

# Journal Pre-proof



## Prevalence, Awareness and Control of Hypertension in Greece before and after the COVID-19 Pandemic: May Measurement Month Survey 2019-2022

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# Impact of the COVID-19 Pandemic on the Prevalence, Awareness, and Control of Hypertension in Greece May Measurement Month (MMM) 2019-2022

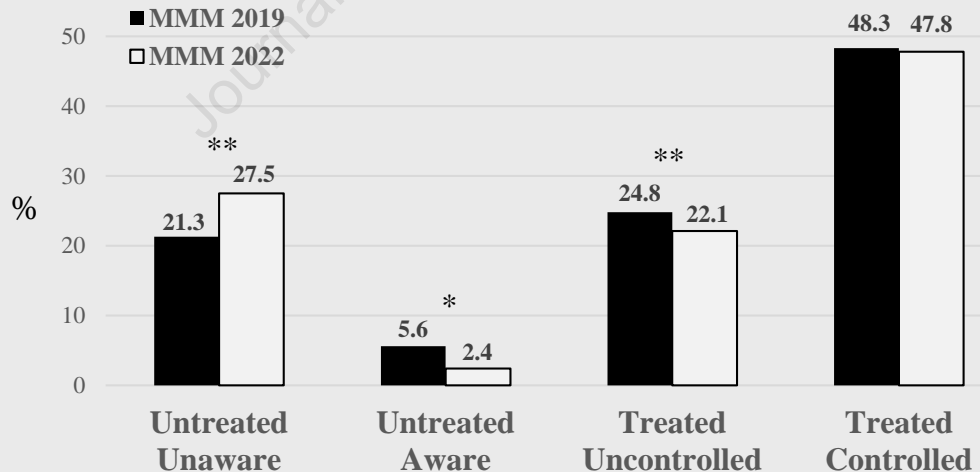
## METHODS

- **Adult volunteers** were evaluated through **opportunistic screening** in public areas in Greece before (*MMM 2019*) and after the COVID-19 pandemic (*MMM 2022*).
- **Medical history** and **triplicate** sitting blood pressure measurements were taken.

## KEY POINTS

- Data from **12,080** individuals were analysed (*MMM 2019*: 5,727; *MMM 2022*: 6,353).
- The **prevalence of hypertension** was **stable** in the two surveys (41.6/42.6% for 2019/2022).
- However, **undiagnosed hypertension** was **more common** after COVID-19 (*Figure*).

Awareness,  
Treatment,  
and Control of  
Hypertension  
in MMM 2019  
and MMM 2022  
surveys



\*, *P*-value <0.05; \*\*, <0.001 compared for MMM 2019 versus 2022 survey.

# Prevalence, Awareness and Control of Hypertension in Greece before and after the COVID-19 Pandemic: May Measurement Month Survey 2019-2022

**Running title:** COVID-19 Pandemic and Hypertension Epidemiology

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**ABSTRACT**

**Background:** The COVID-19 pandemic had an adverse impact on several cardiovascular risk factors. This study investigated the prevalence, awareness and treatment of hypertension in Greece before and after the pandemic. Data were collected in the context of the May Measurement Month (MMM) global survey initiated by the International Society of Hypertension.

**Methods:** Adult volunteers (age  $\geq 18$  years) were recruited through opportunistic screening in public areas across cities in Greece in 2019 and 2022. Medical history and triplicate sitting blood pressure (BP) measurements were taken using validated automated upper-arm cuff devices. The data were uploaded to the international MMM cloud platform. Hypertension was defined as systolic BP  $\geq 140$  mmHg and/or diastolic  $\geq 90$  mmHg, and/or self-reported use of drugs for hypertension. The same threshold was used to define uncontrolled BP in treated individuals.

**Results:** Data from 12,080 adults were collected (5,727/6,353 in MMM 2019/2022; men 46/49%,  $p < 0.01$ ; mean age  $52.7 \pm 16.6 / 54.8 \pm 16.2$ ,  $p < 0.001$ ; smokers, 24.7/30.5,  $p < 0.001$ ; diabetics 12/11.5%,  $p = \text{NS}$ ; cardiovascular disease 5/5.8%,  $p = \text{NS}$ ). The prevalence of hypertension was 41.6/42.6% (MMM 2019/2022,  $p = \text{NS}$ ), with 21.3/27.5% of hypertensives being unaware of their condition ( $p < 0.001$ ), 5.6/2.4% aware untreated ( $p < 0.001$ ), 24.8/22.1% treated uncontrolled ( $p < 0.05$ ), and 48.3/47.8% treated controlled ( $p = \text{NS}$ ).

