0.354	48	38	0.388
<b>Females</b>	10	20	0.284	16	30	0.315
<b>Group A (&lt;50 y/o)</b>	8	10	0.276	2	2	0.298
<b>Group B (51-74 y/o)</b>	56	65	0.322	54	47	0.358
<b>Group C (&gt;75 y/o)</b>	10	15	0.292	8	19	0.274

Study Period A: 16 March 2020 to 1 May 2020, Study Period B: 2 May 2020 to 1 June 2020

Control Period A: 16 March 2019 to 1 May 2019, Control Period B: 2 May 2019 to 1 June 2019

**FIGURE 1:** Number of catheterization interventions at General Hospital of Veroia during the study and control periods

Study Period A: 16 March 2020 to 1 May 2020, Study Period B: 2 May 2020 to 1 June 2020

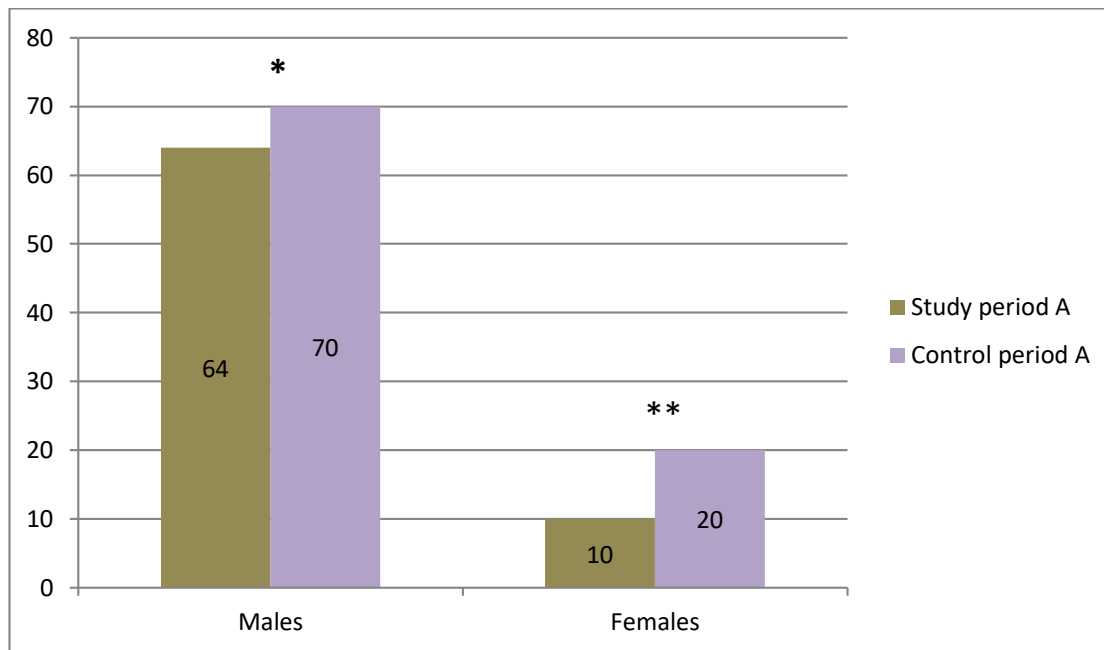
Control Period A: 16 March 2019 to 1 May 2019, Control Period B: 2 May 2019 to 1 June 2019

