Portuguese Journal of Public Health

Research Article

Port J Public Health
DOI: 10.1159/000530747

Received: April 13, 2022
Accepted: April 12, 2023
Published online: June 8, 2023

The Impacts of Heat Waves on Hospital Admissions and Mortality in the Fethiye Province of Turkey

Yunus Ozturk[a] Hakki Baltaci[b] Bülent Oktay Akkoyunlu[c]

[a]Marmara University, Department of Occupationaly Safety, Istanbul, Turkey; [b]Gebze Technical University, Institute of Earth and Marine Sciences, Gebze, Turkey; [c]Marmara University, Department of Physics, Istanbul, Turkey

Keywords
Heat waves · Mortality · Morbidity · Hospital admissions · Fethiye

Abstract
tHeat waves (HWs) are one of the most important atmospheric events that negatively affect human health. In this study, HWs which occurred between May 1 and September 30, 2019 in Fethiye Province (SW Turkey) were investigated for their effects on human health. For this purpose, as a first step, percentile-based threshold criteria and at least three consecutive days' methodology were applied to the daily maximum temperatures to identify HWs. Using these criteria, a total of 3 HWs (HW 1, HW 2, and HW 3) with lengths of 6, 7, and 5 days, respectively, were found in 2019. In statistical analyses, hospital data recorded on HW days (including the 3 lag days) on reference days were compared using the logarithmic Z test method. Hospital data between May 1 and September 30 in the 5 years between 2014 and 2018 were used as reference data. As a result, in the 3 HWs that occurred in 2019, the risk ratios (RRs) and their confidence intervals in HW 1, HW 2, and HW 3 at hospital admissions were 1.09 (95% CI: 1.06–1.12), 1.11 (95% CI: 1.08–1.14), and 1.13 (95% CI: 1.09–1.16), ($p < 0.05$), respectively. When the effect of HW on death was examined, the RR values and confidence intervals in HW 1, HW 2, and HW 3 were 1.90 (95% CI: 1.04–3.46), 1.96 (95% CI: 1.03–3.75), and 2.18 (95% CI: 1.13–4.20), ($p < 0.005$), respectively. As a result, it was found that a total of 22 extra deaths occurred when three HWs were recorded in 2019. When the deaths were analysed by age, it was seen that the most affected group was the elderly (≥65 years), accounting for 82% of deaths. It was determined that 64% of the deaths were male, and 36% were female. These results show that HWs in Fethiye are an important natural disaster that negatively affects human health.

Os impactos das ondas de calor nas admissões hospitalares e mortalidade na província de Fethiye, na Turquia

Palavras Chave
Ondas de calor · Mortalidade · Morbilidade · Internamento hospitalar · Fethiye

karger@karger.com
www.karger.com/pjp

Correspondence to:
Yunus Ozturk, ozturkyunus06@gmail.com

Resumo

As ondas de calor (HWs) são um dos mais importantes eventos atmosféricos que afetam negativamente a saúde humana. Neste estudo, as ondas de calor que ocorreram entre 1 de maio e 30 de setembro de 2019 na província de Fethiye (SW Turquia) foram investigadas pelos seus efeitos na saúde humana. Visando esse objetivo e como primeiro passo, foi aplicada metodologia usando critérios de limiar baseados no percentil e, pelo menos, três dias consecutivos de ocorrência, às temperaturas máximas diárias (Tmax) para identificar as HWs. Utilizando este critério, foi encontrado um total de 3 HWs (HW 1, HW 2, e HW 3) com duração de 6, 7, e 5 dias, respetivamente, em 2019. Nas análises estatísticas, os dados hospitalares registados nos dias HW (incluindo os 3 dias de atraso) nos dias de referência foram comparados utilizando o método de teste logarítmico Z. Os dados hospitalares entre 1 de Maio e 30 de Setembro nos 5 anos entre 2014 e 2018 foram utilizados como dados de referência. Como resultado, nos 3 HWs que ocorreram em 2019, os rácios de risco (RRs) e os seus intervalos de confiança no HW 1, HW 2, e HW 3 nas admissões hospitalares foram de 1,09 (95% CI: 1,06–1,12), 1,11 (95% CI: 1,08–1,14), e 1,13 (95% CI: 1,09–1,16), ($p < 0,05$), respetivamente. Quando o efeito de HWs na morte foi examinado, os valores de RR e intervalos de confiança em HW 1, HW 2, e HW 3 foram 1,90 (95% CI: 1,04–3,46), 1,96 (95% CI: 1,03–3,75), e 2,18 (95% CI: 1,13–4,20), ($p < 0.005$), respetivamente. Como resultado, verificou-se que um total de 22 mortes extras ocorreram quando foram registados três HWs em 2019. Quando as mortes foram analisadas por idade, verificou-se que o grupo mais afetado era o idoso (≥65 anos), sendo responsável por 82% das mortes. Foi determinado que 64% das mortes ocorreram em homens, e 36% em mulheres. Estes resultados mostram que os HWs em Fethiye são desastres naturais importantes que afetam negativamente a saúde humana.