**Conclusions:** In Greece, the COVID-19 pandemic did not appear to affect the prevalence and control of hypertension. However, the rate of undiagnosed hypertension was higher after the pandemic. National strategies need to be implemented for the early detection and optimal management of hypertension in the general population in Greece.

**Keywords:** blood pressure; COVID-19; epidemiology; hypertension; prevalence; screening

## INTRODUCTION

Hypertension affects about one third of adults globally and is the leading modifiable risk factor for cardiovascular disease and death. Meanwhile, the number of individuals with hypertension has doubled over the past 30 years [1,2]. Despite the availability of safe and effective antihypertensive treatment, control rates of hypertension in the general population are rather poor ranging from 7% to 65% [1]. The diagnosis and treatment of hypertension became increasingly challenging with the onset of the COVID-19 pandemic and subsequent lockdowns. The lockdowns and the restrictive measures implemented by national governments reduced the number of outpatients visits and forced doctors and patients to transition to inadequately developed virtual methods for the management of chronic diseases including the diagnosis and follow-up of high blood pressure (BP) [3–8]. The International Society of Hypertension published a position paper providing practical guidance on the virtual diagnosis and management of hypertension, stimulated by the impact of COVID-19 pandemic [7]. Despite the considerable potential of telehealth and virtual assessment during the COVID-19 pandemic, it was challenging to organize and implement them on a population scale within a short time, especially in low- and moderate-income countries and for older people [3,7,9].

Evidence demonstrating the diagnostic and therapeutic challenges of hypertension management on a population scale during the COVID-19 pandemic has been obtained from the May Measurement Month (MMM) campaign initiated by the International Society of Hypertension [10]. The MMM survey conducts large-scale BP measurements globally with the aim of screening for hypertension, raising awareness and improving control [10]. Across three consecutive MMM campaigns conducted before COVID-19 era (2017, 2018, 2019), over 4.2 million adults from more than 100 countries were included, and nearly 1 million found to have untreated or inadequately treated hypertension [10]. The MMM 2020 was deterred due to COVID-19 pandemic and in MMM 2021 the participation of countries was reduced by approximately 50% [10]. The rates of awareness, treatment, and control in the global MMM 2021 were lower compared to those reported in previous MMM campaigns [10]. The impact of the COVID-19 pandemic on hypertension in adults in Greece have not been investigated.

In Greece, the MMM survey was performed within the context of the global MMM program before and after the COVID-19 pandemic (2019, 2022) under the auspices of the Hellenic Society of Hypertension [11]. This analysis examined the impact of the pandemic on the epidemiology of hypertension in the adult population in Greece. The findings of the MMM 2019 survey in Greece regarding the prevalence, awareness, treatment, and control of hypertension were compared with those of the MMM 2022 survey.

## METHODS

The MMM survey in Greece was conducted via opportunistic screening in 5 urban areas in 2019 and 11 in 2022. Screening sites were set up in both indoor and outdoor public spaces, inviting adult ( $\geq 18$  years) to participate voluntarily. Trained physicians gathered anonymized information on medical history and performed BP measurements. The Ethics Committee of the National and Kapodistrian University of Athens and the Scientific Committee of the Sotiria Hospital in Athens approved the execution of the screening survey.

### 1.1 Blood pressure measurement

BP was measured on a single occasion after 5 min sitting rest. The participant's arm was resting on table, mid-arm at heart level, back supported on chair, legs uncrossed and feet flat on floor, and talking was avoided during and between BP measurements [12]. Validated upper-arm automated oscillometric devices equipped with wide-range cuffs (Omron M3 HEM-7131-E; Omron M3 HEM-7154-E; Omron Kyoto, Japan) were used [13–15]. Triplicate BP measurements (1-min interval) were obtained in each individual and the average of 2<sup>nd</sup> and 3<sup>rd</sup> was used in the analyses [12].

### 1.2 Hypertension diagnosis

The diagnosis of hypertension was based on BP measurements and/or self-reported use of drugs for hypertension. Thus, participants were divided into the following categories: (i) Normal BP: untreated individuals with systolic BP  $< 140$  mmHg and diastolic  $< 90$  mmHg, (ii) Hypertension: systolic BP  $\geq 140$  mmHg and/or diastolic  $\geq 90$  mmHg, and/or self-reported use of drugs for hypertension, (iii) Hypertension awareness: self-reported diagnosis of hypertension, (iv) Treated hypertension: self-reported use of drugs for hypertension, (v) Treated uncontrolled hypertension: systolic BP  $\geq 140$  mmHg and/or a diastolic  $\geq 90$  mmHg with self-reported use of drugs for hypertension, (vi) Treated controlled hypertension: systolic BP  $< 140$  mmHg and diastolic  $< 90$  mmHg with self-reported use of drugs for hypertension.