C/A: Coronary Angiographies, PCI: Percutaneous Coronary Interventions

\*  $p=0.4$  compared to the control period A

\*\*  $p=0.4$  compared to the control period B

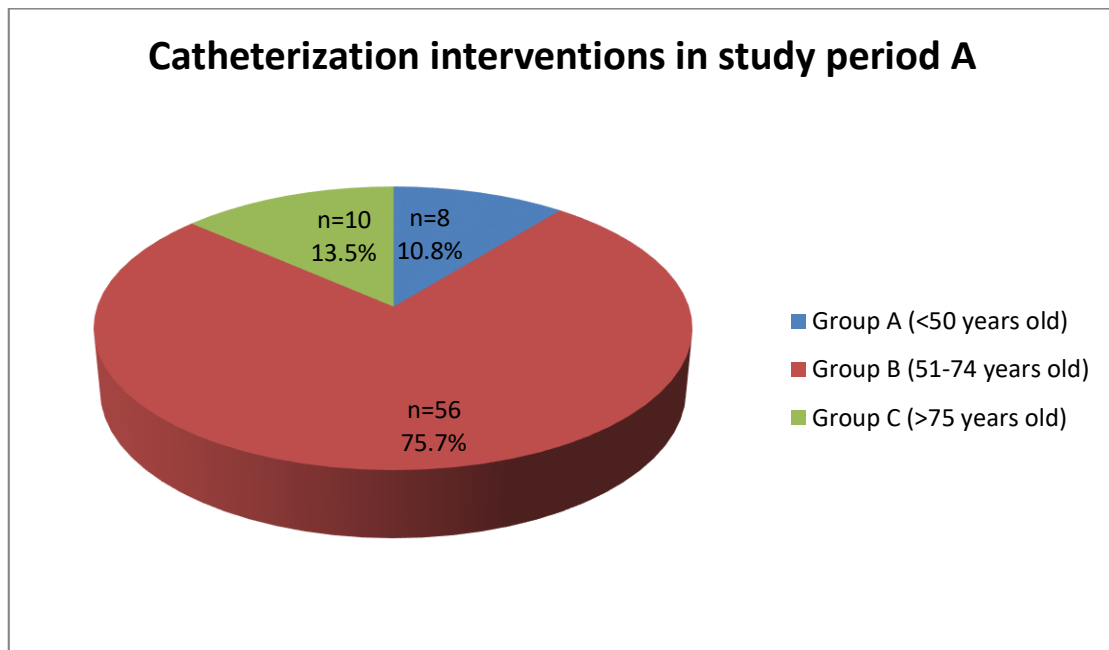


**FIGURE 2:** Gender distribution of study and control periods A

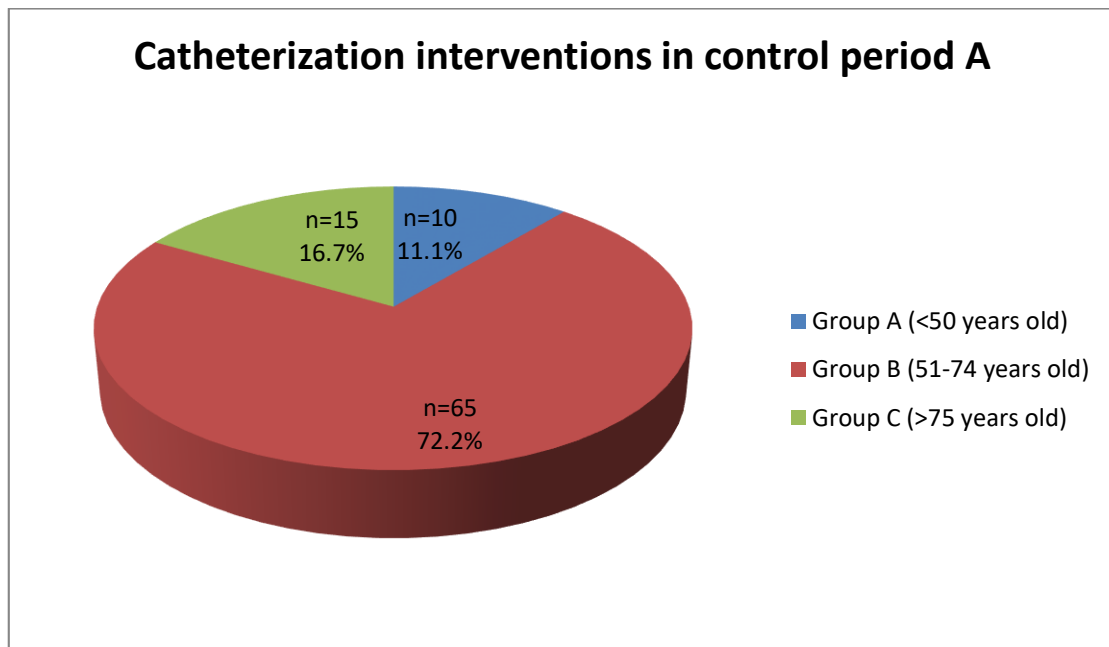
Study Period A: 16 March 2020 to 1 May 2020, Control Period A: 16 March 2019 to 1 May 2019,

