



## Trends in hospital admission for acute diverticulitis in Italy from 2008 to 2015

Gian Andrea Binda<sup>1,2</sup> · F. Mataloni<sup>3</sup> · M. Bruzzone<sup>4</sup> · M. Carabotti<sup>2,5</sup> · R. Cirocchi<sup>2,6</sup> · R. Nascimbeni<sup>2,7</sup> · G. Gambassi<sup>8,9</sup> · A. Amato<sup>2,10</sup> · N. Vettoretto<sup>2,11</sup> · L. Pinnarelli<sup>3</sup> · R. Cuomo<sup>2,12</sup> · B. Annibale<sup>2,5</sup>

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### Abstract

**Background** Epidemiological studies in Western countries have documented an increase of hospitalizations for acute diverticulitis (AD) but Italian evidence is scarce. The aim of the present study was to analyse the trend in hospitalization for AD, including in-hospital mortality, in Italy from 2008 to 2015.

**Methods** Through the Italian Hospital Information System of the National Health System, we identified diverticulitis of the colon as a discharge diagnosis. Age- and gender-specific rates of hospitalization for AD were assessed.

**Results** 174,436 hospitalizations were identified with an increasing rate in 2008–2015 from 39 to 48 per 100,000 inhabitants ( $p < 0.001$ ). The rate of hospitalization was higher for women, but the increasing trend over time was even more pronounced among men (mean increase per year 3.9% and 2.1% among men and women, respectively) ( $p < 0.001$ ). The increased rate of hospitalization was accounted for by patients less than 70 years old, especially those under 60. In contrast, the hospitalization rate for older patients (age  $\geq 70$  years) was higher but remained unchanged during the study period. The number of patients with one hospital admissions was significantly higher than the number of patients with at least two hospitalizations ( $p < 0.001$ ) and both groups showed a significant and comparable increase year by year. The overall in-hospital mortality rate increased from 1.2 to 1.5% ( $p = 0.017$ ). More specifically, the increase was observed in patients at their first hospitalization [from 1 to 1.4% (mean increase per year of 3%,  $p = 0.003$ )]. An increase in mortality was most evident among women (from 1.4 to 1.8%  $p = 0.025$ ) and in older patients [age 70–79 years from 1.2 to 1.7% ( $p = 0.034$ ),  $\geq 80$  years from 2.9 to 4% ( $p = 0.001$ )].

**Conclusions** In Italy, between 2008 and 2015, the rate of hospitalization for AD has been constantly increasing due to the hospitalization of younger individuals, especially men. There was a significant increase of in-hospital mortality especially among women, elderly and during the first hospitalization. These findings suggest the need for increased awareness and clinical skills in the management of this common condition.

**Keywords** Diverticulitis · Female · Hospitalization · Italy · Mortality · Young adult

✉ Gian Andrea Binda  
gabinda@me.com

<sup>1</sup> Department of Surgery, Galliera Hospital, Genoa, Italy

<sup>2</sup> Italian Group of Diverticular Disease (GRIMAD), Rome, Italy

<sup>3</sup> Department of Epidemiology, Lazio Regional Health Service, Rome, Italy

<sup>4</sup> Clinical Epidemiology Unit, Ospedale Policlinico San Martino, Genoa, Italy

<sup>5</sup> Medical-Surgical Department of Clinical Sciences and Translational Medicine, Sapienza University, Rome, Italy

<sup>6</sup> Department of General Surgery and Surgical Oncology, Hospital of Terni, University of Perugia, Terni, Italy

<sup>7</sup> Department of Molecular and Translational Medicine, University of Brescia, Brescia, Italy

<sup>8</sup> Department of Internal Medicine, Università Cattolica del Sacro Cuore, Rome, Italy

<sup>9</sup> Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy

<sup>10</sup> Department of Surgery, Borea Hospital, Sanremo, Imperia, Italy

<sup>11</sup> Department of Surgery, Montichiari, Ospedali Civili Brescia, Brescia, Italy

<sup>12</sup> Department of Clinical Medicine and Surgery, Federico II University, Napoli, Italy

## Introduction

Colonic diverticula are particularly common in Western countries and their prevalence increases with age, affecting up to 60% of individuals over 70 years of age [1]. Although the majority of patients with colonic diverticula remain asymptomatic, about 4% develop acute diverticulitis (AD) [2]. Among gastrointestinal illnesses, diverticulitis is the most common cause of hospitalization in the USA with aggregate hospital costs estimated at \$2.6 billion annually [3]. Several epidemiological studies, conducted in Northern Europe and the USA, have documented an increase in hospital admissions for AD in recent years from the 1990s through 2012 [4–11]. This increased rate of hospital admissions is especially evident among women and younger individuals [5–8, 11]. In Italy, a consensus statement [12] and clinical guidelines [13] about colonic diverticulosis and diverticular disease have been recently published, but no analysis of the trend of hospital admissions for AD has ever been performed.

