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Studying the burden of community-acquired pneumonia in adults aged ≥ 50 years in primary health care: an observational study in rural Crete, Greece

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BACKGROUND: Community-acquired pneumonia (CAP) is a potentially life-threatening condition that often requires hospitalisation particularly in the elderly population or in patients with comorbidities.

AIMS: The aims of this study were to estimate the CAP frequency and severity in a well-defined primary healthcare setting in rural Crete, to record patient characteristics, their immunisation status and to estimate hospitalisation frequency and determinants.

METHODS: An observational study was designed and implemented in a rural setting within the prefecture of Heraklion in the island of Crete, Greece. Eligible patients were those aged 50 years or above, presenting with CAP based on signs and symptoms and positive X-ray findings.

RESULTS: A total of 124 CAP cases were recorded, 40 of which (32.3%) were hospitalised. The age-standardised CAP incidence was estimated to be 236.7 cases per 100,000 persons aged ≥ 50 years. Forty-three patients (35.2%) were vaccinated against pneumococcus. The most frequent chronic illnesses were heart disease (64.5%), chronic obstructive pulmonary disease (32.5%), and type 2 diabetes (21%). Hospitalisation determinants included advanced age (≥ 74 years, Odds ratio (OR) 7.13; P value = 0.001; 95% confidence interval (CI), 2.23–22.79), obesity (OR 3.36, P = 0.037; 95% CI, 1.08–10.52), ≥ 40 pack-years of smoking (OR 3.82, P value = 0.040; 95% CI, 1.07–18.42), presence of multimorbidity (OR 5.77, P value = 0.003; 95% CI, 1.81–18.42) and pneumococcal vaccination (OR 0.29, P value = 0.041; 95% CI, 0.09–0.95).

CONCLUSIONS: This study highlighted patient characteristics and aspects of CAP epidemiology in the context of a rural primary care setting in southern Europe where limited data have been published until now.

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INTRODUCTION

Community-acquired pneumonia (CAP) is one of the most common infectious diseases worldwide that is associated with increased mortality in older adults and in individuals with chronic illnesses.¹ CAP often develops outside the hospital setting and can be caused by a variety of pathogens, by both bacteria and viruses.^{2,3} In the United States, CAP is the leading cause of death caused by infectious diseases.⁴ Its severity and treatment can vary, and a considerable proportion of patients often require hospitalisation. The predominant pathogen in CAP is *Streptococcus pneumoniae* (*S. pneumoniae*), which accounts for a significant part of all cases of bacteraemic pneumonia. *S. pneumoniae* is also responsible for about 50% of all cases requiring admission to the hospital.⁵ Owing to the high antibiotic-resistant strains of *S. pneumoniae*, it is important to detect, diagnose, assess the severity and treat pneumonia in daily clinical practice.^{1,6}

Certain studies have indicated a varying incidence ranging from 1.6 to 9 cases per 1,000 persons in the general adult population.^{5,7–10} These studies have also highlighted inconsistent hospitalisation rates owing to CAP ranging from 8 to 51%. CAP mortality varies significantly between hospitalised patients and outpatients. Studies have reported mortality from a low 5% to a high 15% among hospitalised patients, whereas this figure is less

than 1% for outpatients.^{11,12} The financial burden of the disease worldwide is estimated to be \$4.8 billion for patients aged ≥ 65 years and \$3.6 billion for patients aged < 65 years.¹³ In addition to this, the total cost of inpatient management could be 20 times higher than the total cost for outpatient management.¹⁴ There is much interest about the prevention of CAP and much discussion in the literature has been dedicated to that subject. Vaccines against *S. pneumoniae* are available worldwide and are utilised by health-care services.¹⁵

In their daily practice, general practitioners frequently encounter patients presenting with a vast variety of medical conditions. Sometimes decisions by general practitioners to refer their patient to a specialist are made within a very narrow consultation time, within a duration of 6–12 min.¹⁶ In addition, respiratory tract infections are the most common reason for consultation in primary health care (PHC) resulting in 15% of the total primary care consultations.¹⁷ Under such circumstances and given that CAP is a potentially life-threatening condition, the identification of CAP patients in need of immediate treatment seems to be quite imperative.¹⁸ For all those reasons, diagnosis of CAP in outpatient settings and in PHC remains a challenge owing to the variety of signs and symptoms that can be presented.¹⁹ According to the British Thoracic Society guidelines summary for PHC, CAP has