Introduction

As a result of climate change, there have been large increases in the number and duration of heat waves (HWs) [1]. Substantial temperature increases and the positioning of air masses causing HWs in a region for a long time result in economic, environmental, and human health problems [2]. Recent studies have focused on the negative effects of HWs on deaths and hospital admissions [3–5]. For example, it was found that 70,000 people died because of HW that occurred in Europe in 2003 [6]. In another study, approximately 15,000 people died due to HW in France [7]. A study examining the effects of an HW on human health in California during 2006 showed that approximately 16,166 additional emergency room admissions and 1,600 additional hospitalizations were identified [8]. As a result of an HW that occurred in Sydney, Australia in 2011, a 2% increase in emergency service admissions, a 14% increase in ambulance calls, and a 13% increase in death rates were detected [9]. A study was conducted to examine the effects of an HW that occurred in the US city of Houston in 2011 on death rates and emergency service admissions. From the results, a 3.6% increase in emergency department admissions and a 0.6% increase in mortality rates were found during the HW [10].

In Turkey, studies based on health diseases mainly investigated the role of air quality and background atmospheric mechanisms on human health diseases [11, 12]. However, there have been few studies indicating the effects of HWs on health diseases in Turkey. For example, the death rate increased by 181% in an HW that occurred in İzmir in 2016, resulting in 29 extra deaths [13]. In addition, there was a 19% increase in hospital admissions during HW. When age-specific death rates were examined, a 208% increase in the deaths was of the elderly during the HW periods. The main reasons for deaths were identified as hypertension (37%), dementia (10%), and heart disease (9%). In another study, 419 extra deaths were reported in HWs that occurred between 2013 and 2017 in Istanbul [14]. When the effects of HWs were examined by sex, it was found that female groups were more affected by HWs. Investigating the age-specific effects of HWs determined that people aged 75 and over were more affected. After examining the causes of death in HW periods, it was found that those with heart disease were more affected by HWs. Although these studies were carried out in Istanbul and Izmir, which are the most crowded cities in Turkey, there have not been detailed studies for the other regions of Turkey. Southern areas of Turkey are known as the hot spot regions that are most affected by HWs [2]. In addition to the population density, millions of tourists come to this region during the summer months of every year. Despite the overpopulation of this region in summer and latitudinal proximity to the desert areas and the frequent occurrence of HWs, the health effects associated with HWs have never been investigated. From this large territory, Fethiye is a city with a resident population of approximately 167,000 and an average of 1 million tourists

visit in summer [15]. From this perspective, the impacts of HWs on health risks need to be investigated in detail for Fethiye. For this purpose, the aim of this study is to reveal the effects of HWs on hospital admissions and in-hospital mortality in the Fethiye Province of Turkey. Determining the relationship between high temperatures, deaths, and hospital admissions will shed light on future studies to minimize the potential health risks.