The primary endpoint of our study was to analyse the nationwide hospital admission rates for AD between 2008 and 2015 in Italy, using administrative data. As secondary endpoint, we investigated the association between hospital admissions for AD with gender, age categories, and in-hospital mortality during admission.

## Materials and methods

### Data sources and patient population

Data were extracted from the Italian Hospital Information System (HIS) that collects clinical and administrative information regarding each hospital admission of every patient discharged from any hospital in Italy. This data source contains patient demographic data (gender, age), admission and discharge dates, up to six discharge diagnoses [International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM)], and living status at discharge (alive, dead, transferred to another hospital). The National Outcome Program (PNE) of the National Agency for Regional Health Services (AgeNaS) is in charge of the management and analysis of data.

All hospital admissions that occurred between 2008 and 2015 were analysed. Then, we extracted information on every admission with a diagnosis of diverticulitis of the colon [ICD-9-CM code 562.11 (diverticulitis without mention of haemorrhage) and 562.13 (diverticulitis with mention of haemorrhage)] either as a primary diagnosis or as secondary diagnosis but with a complication of

diverticulitis as a primary diagnosis. Hospital admissions regarding patients under 18 years of age and those with a diagnosis of colon or rectal cancer (ICD-9-CM 153.0–153.9, 197.5) were excluded.

Rates of hospital admissions were analysed based on the following variables: (1) six age categories (18–39, 40–49, 50–59, 60–69, 70–79,  $\geq 80$  years); (2) gender. Patients with more than one hospital admission for AD (1+) were also identified for each given year. In-hospital mortality was calculated considering all hospital admissions for AD that ended with the death of the patient as opposed to discharge or transfer.

### Statistical analysis

Prevalence rates are reported by 100,000 individuals. Statistical analysis was performed using Student's *t* test and the Wald test as appropriate. A two-tailed *p* value  $< 0.05$  was considered statistically significant. Statistical analysis was performed using Stata 13 Software [14].

## Results

### Hospital admissions for AD

Between 2008 and 2015, a total of 174,436 patients were hospitalized for AD. Patient characteristics are listed in Table 1. Women (54.9%) were more frequently hospitalized and the median age was 70 years. Over the study period, the number of hospital admissions for AD increased by 30% (from 18,797 to 24,342) ( $p < 0.001$ ), whereas during the

**Table 1** General clinical characteristics of patients hospitalized in Italy for acute diverticulitis from 2008 to 2015

	No. (%)
Sex	
Male	78.745 (45.1%)
Female	95.691 (54.9%)
Age, median (IQR), years	70, 56–80
Age group	
18–39	8.078 (4.63%)
40–49	18.084 (10.37%)
50–59	26.414 (15.14%)
60–69	33.787 (19.37%)
70–79	44.129 (25.30%)
$\geq 80$	43.944 (25.19%)
Hospitalization rate for AD (per 100,000 individuals)	44
Admission rate for AD (per 100,000 hospitalizations)	248