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been defined as symptoms of an acute lower respiratory tract illness, new focal chest signs on examination, evidence of systemic illness, no other explanation for the illness, and a clinical decision that should be treated as CAP.¹⁸

In rural Greece, the management of CAP in the community is primarily performed by general practitioners serving remote and rural practices or health-care centres. However, as a patient gate-keeping system is lacking in the country, patients are able to visit public hospitals or even private clinics whenever they choose. As regards CAP epidemiology, there is in general a paucity of data in the country. There are still questions about the incidence rates of CAP in PHC, the vaccination coverage of patients affected by CAP and the underlying conditions that could favour this infection. It is unknown as to what extent the changing human and social environment on rural Crete has an impact on CAP morbidity and its hospitalisation rates. In addition, although certain empirical studies carried out at a primary care level in Crete indicated a poor vaccination rate against pneumococcus in people with chronic diseases, it remained unclear as to what extent patients affected with CAP were vaccinated or not.

Aims and objectives of the study

To that purpose, an observational study was designed and implemented in rural Crete to gain insights into the burden of CAP. This study aimed to assess the CAP incidence among residents of a well-defined rural area who visited the selected health-care services (both primary and hospital), the frequency of the underlying chronic conditions of CAP patients, smoking and alcohol consumption and their level of vaccination coverage against pneumococcus and influenza. The study's objectives were to assess the severity of CAP cases in the community, to estimate the hospitalisation rates due to CAP and identify the hospitalisation determinants to assess the possible preventive role of pneumococcal vaccination in adults. The results of this study are expected to have an impact on both continuous professional education and health policy.

MATERIALS AND METHODS

Setting

A cross-sectional, multicentre study was designed and implemented in a well-defined rural setting in the prefecture of the Heraklion district in the island of Crete, Greece. The duration of the observation period was 1 year (from 15 March 2011 to 15 March 2012). The permanent residents of rural areas in the Prefecture of Heraklion served as the target population. The selected setting included all six rural public PHC capacities of the district and namely the Health Centers of Ano Viannos, Arkalochori, Kastelli, Agia Varvara, Moires and Charakas and both pulmonary hospital clinics located in the Heraklion city (namely Venizeleio & PAGNI hospitals). The two pulmonary clinics had access to the respective hospitals' emergency care units. The selected setting covered all possible public health facilities where the rural population could have access to.

Population and inclusion–exclusion criteria

Eligible patients were those aged 50 years or older, permanent residents of the rural area in the prefecture of the Heraklion district ($n=45,300$) who visited one of the six PHC capacities in the rural areas of the Heraklion prefecture, or one of the two public pulmonary hospital clinics, and presented signs and symptoms of a lower respiratory infection with an X-ray confirming CAP. Previously hospitalised patients (for whatever reason other than CAP) discharged less than 14 days from hospital who presented signs and symptoms of pneumonia were intended to be excluded from the study in order to avoid cases of nosocomial infection. However, there were no such cases in our study.

Measurements and data collection

Structured and pretested baseline and follow-up questionnaires were used in order to elicit information on patients' characteristics. The baseline

questionnaire included questions about the participants' socio-demographic status (age, gender, educational and marital status), their socio-economic status (employment status, number of housemates and those aged 5 years or less, smoking and alcohol consumption), and immunisation status (vaccination against pneumococcus and influenza). Information regarding chronic illnesses and prescribed medication were obtained from the available patients' medical records. Baseline questionnaires also included information on symptoms and clinical signs of the disease (temperature, confusion, chest pain, respiratory auscultation sounds, lung-percussion, dyspnoea, chest pain, and sleep hyperhidrosis). Follow-up questionnaires were used for hospitalised patients and outpatients. These questionnaires included information regarding inpatient and outpatient disease management (referral to the hospital and outpatients' number of visits to their general practitioners, number of days in hospital, haematological and laboratory diagnostic tests, referral to the intensive care unit, re-hospitalisation, and medications). Clinical measurements recorded in both questionnaires included systolic and diastolic blood pressure (measured in mmHg), respiratory rate (measured in breaths per minute—b.p.m.) and O₂ saturation (%). Haemoglobin, arterial oxygen, and white blood cell count were obtained from blood samples. Questionnaires were collected, checked for completeness and consistency and their data were stored in an electronic database.