### 1.3 Statistical analysis

The national dataset was derived from the online global MMM cloud database. Means and standard deviations for continuous variables and percentages for categorical variables were provided. The distribution normality of the variables was assessed using the Kolmogorov–Smirnov test. Differences in continuous variables were tested using one-way analysis of variance (ANOVA) or Kruskal-Wallis test as appropriate and differences in categorical variables using Chi-square test. Multivariable logistic regression analysis was conducted to examine the prevalence of hypertension, treated controlled hypertension, treated uncontrolled hypertension, aware untreated hypertension and unaware untreated hypertension, with age, sex, and smoking as independent variables. A two-sided  $p < 0.05$  was considered statistically significant. The statistical analysis was performed by STATA software (version 13.0; Stata Corp, College Station, Texas, USA).

## RESULTS

Data from 12,080 adults were collected in 11 large cities in Greece before and after the COVID-19 pandemic through the implementation of MMM 2019 and the 2022 screening programs.

### 2.1 MMM 2019



A total of 5,848 individuals were recruited, 121 with missing data were excluded, and 5,727 with complete data were analyzed (Cities: Heraklion 25.8%, Athens 25.5%, Thessaloniki 23.6%, Ioannina 18.7%, Kavala 6.4%). Characteristics of the participants are presented in **Table 1**. The prevalence of hypertension was 41.6%, and was considerably increased with aging, exceeding 85% in both men and women older than 80 years. The prevalence, awareness, treatment, and control of hypertension are shown in **Table 2** and **Fig. 1**. Twenty-one per cent of patients with hypertension were unaware of their condition and this rate was higher in men and in younger participants (**Table 2, Fig. 2**).

### 2.2 MMM 2022

A total of 6,373 individuals were recruited, 20 with missing data were excluded and 6,353 with complete data were analyzed (Cities: Ioannina 15.8%, Thessaloniki 15.3%, Athens 13.5%, Heraklion 11.7%, Tripoli 8.3%, Chania 7.9%, Kalamata 7.2%, Kavala 6.7%, Patra 6.1%, Volos 5.4%, Lamia 2.2%). Characteristics of the participants are presented in **Table 1**. The prevalence of hypertension was 42.6%, and was considerably increased with aging, exceeding 70% in both men and women older than 80 years. The prevalence, awareness, treatment, and control of hypertension are shown in **Table 2** and **Fig. 1**. Among patients with hypertension, about 28% were unaware and this rate was higher in men and younger participants compared to women and older, respectively (**Table 2, Fig. 2**).

### 2.3 MMM 2019 vs 2022

Similar numbers of participants were recruited in the 2019 and 2022 MMM surveys. Participants in MMM 2022 were slightly older, with fewer women and more smokers (**Table 1**). The number of participants aged  $\geq 50$  years was higher in MMM 2022 compared to 2019, and this trend was observed in both men and women (2019/2022:  $\geq 50$  years men: 56.8/69.6%,  $\geq 50$  years women: 56.7/61.3%, all  $p < 0.001$ ). For those aged  $\geq 50$  years, the women:men ratio was higher in 2019 compared to 2022. The prevalence of hypertension was remarkably stable before and after COVID-19 and increased considerably with ageing in both surveys (**Table 1**). In both surveys women were less likely to have hypertension (men/women, 2019: 50.9/33.6%; 2022: 48.8/34.6, all  $p < 0.001$ ) (**Table 2**).