No number, AD acute diverticulitis

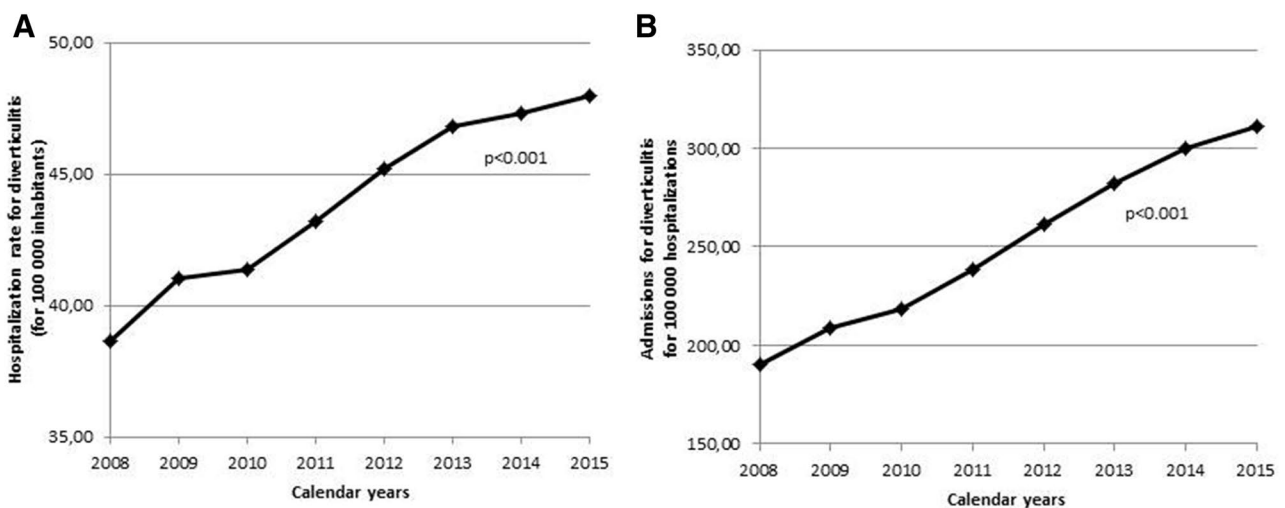
same time, the overall number of all-cause hospitalizations decreased by 25% (from 9,890,961 to 7,827,402) ( $p < 0.001$ ).

The overall rate of hospital admissions for AD per 100,000 inhabitants was 44 increasing progressively from 39 in 2008 to 48 in 2015, a yearly increase of over 3% ( $p < 0.001$ ) (Fig. 1a). The overall rate of hospital admissions for AD per 100,000 hospitalizations was 248 increasing from 190 in 2008 to 310 in 2015, with a 7.5% increase per year ( $p < 0.001$ ) (Fig. 1b).

## Rates of hospital admissions for AD by gender and age

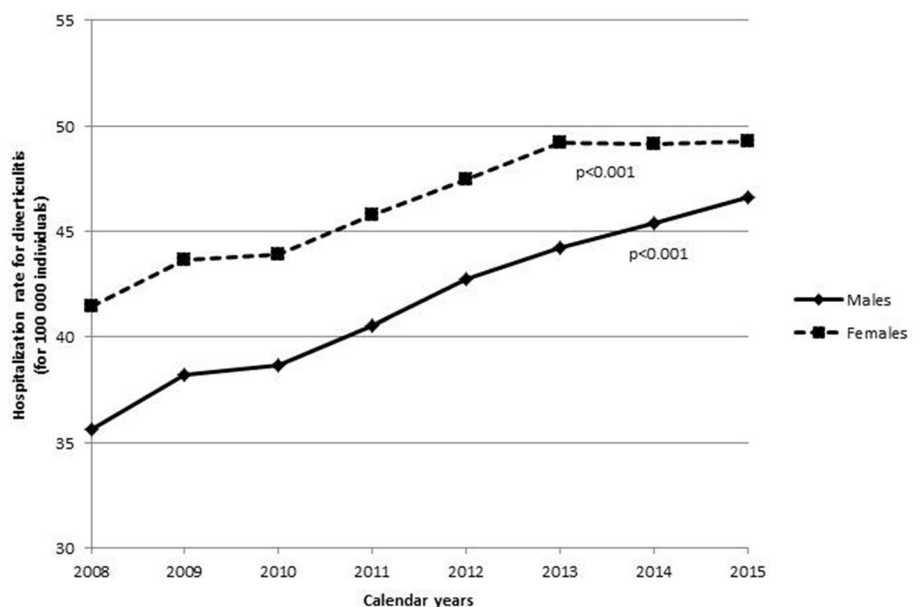
Rates of hospital admissions for AD per 100,000 individuals by gender are illustrated in Fig. 2. Women had higher rates of hospital admissions than men ( $p < 0.001$ ). Rates of hospital admissions for AD increased significantly ( $p < 0.001$ ) for both gender categories, but to a greater extent among men (mean increase per year 3.9% compared to 2.1% among women).