Definitions

CAP was defined as a respiratory infection associated with signs and symptoms of an acute lower respiratory infection according to the British Thoracic Society confirmed with a lung infiltrate in the chest X-ray.¹⁸ The CRB-65^{20,21} (C: confusion, R: respiratory rate, B: blood pressure, 65 years of age and older) score was computed for each patient with complete data in order to provide information regarding the severity of the disease. Patients were classified as obese when body mass index (BMI) > 30 kg/m². Smokers were classified as never smokers, light smokers or moderate smokers (1–39 pack-years of smoking), and heavy smokers (40 or more pack-years of smoking). Multimorbidity was defined as the presence of two or more chronic illnesses.

Bioethics

This study was designed by a research team at the Clinic of Social and Family Medicine and was approved by the Commission of Bioethics of the University Hospital of Heraklion (protocol number: 13541, 20.11.2010). All patients were enrolled after being informed about the study and provided a written consent.

Statistical analysis

Univariate analysis of continuous variables (age and BMI) was performed using the nonparametric Mann–Whitney test. Univariate analysis of categorical variables was performed using the χ^2 -test of independence, as well as Fisher's exact test. Age was dichotomised at median into two categories (≥ 74 years, < 74 years). Patients were also dichotomised into two categories according to their BMI (obese: those with a BMI > 30 kg/m², and nonobese: those with a BMI \leq 30 kg/m²). From the data collected from questionnaires, the number of pack-years was computed for each patient. After quartile analysis, the number of pack-years of smoking was divided into three categories: 0 pack-years, nonsmokers; 1–39 pack-years of smoking, low and moderate amount of smoking; ≥ 40 pack-years of smoking, heavy smokers. Unconditional multivariate logistic regression with the dependent variable being the patient hospitalisation (yes/no) was performed in order to identify the determinants for hospitalisation due to CAP. The independent variables used in the regression model were age category (≥ 74 / < 74 years), presence of obesity (yes/no), pack-years of smoking category (0 pack-years/(1–39) pack-years/ ≥ 40 pack-years), presence of multimorbidity (yes/no), and pneumococcal vaccination (yes/no). The Hosmer and Lemeshow test was used to assess the fit of the model. Inpatients were also dichotomised at median according to the level of arterial oxygen in their blood (≤ 58.8 and > 58.8 mg/dl). The level of statistical significance was set to 5%, and the statistical software package used was SPSS Statistics version 19 (IBM, Chicago, IL, USA).

RESULTS

CAP frequency, general information on patient demographics, smoking, and socio-economic and vaccination status

A total of 124 CAP cases were registered, 64 were men (51.6%) and 60 were women (48.2%). The crude incidence of CAP was estimated to be 273.5 cases per 100,000 persons aged 50 years or older. On the basis of the European standard population, the age-standardised incidence of CAP was estimated to be 236.7 cases per 100,000 persons aged 50 years or older.

Forty patients (32.3%) were hospitalised, whereas the remaining 84 cases were treated as outpatients. Two out of the 40 hospitalised patients died during hospitalisation and one patient was re-admitted owing to CAP 3 months after the initial discharge. Demographic, socio-economical, and anthropometric characteristics are depicted in Table 1. Significant differences between men and women were observed only with regard to smoking and alcohol consumption. Forty-five percent of patients were current/former smokers, almost one-third of patients were obese (31.9%) and although the majority (61.5%) were vaccinated against influenza only a minority were vaccinated against pneumococcus with the 23-valent polysaccharide vaccine (35.2%). Most patients were married (71.8%), retired or housewives (86.1%), and with no or only primary education (87.5%). The median reported number of housemates was two. Only two participants reported living together with children aged less than 5 years. The median reported number of rooms in the participants' household was four.

Underlying morbidity

Heart disease was the most common chronic illness (64.5%), followed by chronic obstructive pulmonary disease (COPD) (32.5%) and type 2 diabetes (21.0%). A significant proportion of patients suffered from multimorbidity (43%). Significant differences in frequencies of chronic illnesses between men and women were reported for COPD, which was more predominant in men (odds ratio (OR) 3.80, 95% confidence interval (CI), 1.67–8.60, $P < 0.001$), and asthma, which was more evident in women (male to female OR 0.12, 95% CI, 0.01–0.99, $P = 0.022$). Further details are shown in Table 2.