\*  $p=0.7$  compared to the control period A

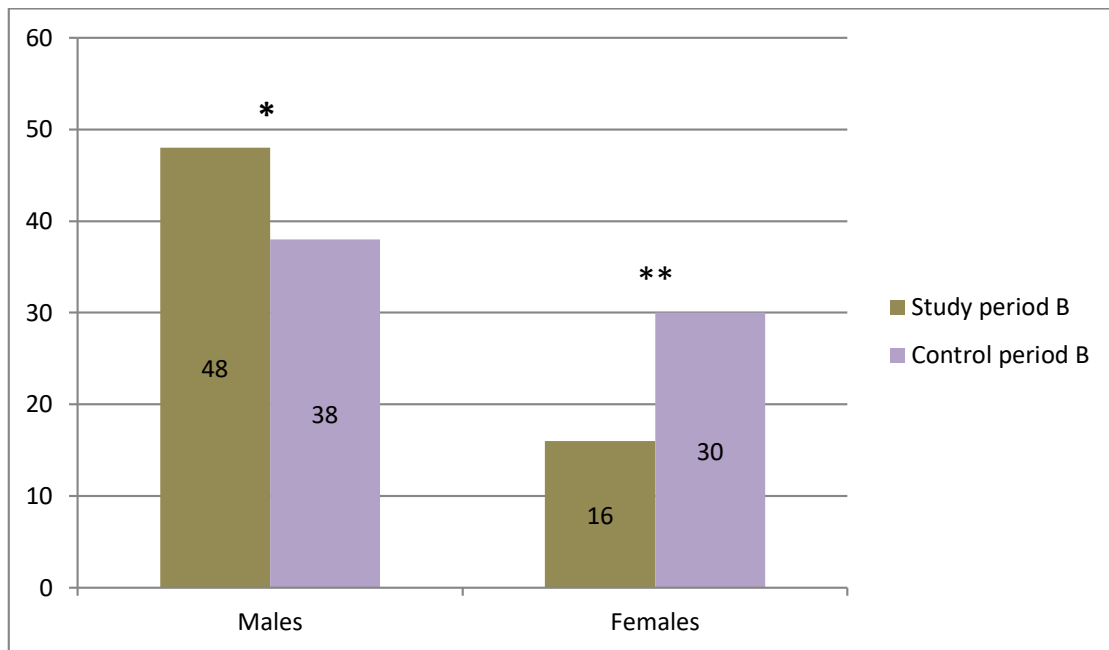
\*\*  $p=0.1$  compared to the control period A

**FIGURE 3:** Age distribution of catheterization interventions at General Hospital of Veroia during the study period A.

Study Period A: 16 March 2020 to 1 May 2020

**FIGURE 4:** Age distribution of catheterization interventions at General Hospital of Veroia during the control period A.

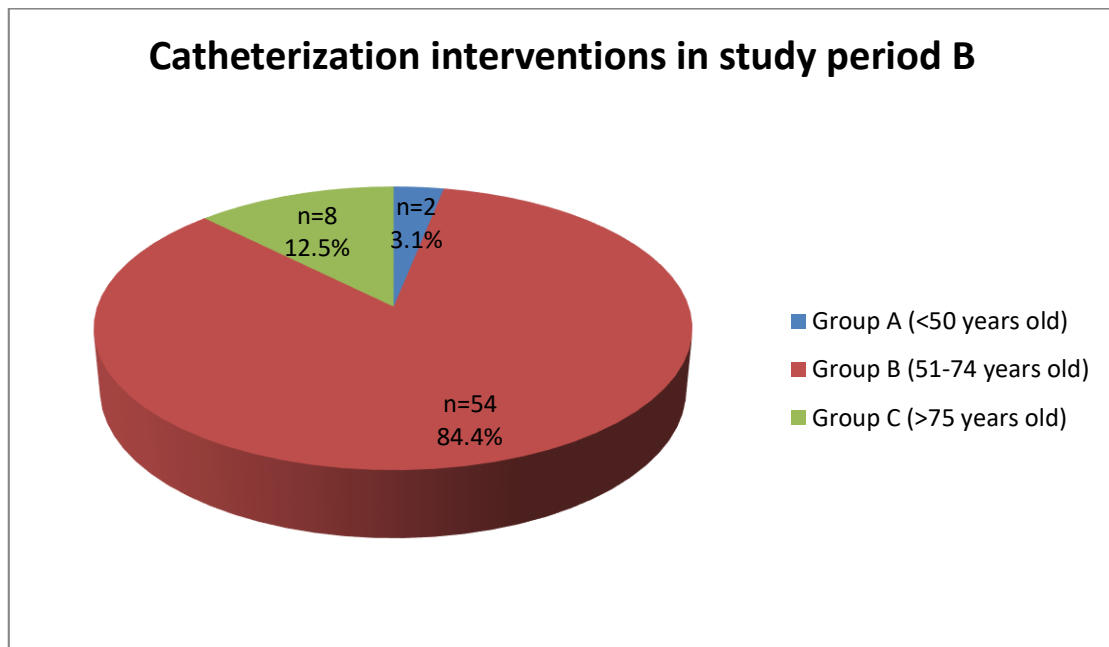
Control Period A: 16 March 2019 to 1 May 2019