Rates of hospital admissions for AD per 100,000 individuals by age categories are reported in Fig. 3. Rates were higher for patients over 80 years old (mean number of hospitalizations  $152.94 \pm \text{SD } 2.87$ ) and for those 70–79 years

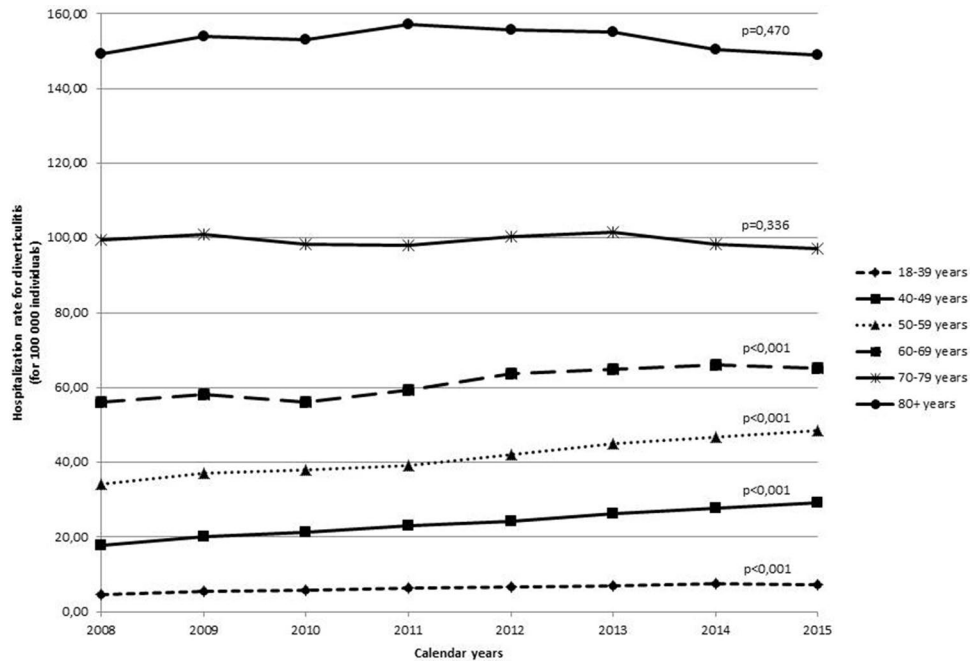


**Fig. 1** Hospitalization rate for diverticulitis per 100,000 individuals (a) and per 100,000 total hospitalizations (b)