Vaccination rates in patients with comorbid conditions

Immunisation rates against pneumococcus were higher among patients with certain comorbidities. Specifically, the vaccination coverage against pneumococcus in patients suffering from COPD was 43% (18/40), in patients with asthma it was 50% (4/8), in patients with heart disease it was 45% (35/78), and in patients with type 2 diabetes it was 44% (11/25). Only patients with heart disease were vaccinated at a significantly higher frequency compared with those without heart disease (45 vs. 18%, OR 3.66, 95% CI, 1.51–8.89, $P = 0.003$). The vaccination coverage for influenza was 70% (28/40) in patients suffering from COPD, in patients with asthma it was 87.5% (7/8), in patients with heart disease it was 69% (54/78), and in patients with type 2 diabetes it was 72% (18/25). Only patients with underlying heart disease were vaccinated at a significantly higher frequency compared with those without heart disease (69% vs. 48%, OR 2.46, 95% CI, 1.15–5.28, $P = 0.019$).

Hospitalised and outpatient features

Hospitalised patients were significantly older compared with outpatients (OR 1.05, 95% CI, 1.01–1.08, $P = 0.025$), with more pack-years of smoking (OR 3.43, 95% CI, 1.44–8.12, $P = 0.015$ for 40 or more pack-years of smoking). COPD was the only comorbidity that differed in favour of hospitalised patients (OR 6.28, 95% CI, 2.73–14.48, $P < 0.0001$). Asthma, heart disease, and type 2 diabetes were more frequently observed among hospitalised patients compared with outpatients, but none of the above differences were found to be statistically significant. Hospitalised patients reported multimorbidity at a significantly higher proportion compared with outpatients (OR 4.57, 95% CI, 2.03–10.30, $P < 0.0001$).

As regards patients' clinical measurements, respiratory rate, and white blood cell in the peripheral blood had significantly higher values in the hospitalised group (OR 1.02, 95% CI, 1.06–1.25 and OR 1.33, 95% CI, 1.29–2.37, $P < 0.0001$ for respiratory rate and white blood cell, respectively), whereas O_2 saturation and haemoglobin concentration were significantly lower (OR 0.82, 95% CI, 0.73–0.92, $P < 0.0001$ for O_2 saturation and OR 0.70, 95% CI, 0.54–0.91, $P = 0.001$ for haemoglobin). The CRB-65 score was more frequently available in hospitalised patients (92.5%)

Table 1. General characteristics of recorded CAP patients

	All patients (n = 124)	Men (n = 64)	Women (n = 60)	Odds ratio (95% CI) P value
Age ^a (years)	74 (50–95; 18)	73 (50–95; 17)	75 (50–91; 20)	1.01 (0.97–1.04) 0.830
BMI ^a (kg/m ²)	28 (17–48; 5)	27 (18–42; 4)	39 (17–48; 9)	0.91 (0.85–0.98) 0.014
Obese (BMI > 30 kg/m ²)	38 (31.9%)	15 (24.2%)	23 (40.4%)	0.47 (0.21–1.04) 0.059
<i>Smoking</i>				< 0.0001
0 pack-years	60 (55.0%)	16 (29.6%)	44 (80.0%)	0.11 (0.04–0.25)
1–39 pack-years	16 (14.7%)	12 (22.2%)	4 (7.3%)	3.64 (1.09–12.13)
≥ 40 pack-years	33 (30.3%)	26 (48.1%)	7 (12.7%)	6.37 (2.45–16.56)
<i>Alcohol</i>				
Current/former users	32 (26.2%)	26 (41.9%)	6 (10.0%)	6.50 (2.43–17.37) < 0.0001
Vaccinated against influenza	75 (61.5%)	37 (59.7%)	38 (63.3%)	0.68 (0.41–1.78) 0.678
Vaccinated against pneumococcus	43 (35.2%)	24 (38.7%)	19 (31.7%)	1.32 (0.62–2.82) 0.453
<i>Education level</i>				
None/primary	105 (87.5%)	54 (88.5%)	51 (86.4%)	0.83 (0.28–2.44) 0.730
<i>Marital status</i>				
Married	89 (74.8%)	48 (77.4%)	41 (71.9%)	1.34 (0.58–3.07) 0.491
Single/divorced/widowed	30 (25.2%)	14 (22.6%)	16 (28.1%)	
No. of housemates ^a	2 (0–6; 1)	2 (0–6; 2)	2 (0–5; 1)	1.03 (0.77–1.37) 0.721

Abbreviations: BMI, body mass index; CAP, community-acquired pneumonia; CI, confidence interval.

^aContinuous variables are presented as median (min–max; interquartile range).