Data and Methods

Study Area and Hospital Data

In this study, the Fethiye Province of Mugla, located in southwestern Turkey, was chosen as the study area. Fethiye is located at 36° 39' 5'' °N and 29° 7' 23'' °E coordinates. It has a surface area of 3,055 km^2 and a population of 167,114. Fethiye has a Mediterranean climate with hot and dry summers and mild and rainy winters. Therefore, the hottest summer month is August with an average temperature of 32°C, and the coldest month is January with an average temperature of 10°C. Its annual average temperature is 21°C [16].

Hospital data were obtained from the Fethiye State Hospital between 1 May and 30 September in the 5 years between 2014 and 2019. Hospital data included daily hospital admissions and death records and were provided with permission from the Mugla Provincial Health Directorate. Using these data, increases in hospital admissions and deaths during HWs were examined. Hospital mortality data included age and sex parameters. The effects of HWs on age were examined by separating two groups: adult (15–64 years) and elderly (≥65 years). Additionally, the effects of HWs on sex were also investigated.

Meteorological Data and HW Definition

For analysis, 60 years of daily maximum temperature (Tmax) data of Fethiye Province were provided by the Turkish State Meteorological Service (TSMS) from 1960 to 2019. Daily Tmax values were used to determine the HWs that occurred in 2019. When the definitions of HWs were examined, it was evident that there is no single definition. Therefore, many definitions are used in the examined studies [17]. In these definitions, daily maximum [18], minimum [19], average temperatures [20]; relative temperatures such as 90% and 95% [21]; constant threshold values such as 28°C and 35°C [22]; and durations of consecutive temperatures such as 2 days, 3 days, or 4 days [23] were used. In our study, 90th percentile of Tmax and at least three consecutive days (≥3) were defined based on the long-term station-based daily Tmax for the period 1960–2019. With this definition, 3 HWs with lengths of 6, 7, and 5 days were identified in 2019. In previous studies, lag days after HW were considered [14, 24]. A study conducted in Brisbane, Australia found that the greatest effect of heat occurred on the first day of exposure, then decreased rapidly, and returned to baseline levels within 5 days [25]. According to this study, the HW effect ended on the third day. In our study, 3-lag days were added to each HW, like the study published by Huang et al. 2012. Thus, because of the added 3 lag days, the length of HW 1 was 9 days, the length of HW 2 was 10 days, and the length of HW 3 was 8 days.

Statistical Analysis

SPSS V21.0 (SPSS Inc., Chicago, IL, USA) was used for analysis. Increases in hospital admissions, death rates, and sex- and age-specific mortality rates during 3-lag day HW periods were calculated using Equations 1 and 2 below. Risk ratios (RRs) and 95% confidence intervals were calculated using Equation 3 below ($p < 0.05$).

Natural logarithmic Z tests were used to compare the 3-lag day HW period, mortality with the reference period, and mortality rates [14]. Z tests were conducted with Equation 6 below and *p value* were conducted with Equation 7 below.

$$DR_{(HeatWave)} = \frac{Number\ of\ Deaths\ Heatwave\ Period}{Population^{*}Number\ of\ Days\ Heatwave\ Periods} \quad (1)$$

$$DR_{(Reference\ Period)} = \frac{Number\ of\ Deaths\ Referance\ Period}{Population^{*}Number\ of\ Days\ Reference\ Periods} \quad (2)$$

$$RR = \frac{DR_{(Heatwave)}}{DR_{(Reference\ Period)}} \quad (3)$$

$$var\,(DR_{Heatwave}) = \sqrt{\frac{Number\ of\ Deaths\ Heatwave\ Period}{(Population^{*}Number\ of\ Days\ Heatwave\ Periods)^{2}}} \quad (4)$$

$$var\left(DR_{Reference\ Period}\right) = \sqrt{\frac{Number\ of\ Deaths\ Reference\ Period}{(Population^{*}Number\ of\ Days\ Reference\ Periods)^{2}}} \quad (5)$$

$$Z = \frac{\ln\,(DR_{heat\ wave}) - \ln\,\left(DR_{reference\ period}\right)}{\sqrt{\frac{var\,(DR_{heat\ wave})}{(DR_{heat\ wave})^{2}} + \frac{var\,\left(DR_{reference\ period}\right)}{\left(DR_{reference\ period}\right)^{2}}}} \quad (6)$$

$$p\,\text{value} = 2 \times (1 - Normdist\,(Z, average;\ standard\ deviation; cumulative)) \quad (7)$$