**Fig. 2** Prevalence of hospitalization for diverticulitis for 100,000 individuals by gender categories



**Fig. 3** Prevalence of hospitalization for acute diverticulitis per 100,000 individuals by age categories

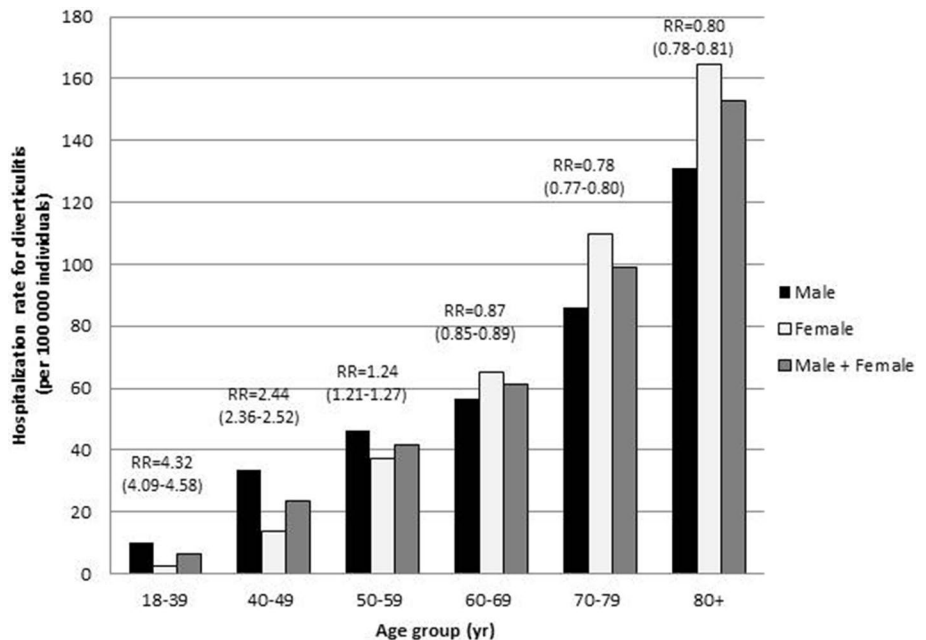


old (mean number of hospitalizations  $99.23 \pm SD 1.49$ ). However, the rates in these two age groups were unchanged between 2008 and 2015 with a no significant 0.2% decrease per year for both groups. Individuals 18–39 years old experienced the lowest rate of hospitalizations for AD (mean  $6.32 \pm SD 0.93$ ). However, in this age category, the rate of hospital admissions for AD increased over the study period, with a mean increase of 6.6% per year ( $p < 0.001$ ). A statistically significant increase in the rate of hospital admissions was also documented for patients 60–69 years old (mean

increase 2.7% per year), patients 50–59 years (mean increase 5.1% per year), and it was greatest for patients 40–49 years old (mean increase 7.1% per year).

Figure 4 illustrates the hospitalization rate for AD in age categories, stratified by sex. Among patients below the age of 60 men predominated and the male-to-female ratio for admissions was 4.32 (95% CI 4.09–4.58), 2.44 (95% CI 2.36–2.52) and 1.24 (95% CI 1.21–1.27) for patients 18–39, 40–49 and 50–59 years, respectively. In contrast, among those over 60 years old women predominated with

**Fig. 4** Hospitalization rate for acute diverticulitis in age categories, stratified by sex



a male–female ratio of 0.87 (95% CI 0.85–0.89), 0.78 (95% CI 0.77–0.80), 0.80 (95% CI 0.78–0.81) for patients 60–69, 70–79 and  $\geq 80$  years, respectively.

### Number of hospital admissions for AD for each patient

Between 2008 and 2015, the annual number of patients with one hospital admission for AD increased from 16,529 to 21,279 ( $p < 0.001$ ) (Fig. 5a) and the number of those with at least two hospital admissions increased from 1048 to 1519 ( $p < 0.001$ ) (Fig. 5b). The growth trend of both groups was comparable with no significant differences. The number of patients with one hospital admission was significantly higher than the number of patients with at least two hospitalizations ( $p < 0.001$ ).

### In-hospital mortality

During the study period, the overall in-hospital mortality rate increased significantly from 1.2 to 1.5% ( $p = 0.017$ ). An increase of in-hospital mortality was only evident for women ( $p = 0.025$ ) and for patients in age categories above 70 years (Table 2). Between 2008 and 2015, in-hospital mortality of patients with one hospitalization increased from 1 to 1.4% (mean increase per year of 3%,  $p = 0.003$ ) whereas in patients with  $\geq 2$  hospitalization it was almost stable changing from 1.2 to 1.3% (mean increase per year of 1.4%,  $p = 0.717$ ).

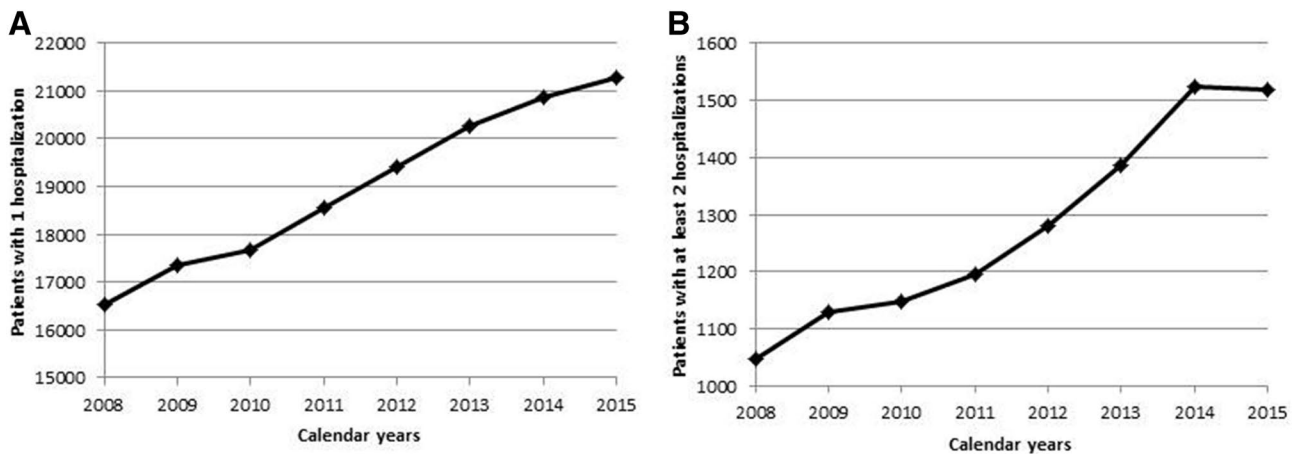


Fig. 5 Trend of patients with 1 (a) and with  $\geq 2$  hospitalizations (b) from 2008 to 2015