Table 2. Frequencies of common chronic illnesses of recorded CAP patients

	All patients (n = 124)	Men (n = 64)	Women (n = 60)	Odds ratio (95% CI) P value
COPD	40 (32.5%)	29 (46.0%)	11 (18.3%)	3.80 (1.67–8.60) 0.001
Asthma	8 (6.5%)	1 (1.6%)	7 (11.9%)	0.12 (0.01–0.99) 0.022 ^a
Heart disease	80 (64.5%)	37 (57.8%)	43 (71.7%)	0.54 (0.26–1.15) 0.107
Type 2 diabetes	26 (21.0%)	11 (17.2%)	15 (25.0%)	0.62 (0.26–1.49) 0.286
Immunosuppressive	4 (3.3%)	1 (1.6%)	3 (5.1%)	0.30 (0.03–2.98) 0.353
Malignancy	7 (5.6%)	3 (4.7%)	4 (6.7%)	0.69 (0.15–3.21) 0.711
Multimorbidity	52 (43.3%)	28 (45.2%)	24 (41.4%)	1.17 (0.57–2.41) 0.676

Odds ratio using women as the reference category.

Abbreviations: CAP, community-acquired pneumonia; CI, confidence interval; COPD, chronic obstructive pulmonary disease.

^aFisher's exact test.

Table 3. Univariate analyses of factors between hospitalised patients and outpatients

	Hospitalised (n = 40)	Outpatients (n = 84)	Odds ratio (95% CI) P value
Age ^a	78 (53–94; 10)	69 (50–95; 21)	1.05 (1.01–1.08) 0.025
Male gender	22 (55.0%)	42 (50.0%)	0.60 (0.57–2.60) 0.602
BMI ^a (kg/m ²)	28.6 (20.0–41.8; 5.5)	27.6 (17.1–47.6; 5.6)	1.02 (0.95–1.09) 0.397
Obese (BMI > 30 kg/m ²)	15 (37.5%)	23 (29.1%)	1.46 (0.65–3.26) 0.354
Smoking			0.015
0 pack-years	15 (42.9%)	45 (60.8%)	0.48 (0.21–1.09)
1–39 pack-years	3 (8.6%)	13 (17.6%)	0.40 (0.11–1.51)
≥ 40 pack-years	17 (48.6%)	16 (21.6%)	3.43 (1.44–8.12)
Alcohol			0.78 (0.32–1.90) 0.578
Current/former users	9 (23.1%)	23 (27.7%)	
Vaccinated against influenza	25 (64.1%)	50 (60.2%)	1.18 (0.54–2.59) 0.680
Vaccinated against pneumococcus	11 (28.2%)	32 (38.6%)	0.63 (0.27–1.43) 0.264
COPD	24 (60.0%)	16 (19.3%)	6.28 (2.73–14.48) < 0.0001
Asthma	5 (12.5%)	3 (3.7%)	3.76 (0.85–16.62) 0.064
Heart disease	30 (75.0%)	50 (59.5%)	2.04 (0.88–4.72) 0.092
Type 2 diabetes	10 (25.0%)	16 (19.0%)	1.42 (0.58–3.48) 0.447
Immunosuppressed	3 (7.5%)	1 (1.2%)	6.57 (0.66–65.26) 0.103
Malignancy	2 (5.0%)	5 (6.0%)	0.83 (0.15–4.48) 0.830
Multimorbidity	27 (67.5%)	25 (31.2%)	4.57 (2.03–10.30) < 0.0001
SBP ^a	130 (104–191; 25)	134 (105–180; 16)	0.99 (0.97–1.02) 0.449
DBP ^a	76 (55–128; 15)	80 (50–120; 10)	1.00 (0.97–1.04) 0.524
Respiratory rate ^a (b.p.m.)	24 (14–36; 8)	17 (10–39; 7)	1.02 (1.06–1.25) < 0.0001
O ₂ Saturation ^a (%)	92 (72–97; 6)	94 (78–99; 3)	0.82 (0.73–0.92) < 0.0001
Hb ^a (mg/dl)	11.9 (9.1–16.0; 3.0)	13.3 (5.7–18.1; 1.8)	0.70 (0.54–0.91) 0.001
WBC ^a (mg/dl)	10,550 (5,900–35,000; 7,650)	9,550 (3,700–18,100; 5,975)	1.33 (1.29–2.37) 0.032
Sleep hyperhidrosis	2 (5.3%)	42 (50.0%)	0.06 (0.01–0.25) < 0.0001
Confusion	5 (12.8%)	2 (2.4%)	6.03 (1.12–32.60) 0.032
Chest pain	7 (17.9%)	35 (41.7%)	0.31 (0.12–0.77) 0.01
Abnormal respiratory sounds	36 (94.7%)	68 (81.0%)	4.24 (0.92–19.45) 0.047
CRB-65 score			2.21 (0.68–7.22) 0.184
0	5 (13.5%)	10 (25.6%)	
≥ 1	32 (86.5%)	29 (74.4%)	

Odds ratios are computed using outpatients as the reference category. Odds ratios for continuous variables refer to a unit increase in each value except WBC, where they refer to one thousand units increase in its value.