Among participants with hypertension, the rate of treated controlled patients was similar in the two surveys (2019/2022: 48.3/47.8%,  $p = 0.69$ ), with women tending to have better control of hypertension (men/women, 2019: 42.8/55.6%,  $p < 0.001$ ; 2022: 44.3/52.7,  $p < 0.001$ ) (**Table 2**). However, in MMM 2022 there were fewer aware untreated patients (2019/2022: 5.6/2.4%,  $p < 0.001$ ), and treated uncontrolled ones (2019/2022: 24.8/22.1%,  $p = 0.03$ ). Unaware untreated hypertension was more common in MMM 2022 (2019/2022: 21.3/27.5%,  $p < 0.001$ ), in both men (2019/2022: 22.9/30.2%,  $p < 0.0001$ ) and women (19.2/23.6%,  $p = 0.03$ ) (**Table 2**). In both surveys women were more likely to be aware of hypertension (men/women, 2019: 77.1/80.8%,  $p = 0.009$ ; 2022: 69.8/76.4,  $p < 0.001$ ) (**Table 2**). The rate of unaware hypertension decreased with aging in both women and men in both surveys, yet the number of unaware hypertensives in each age group was higher in MMM 2022 (**Fig. 2**). While the higher prevalence in the MMM 2022 campaign is evident across all age groups, statistical significance is only observed among men aged 30-79 years (**Fig. 2**). When multivariable regression analysis was employed, the aforementioned results remained consistent even after adjusting for discrepancies in age, sex, and smoking prevalence between the two MMM campaigns.

## DISCUSSION

This study assessed the prevalence, awareness, treatment and control of hypertension in adult population in Greece before and after the COVID-19 pandemic. Data were derived from two surveys using the same methodology with opportunistic screening on voluntary basis in selected urban areas. The main findings of this analysis are: (i) the prevalence of hypertension is high in Greece at about 40% and was not affected by the COVID-19 pandemic, (ii) the percentage of treated controlled hypertension did not change in the two surveys (~50%), and (iii) the proportion of individuals with undiagnosed hypertension seemed to be increased after the pandemic in both men and women.

The prevalence of hypertension remained consistently high in the two periods (~40%), and in line with the findings of the recent nationwide epidemiological study EMENO in Greece [16]. The stability in the recorded prevalence of hypertension in the MMM studies across the 2 different periods and the agreement with the findings of the national epidemiological study are reassuring for this work. The rate of treated and controlled hypertension remained stable before and after COVID-19. In contrast, the rate of undiagnosed hypertensives was increased, probably due to the after the implementation of restrictive measures in the community during the COVID-19 pandemic with limited access to healthcare professionals. Participants in MMM 2022 were more likely to be older and men. Older people are known to have higher rates of hypertension diagnosis and treatment, suggesting that the older average age in MMM 2022 is not the reason for the higher rate of undiagnosed hypertension after the pandemic. On the other hand, men more frequently have undiagnosed hypertension than women [11,16,17]. While this sex difference could have influenced the results by increasing the number of undiagnosed hypertensives, it is important to note that this rise was observed in both men and women (**Table 1, Fig. 2**) [16].

### 3.1 Pandemic Effects on a Global Scale

Analyses of the global MMM survey showed decreased awareness, treatment, and control after the COVID-19 pandemic [10]. Similar results were shown from prescribed medication records for hypertension in England, Scotland and Wales between April 2018 and July 2021 [18]. The latter study revealed a significant reduction in prescribed and dispensed antihypertensive drugs during lockdown periods and showed that approximately 500,000 fewer individuals than expected initiated treatment for hypertension [18]. Additionally, data showing a negative impact of the COVID-19 pandemic on applying hypertension-related diagnostic procedures and on the proportion of hypertension control come from smaller studies conducted in Excellence Centers of the European Society of Hypertension [8,19].

Factors that might have contributed to a different and more positive epidemiological situation in Greece compared to other countries can be considered. First, the consistent percentage of treated and controlled hypertension before and after the COVID-19 pandemic highlights the widespread use of self-home BP monitoring in Greece, which probably contributed considerably to satisfactory hypertension follow-up during the pandemic [20,21]. Second, alternative approaches to conventional medical visits, such as video or telephone communications, supported continuing follow up during lockdowns [22]. This was the case in other countries as well where there were no virtual visits before the pandemic, and in 2020 more than half of the visits were virtual [22]. In Greece, the adoption of telephone communications, which are common among patients and primary care doctors, certainly enabled patients to maintain access to the healthcare system and receive essential medical advice from a distance. Third, in many countries, including Greece, the vast majority of prescriptions are dispensed electronically. In primary care in England, e-prescriptions surpassed 85% [23]. Thus, in Greece the wide availability of self-home BP monitoring, the ability to communicate with their healthcare providers through telephone visits, and the continuation of treatment via e-prescriptions (up to 6-month prescriptions for hypertension),

probably explain the stable levels of treated and controlled hypertensives during the pandemic. Although diagnosed hypertensives in Greece seemed to benefit from the above, screening programs could not be performed during the pandemic leading to an increased number of undiagnosed hypertensives.