**Table 2** In-hospital mortality of patients admitted for acute diverticulitis from 2008 to 2015

%	2008	2009	2010	2011	2012	2013	2014	2015	<i>p</i> value for trend
Overall	1.17	1.29	1.4	1.4	1.53	1.49	1.28	1.5	0.017
Gender									
Male	0.93	0.85	1.2	1.22	1.19	1.08	0.99	1.15	0.218
Female	1.37	1.64	1.57	1.53	1.8	1.83	1.52	1.8	0.025
Patient's age									
18–39 years	0	0.11	0	0.2	0	0.09	0.08	0	0.865
40–49 years	0.19	0.11	0.2	0.09	0.09	0	0	0.03	0.008
50–59 years	0.27	0.25	0.27	0.26	0.24	0.22	0.23	0.14	0.241
60–69 years	0.21	0.58	0.65	0.52	0.48	0.6	0.68	0.53	0.098
70–79 years	1.2	1.06	1.27	0.13	1.32	1.19	1.25	1.7	0.034
$\geq 80$ years	2.91	3.3	3.43	3.46	4.14	4.19	3.34	4.03	0.001
Number of hospitalizations									
1	1	1.14	1.21	1.22	1.38	1.34	1.11	1.4	0.003
$\geq 2$	1.24	0.97	1.48	1.51	1.17	0.94	0.99	1.32	0.717

## Discussion

The findings of this Italian nationwide study show a significant increase of the number and the rate of hospital admission for AD between 2008 and 2015 of 30% and 3.2% per year respectively, while in the same period, the global number of hospital admissions in Italy significantly declined by 25%. These temporal trends suggest true changes in the epidemiology of AD in terms of incidence and severity of the disease rather than a lower threshold for hospitalization.

Our figures are consistent with those obtained by several studies from other Western countries (Table 3). However, these data are not fully comparable due to the different organizations of the health systems and the heterogeneous administrative source. Some countries manage health care according to the Beveridge model (the government provides funding through tax payments), some according to the Bismarck model (insurance system financed jointly by employers and employees), and others by means of a hybrid system.

Our study reports the largest national analysis from a Beveridge-type system. Among similar countries, Paterson et al. [8] investigated the burden of diverticular disease in Scotland over a decade founding an average increase in the incidence of hospital admissions for AD of 4.5% per year but the sample includes elective day-case admissions for

colonoscopy. In New Zealand, Vather et al. [17] described the trend of acute hospital admission for diverticular disease showing a steady increase over the 12.5-year study period but potential bias could affect the data extraction from the national database. It does not reliably differentiate diverticular bleeding from acute diverticulitis and does not provide for mandatory recording of the secondary diagnoses. Jeyarajah and Papagrigroriadis [5] found a remarkable threefold increase of hospital admissions over a decade in a small series from a single institution.

Several investigations examined the same subject in the USA and reported similar epidemiological trends of admission for AD in the context of a hybrid health system [6, 7, 9, 11, 15–17]. Most of them [6, 7, 9, 15] were able to analyse very large sample using the National Inpatient Sample database, which is a nationally representative sample of approximately 20% of the hospital discharges within the USA [6]. Our source of data was able to collect every hospital admission to any Italian hospital, avoiding any potential selection bias due to their public or private nature rather than to the regional areas (north / south, urban/rural).

As previously reported in the literature, we found that the overall rate of hospital admissions for AD was significantly higher among women than men. The trend significantly increases year by year for both gender group, but unlike other authors [4, 7, 9], we found that the male–female ratio constantly decreased over the study period.