Abbreviations: BMI, body mass index; CAP, community-acquired pneumonia; CI, confidence interval; COPD, chronic obstructive pulmonary disease; CRB-65, C:confusion, R:respiratory rate, B:blood pressure at 65 years of age and older; DBP, diastolic blood pressure; Hb, haemoglobin; SBP, systolic blood pressure; WBC, white blood cell.

^aContinuous variables are presented as median (min–max; interquartile range).

compared with 39/84 in outpatients (46.4%). The majority of patients presented CRB-65 scores ≥ 1 , with 10 outpatients (25.6%) and 5 inpatients (13.5%) presenting CRB-65 score = 0. More details are depicted in Table 3.

Determinants for hospitalisation in CAP patients

Multivariate logistic regression was performed to identify independent predictors associated with hospitalisation due to

CAP. Significant determinants were advanced age (≥ 74 years, OR 7.1, 95% CI, 2.23–22.79, $P=0.001$), underlying obesity (BMI > 30 kg/m², OR 3.4, 95% CI, 1.08–10.52, $P=0.037$), smoking (≥ 40 pack-years, OR 3.8, 95% CI, 1.81–18.42, $P=0.040$), underlying multimorbidity (OR 5.8, 95% CI, 1.81–18.42, $P=0.003$), and pneumococcal vaccination (OR 0.29, 95% CI, 0.09–0.95, $P=0.041$). Details of the regression model are presented in Table 4.

Length of hospitalisation

The median duration of hospitalisation was 7 days and was significantly higher for women compared with men ($P=0.032$), in the winter season ($P=0.001$), when malignancy was present ($P<0.027$) and when arterial oxygen concentration was less or equal to 58.8 mg/dl ($P=0.040$). There was also a trend for increased duration of hospitalisation when tachypnoea was present at the time of the first examination ($P=0.051$). No significant variation in the duration of hospitalisation was observed upon comparisons with regard to patients' age, different BMI groups, or chronic conditions (heart disease, COPD, type 2 diabetes, and asthma) (data not shown). Results are presented in Table 5.

Table 4. Logistic regression predicting the odds of hospitalisation due to CAP ($n=104$ cases included in the analysis)

Determinant	Odds ratio	95% CI	P value
Age ≥ 74 years	7.13	2.23–22.79	0.001
Obese	3.36	1.08–10.52	0.037
0 Pack-years	1.00 (reference)		0.019
1–39 Pack-years of smoking	0.317	0.06–1.73	0.185
≥ 40 Pack-years of smoking	3.817	1.07–13.68	0.040
Multimorbidity	5.77	1.81–18.42	0.003
Vaccinated against pneumococcus	0.29	0.09–0.95	0.041

χ^2 -test 36.639 on d.f. 6; P value <0.0001 ; pseudo- $R^2=0.412$.
95% CI, 95% confidence interval, Hosmer and Lemeshow χ^2 -test 6.39; $P=0.604$.
Abbreviations: CAP, community-acquired pneumonia; CI, confidence interval.

Table 5. Duration of hospitalisation

	Days in hospital ^a	P value
Gender		0.032
Male	6.5 (2–20; 6)	
Female	8.0 (4–16; 7)	
Season of CAP occurrence		0.001
Winter	12 (7–20; 6)	
Other	7 (2–16; 4)	
Malignancy		0.027
Yes	17 (14–20; 6)	
No	7 (2–16; 6)	
Asthma		0.089
Yes	8 (7–16; 7)	
No	7 (2–20; 6)	
Dyspnoea		0.067
Yes	7.5 (3–20; 6)	
No	5 (2–8; 5)	
Tachypnoea		0.051
Yes	7 (3–20; 6)	
No	4 (2–7; 5)	
Lung-percussion		0.081
Abnormal	8 (4–16; 5)	
Normal	7 (2–20; 6)	
PaO ₂ (mg/dl)		0.040
≤ 58.8	8 (4–16; 5)	
> 58.8	6 (2–20; 4)	

Abbreviation: CAP, community-acquired pneumonia.

^aContinuous variables are presented as median (min—max; interquartile range).