### 3.2 Limitations

These results should be interpreted by considering the methodology of the MMM sampling, which does not include a nationally representative sample of the general adult population in Greece. A previous study compared the prevalence of hypertension in Greece assessed in the 2019 MMM survey with that of the national epidemiological study EMENO, and it found that while the MMM accurately estimated the prevalence of hypertension, it overestimated the rate of controlled hypertension [17]. Furthermore, in the 2019 MMM survey participants were recruited in 5 cities, whereas in 2022 in 6 additional ones.

### 3.3 Future Perspectives

Pandemics may have detrimental effects on the diagnosis and management of modifiable cardiovascular risk factors, adding to the general consequences to public health. Virtual visits, home BP telemonitoring, e-prescriptions, and other technological tools and strategies need to be developed and tested for implementing telehealth in daily clinical practice, which indeed may improve the care of patients with hypertension even in the absence of a pandemic[3,5,7].

### **CONFLICT OF INTEREST**

M.S.K. has received lecture and consulting fees by Elpen, Menarini, Guidotti and Servier. A.K. has received lecture and consulting fees by Elpen, Menarini, and Servier. D. K. has received lecture and consulting fees by Servier, Elpen, Menarini. V.K. has received lecture and consulting fees by Elpen, Menarini, Servier, Vianex, Viatrix and Novartis. A.Ma. has received lecture and consulting fees by Menarini, Berlin Chemie Ferrer. G.S.S. has received lecture and consulting fees by Omron Healthcare Japan & Europe, Elpen, Menarini, and Servier.

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**Table 1.**

Participants' characteristics in the MMM 2019 and 2022 surveys in Greece [mean (SD)].

<b>MMM Greece</b>	<b>2019</b>	<b>2022</b>	<b>P</b>
Participants	5,727	6,353	-
Age (mean±SD, years)	52.7±16.6	54.8±16.2	<0.001
Men/Women (%)	46/54	49/51	<0.001
Current smokers (%)	24.7	30.5	<0.001
Diabetes mellitus (%)	12.0	11.5	0.40
Cardiovascular disease (%)	5.0	5.1	0.79
Systolic BP (mean±SD, mmHg)	123.5±17.3	124.5±17.1	0.002
Diastolic BP (mean±SD, mmHg)	77.4±10.4	77.5±10.5	0.34
Hypertension (%)	41.6	42.6	0.27

BP: blood pressure

**Table 2.**

Prevalence, awareness, treatment, and control of hypertension in the MMM 2019 and 2022 surveys in Greece [% (95% CI)].

MMM	Hypertension Prevalence	Unaware Untreated	Aware Untreated	Treated Uncontrolled	Treated Controlled
<b>2019</b>	41.6 (40.4, 42.9)	21.3** (19.7, 22.9)	5.6** (4.7, 6.5)	24.8* (23.1, 26.5)	48.3 (46.3, 50.4)
<i>Men</i>	50.9‡ (49.1, 52.9)	22.9† (20.7, 25.2)	6.9†† (5.5, 8.2)	27.4‡ (25.0, 29.8)	42.8‡ (40.2, 45.5)
<i>Women</i>	33.6 (31.9, 35.2)	19.2 (16.8, 21.6)	3.9 (2.7, 5.1)	21.3 (18.8, 23.8)	55.6 (52.6, 58.7)
<b>2022</b>	42.6 (41.4, 43.8)	27.5 (25.8, 29.2)	2.4 (1.8, 3.0)	22.1 (20.5, 23.7)	47.8 (45.9, 49.7)
<i>Men</i>	48.8‡ (47.0, 50.6)	30.2‡ (28.6, 31.8)	2.5 (1.9, 3.0)	22.8 (21.3, 24.3)	44.3‡ (42.6, 46.0)
<i>Women</i>	34.6 (33.0, 36.2)	23.6 (21.8, 25.4)	2.3 (1.7, 2.9)	21.1 (19.4, 22.8)	52.7 (50.6, 54.8)

\*, *P*-value <0.05; \*\*, <0.001 compared to the MMM 2022 survey.

†, *P*-value <0.05; ††, <0.01; ‡, <0.001 compared to women in the same MMM survey.

**Legend to Figure 1**

Awareness, treatment, and control of hypertension in MMM 2019 and 2022 surveys.

**Footnote to Figure 1**

*, P-value <0.05; \*\*, <0.001 compared to the MMM 2022 survey.*

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**Legend to Figure 2**

Prevalence of unaware hypertension according to sex and age in MMM 2019 and 2022.

**Footnote to Figure 2**

*\*, P-value <0.0001 compared to the MMM 2022 survey.*

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