**Table 3** Previous studies on epidemiology of Diverticulitis from National databases

Author	Year	Country	Data source	Obs. period	Sample size	Incidence/100,000/year	Annual trend
Kang [4]	2003	England	Hospital Episode Statistics database (NHS)	1989–2000		25.1–28.2	↑
Jeyarajah [5]	2008	England	Hospital Episode Statistics database (NHS)	1995–2004	2979	71–263/year	↑
Etzioni [6]	2009	US	Nationwide inpatient sample	1998–2005	267,000	58.9–71	↑
Nguyen [7]	2011	US	Nationwide inpatient sample	1998–2005	323,097	61.8–75.5	↑
Masoomi [15]	2011	US	Nationwide inpatient sample	2002–2007	1,073,397	Average increase: 9.5% per year	↑
Paterson [8]	2014	Scotland	Scottish morbidity records (NHS)	2000–2010	87,314	Average increase: 4.5% per year	↑
Talabani [10]	2014	Norway	Levanger Hospital database	1988–2012	650	17.9–51.1	↑
Barucha [11]	2015	US	Rochester Epidemiology Project	1987–2007	3222	115–188	↑
Simianu [16]	2015	US	Washington State CHARS database	1987–2012	84,313	34–85	↑
Vather [17]	2015	New Zealand	National Health System	2000–2012	25,167	1443–2701 no hospital admission per year	
Wheat [9]	2016	US	Nationwide inpatient sample	2000–2010	2,151,023	74.1–91.9	↑
Bollom [18]	2017	US	National emergency department sample	2006–2013	268,767–360,272 per year	89.8–113.9 (ED visits)	↑

RR rate ratio (95% CI)

The analysis of our data categorized by age shows that elderly patients over 70 years of age had the highest rate of hospital admission during the 8-year period but the trend is stable, whereas the increase of the number of hospitalizations over time is to be entirely attributed to the younger cohorts of patients under the age of 60. These findings are consistent with previous epidemiological studies carried out in other European countries and in USA and Jeyarajah and Papagrigroriadis [5] reported that the mean age at admission decreased between 1995 and 2004 [5, 6, 8, 9, 11, 17, 18].

Nguyen and colleagues [7] and Kang and colleagues [4] found that in the age category <45 years, AD-related hospital admissions were more common among men whilst the opposite was true in older age groups; Talabani et al. [10] found that the effect of age over time is linear for females and non linear for the males. Similarly, the stratification of our sample by sex and age demonstrates that AD is male predominant among younger patients and female predominant among older ones. There is no clear-cut explanation of these epidemiological features but they suggest two pathways in the pathogenesis of the disease: the first is age-related as the prevalence of the diverticular disease rises with age [1], the second is probably related to different risk factors such as fibre intake, dietary habits, obesity, colonic functional or structural abnormalities, but further studies are needed to elucidate these issues. Ethnic susceptibility was suggested in the past but to date no definitive conclusion regarding this have been drawn [9, 19]. In our study, a large cohort of patients from a Mediterranean country was investigated for the first time and our results show that the epidemiological trends are similar to those in other Western developed countries. This could give rise to debate about the supposed protective role of the so-called “Mediterranean diet”, vs. the dietary habits of the fast-food generation.

According to the natural history of diverticulitis, the number of patients with one hospital admission was significantly higher than the number of patients with two or more hospitalizations. The significantly increasing annual number of patients with one hospital admission during the study period confirms that the growing overall hospitalization for AD is related to a true rising incidence of the disease.

Overall in-hospital mortality significantly increased from 1.2% to 1.5%: the increased rate was observed exclusively in the patients with one admission, confirming that the most severe presentation of AD is during the first episodes [20–22]. This increase in hospital mortality over time was not observed by similar studies [4, 6, 18] and deserves further investigation. Mortality rates were higher in patients 70+ years old and in women which is consistent with results of other studies [4, 6, 8]. A further analysis, already planned, about complications of AD from this database, will give more detailed explanations about in-hospital mortality.

## Conclusions

This study investigated the largest sample of patients hospitalized for AD in a Beveridge-type health system and it is the first report from a Mediterranean country. In Italy, between 2008 and 2015, the rate of hospital admissions for AD significantly increased. The hospitalization rate was higher in the elderly  $\geq 70$  years of age but its rise over time was due to the increasing hospitalization of younger individuals, especially men. The causes of this emerging pattern are unknown but these findings suggest that there are two pathways in the pathogenesis of AD. Furthermore, these results emphasise the need for an increased awareness regarding AD and for the development of appropriate clinical skills in the management of this increasingly common clinical entity.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This article does not contain any studies with human participants performed by any authors.

**Informed consent** For this type of study formal consent is not required.

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