DISCUSSION

Main findings

This study highlighted certain key issues regarding various aspects of CAP in adults within the context of PHC. The hospitalisation rate was 32%, with a median duration of 7 days and an overall mortality of less than 2% all within hospital. With regard to patient characteristics, about one-third of patients were obese and almost half were current or former smokers. Forty-two percent of CAP patients reported multimorbidity, with the most frequent chronic conditions being heart diseases followed by COPD and type 2 diabetes. Approximately one-third of patients were vaccinated against pneumococcus, with the 23-valent polysaccharide vaccine, and almost two-thirds were vaccinated against influenza. Advanced age, obesity, underlying multimorbidity, and smoking independently increased the odds for hospitalisation due to CAP, whereas pneumococcal vaccination decreased the respective odds.

Interpretation of findings in relation to previously published work *CAP incidence*. The annual age-standardised CAP incidence in the present study was found to be 236.7 cases per 100,000 persons aged 50 years or above. A similar annual CAP incidence of 233 per 100,000 persons was also reported by a study conducted in the United Kingdom.²² Both our study and the UK study were conducted within the primary care context and are among the few studies to have explored CAP incidence in primary care in Europe.

This study did not include information about the causal agents of CAP as no blood cultures were performed to identify the pathogens as in other recent studies.²³ Despite the fact that the identification of CAP causality was not the focus of the present study, urine samples were collected from all 124 patients. All samples were stored at a temperature of -20°C and subsequently sent for analysis at the Pfizer laboratories in New York. Using the Luminex Urinary Antigen Detection method, six cases of *S. pneumoniae* (5%) were identified. The most prevalent serotype was Pn 19A (three cases) followed by Pn 23F, Pn 3, and Pn 7F (one case for each serotype).

Findings related to patient characteristics. No significant gender differences were found. Our results were similar to other studies that showed equal CAP male to female ratios^{24,25} and contrary to another primary care study where women were disproportionately diagnosed with pneumonia.¹⁹ Significant differences were observed in our study in terms of alcohol and smoking, indicating a male predominance. This may be explained by the fact that our sample was mainly rural where these 'habits' are considered mainly a male 'activity' (personal observations of the authors who serve these rural areas). In our study, the rate of those who were current/former smokers was 45% (70% in men and 20% in women) and was higher particularly in men compared with another Greek study²⁶ where the prevalence of smoking was estimated at 41% (45% in men, 38% in women). The majority of patients were classified as either overweight or obese. This finding was expected, as a recent primary care study regarding new cases of anaemia that was conducted in a similar setting in rural Crete found that 77% of participants were overweight or obese as well.²⁷

Research previously conducted in Greece has already reported the most common diagnoses made in the primary care setting.^{28,29} These diagnoses were used as a guide to record chronic illnesses in our study. About two-thirds of patients reported suffering from cardiovascular diseases, one-third from COPD and 21% from type 2 diabetes. COPD frequency was significantly higher in men compared with women and an explanation can be owing to the fact that men were smokers at a much higher extent compared with women. Moreover, this is in accordance with the only study that examined COPD prevalence

at the national level in Greece, including rural areas, and found a male gender-standardised prevalence of 11.6%, whereas for women it was 4.8%.³⁰ The frequency of type 2 diabetes was almost 25% in women and 17% in men and can be explained by the increased BMI observed in women compared with men. Despite the within-gender variations, these major chronic conditions appear to be more frequent in the population of our study compared with other Greek studies.^{27,31,32} Nevertheless, our findings seem to be in accordance with the literature, which suggests that patients suffering from heart diseases, COPD, or type 2 diabetes are at a higher risk for CAP.^{19,33,34}

Findings related to hospitalisations. Owing to the great discrepancies in the recognition and management of CAP, there is a need for primary care physicians to be able to recognise which cases should be referred to hospitals.³⁵ For this reason, numerous severity scoring systems have been developed and proposed for use in primary care, such as the CURB-65 and the CRB-65.^{20,21} In the present study, the CRB-65 was used, as the only difference between the two tools was that the CURB-65 includes urea estimation, which is not always available in primary care practices. The CRB-65 has been proved as a simple tool that can be used at a community level.³⁶ Our study revealed that the majority of our patients with a low-risk CRB-65 score were managed at home. However, a significant percentage of patients with a low score were admitted to the hospital, raising concerns that primary care physicians may over-refer patients to the hospitals. The widely used primary care measurement of pulse oximetry has been shown to be useful when making a decision regarding hospitalisation, as there were significant differences in oxygen saturation levels between hospitalised patients and outpatients. Increasing hypoxaemia is associated with higher mortality and critical care admission even when adjusted for CRB-65; therefore, its use should be recommended.^{37,38}