**FIGURE 5:** Gender distribution of study and control periods B

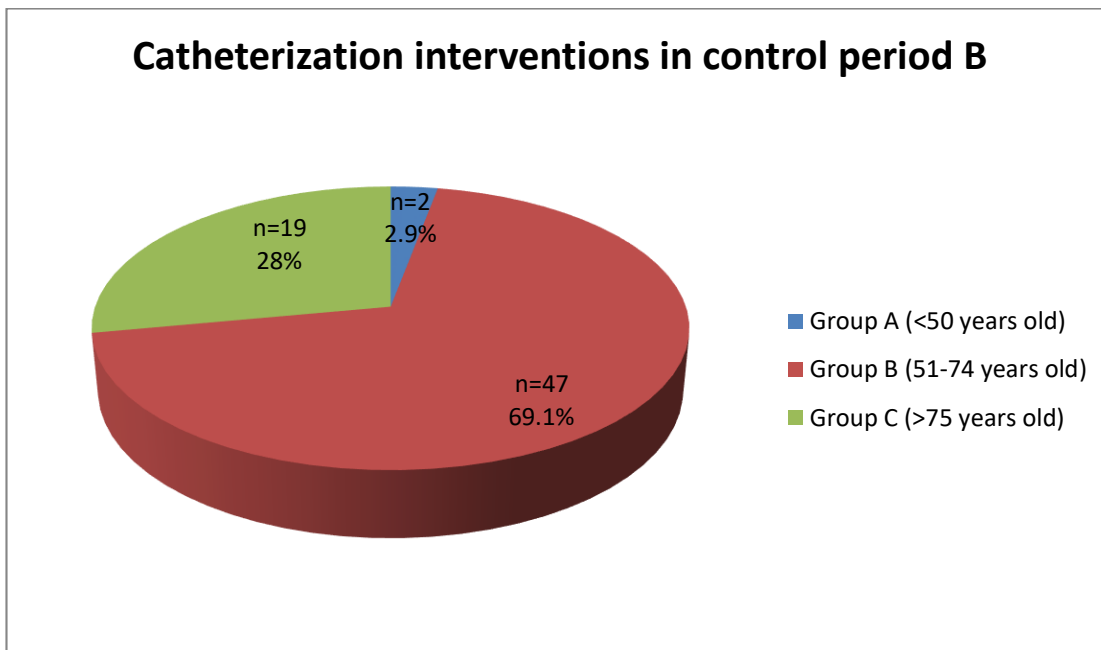
Study Period B: 2 May 2020 to 1 June 2020, Control Period B: 2 May 2019 to 1 June 2019

\*  $p=0.2$  compared to the control period B

\*\*  $p=0.6$  compared to the control period B

**FIGURE 6:** Age distribution of catheterization interventions at General Hospital of Veroia during the study period B

Study Period B: 2 May 2020 to 1 June 2020

**FIGURE 7:** Age distribution of catheterization interventions at General Hospital of Veroia during the control period B

Control Period B: 2 May 2019 to 1 June 2019