In our study population, about one-third of CAP patients required inpatient hospitalisation. This rate seems within the boundaries reported in the literature, yet somewhat higher from that reported in a large retrospective study of patients aged ≥ 50 years conducted in the United States.³⁹ Results of this study with regard to hospitalisation determinants adds to the discussion regarding the necessity of pneumococcal vaccination, indicating that vaccinated patients presented lower odds for hospitalisation compared with nonvaccinated patients. In addition, advanced age and underlying multimorbidity independently increased the odds for patient hospitalisation similarly to other studies that showed increased incidence, burden and mortality as age and multimorbidity increased.^{25,39,40} Primary care physicians should take age and multimorbidity into account when managing CAP patients, as older age and multimorbidities correlate with a higher mortality.²⁵ Obese patients in our study also presented higher odds for hospitalisation compared with nonobese patients, in parallel with findings of studies dealing with H1N1 influenza that reported higher hospitalisation rates among obese patients.^{41–44} Besides these, pack-years independently of chronic conditions increased the odds for hospitalisation similarly to other studies that showed a strong correlation of pack-years with invasive pneumococcal disease.^{45,46}

Findings related to CAP patients' immunisation status. About one-third of CAP patients were vaccinated against pneumococcus and two-thirds against influenza. Although the rate of vaccination against pneumococcus was significantly higher in patients with underlying heart disease, this was not the case for patients with underlying COPD, asthma, or type 2 diabetes. Overall, the level of vaccination coverage against pneumococcus was found to be somewhat low given the fact that the majority of patients were at a high risk for pneumococcal disease either owing to age or

comorbidities. This is in accordance with the 2010 International Primary Care Respiratory Group research needs statement that highlighted the need of finding effective strategies to improve uptake rated for vaccination.¹⁷ The rate of vaccination against influenza was relatively high in CAP patients suffering from certain chronic illnesses such as COPD, asthma, or type 2 diabetes. CAP patients suffering from heart disease were vaccinated at a significantly higher proportion compared with CAP patients without underlying heart disease.

Strengths and limitations

This study is subjected to the limitations of any observational study. As a result, an overall underestimation in the number of reported CAP cases that affected the general estimation of CAP incidence in our setting is possible, as a gate-keeping system is not established in the Greek Health Care system. In an effort to diminish this effect, a capture–re-capture study was conducted that estimated a prevalence of CAP as 296.5 cases per 100,000 persons. On the basis of this approach, a total of 59.8 CAP cases per 100,000 persons were possibly not captured either because they were hospitalised in private clinics or received medical care outside of the primary or secondary health-care resources that participated in the study. As our primary focus was to measure the burden of CAP in primary care, this study did not use a control group, and thus it missed the chance of discussing current findings with a comparative view. Finally, the study period was of 1 year; therefore, conclusions could be considered safe in terms of seasonal variation.⁴⁷ Despite these limitations, this study, to our knowledge, is the first primary care-based observational study that reports the real burden of CAP in the PHC services.

Implications for future research, policy, and practice

This study has highlighted several aspects regarding the burden and epidemiology of CAP in the context of a rural PHC setting in southern Europe, where limited data have been published until now. This study could also add to the ongoing literature discussion regarding the effectiveness of pneumococcal vaccination in older adults. The findings could contribute to the formation of guidelines regarding CAP prevention and timely treatment of at-risk patients within primary care settings.

CONCLUSIONS

This observational study that was conducted in rural primary care services succeeded in recording the majority of CAP cases and highlighted certain determinants regarding patients' hospitalisation. Certain outcomes of the study could serve the primary care reform that is currently under discussion in Greece during the austerity period.

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CONTRIBUTIONS

AB participated in the study, performed data entry and analyses, was the main author of the article, and drafted the manuscript. GD participated in the study as coordinator and reviewed the manuscript. IT participated in the study, was a co-author of the article, and reviewed the manuscript. NS conceived and supervised the study, was a co-author of the article, and reviewed the manuscript. All authors have approved the final manuscript. CL conceived and supervised the study, was a co-author of the article, and reviewed the final version of the manuscript.

COMPETING INTERESTS

IT is an Associate editor of *npj Primary Care Respiratory Medicine*, but was not involved in the editorial review of, nor the decision to publish, this article. All other authors declare no conflict of interest.

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