Here, DR_{heatwave} shows the mortality rate in the HW periods during summer months in 2019, and $DR_{\text{reference period}}$ shows the mortality rates in the reference periods (2014–2018). In the analyses, the hospital data recorded in the 3 HW periods between 1 May and September 30, 2019 were compared with the hospital data recorded in the reference periods. For the analysis, 1 May to 30 September between 2014 and 2018 were chosen as the reference period. The start and end dates of the reference days used for comparison are the same as the start and end dates of the HWs in days and months. Thus, the number of days of the reference period was equal to the number of days of the HW periods.

Results

The average temperatures, population, and daily death rates by sex and age between 2014 and 2019 are shown in Table 1. Between 2014 and 2019, the daily death rate ranged from 0.94 to 1.3. With a daily death rate of 1.3, 2019 had the

Table 1. Descriptive statistics by years

Studying period	2014	2015	2016	2017	2018	2019
Mean temperatures (1 May-30 September)	32.3 (21.2–42)	32.2 (22.6–40.3)	32.5 (20.3–41.1)	32.7 (20.9–43.7)	33 (23.9–40.5)	32.6 (18.1–40.3)
Population	145,643	147,703	151,474	153,963	157,745	162,686
Daily death rates	1.02	0.94	1.02	0.97	1.14	1.30
Daily women death rates	0.42	0.33	0.46	0.45	0.58	0.56
Daily men death rates	0.60	0.60	0.55	0.52	0.55	0.73
Daily death rates by age						
0–14	0.012	0.00	0.00	0.00	0.00	0.01
15–64	0.25	0.43	0.20	0.19	0.21	0.24
≥65	0.73	0.74	0.80	0.81	0.79	0.75

highest number of deaths compared to the reference years. The daily average temperatures were the highest at 33°C in 2018, daily Tmax was 43.7°C in 2017, and the lowest daily minimum temperature was 18.1°C in 2019. When the daily death rates were examined by age, it was determined that the death rates were higher in elderly people than the adults. Since the death rates in children (0–14) were very low, they were not considered in the analysis. Considering the death rates by sex, the male death rate was higher than the female death rate, except in 2018. While the male death rate was the highest in 2019 compared to the other years, the female mortality rate was found to be the highest during the extended summer of 2018.

HWs and Hospital Admissions

Increases in hospital admissions during HW periods were examined. The RR and confidence intervals showing the relationship between HWs and hospital admissions are shown in Table 2. Accordingly, the RRs showing the relationship between hospital admissions and HW 1, HW 2, and HW 3 were 1.09 (95% CI: 1.06–1.12, $p < 0.05$), 1.11 (95% CI: 1.08–1.14, $p < 0.05$), and 1.13 (95% CI: 1.09–1.16, $p < 0.05$), respectively. Figure 1 shows the relationship between HWs and hospital admissions in 2019.

HWs and Deaths

Table 3 shows the temperature-death relationship during the HW periods that occurred in 2019. In 2019, the RRs showing the effect of HW 1, HW 2, and HW 3 on death were 1.90 (95% CI: 1.04–3.46, $p < 0.05$), 1.96 (95% CI: 1.03–3.75, $p < 0.05$), and 2.18 (95% CI: 1.13–4.20, $p < 0.05$), respectively.

To determine the effects of HWs by age, deaths occurring between May 1 and September 30, 2019 were classified according to age. As shown in Table 4, the death rate of elderly people was higher than that of people aged 15–64 during the HW period. The RRs showing the effect of HW 1, HW 2, and HW 3 on mortality at the age of 65 and over were 2.06 (95% CI: 1.01–4.19, $p < 0.05$), 2.81 (95% CI: 1.37–5.75, $p < 0.05$), and 1.78 (95% CI: 0.79–4.03, $p > 0.05$), respectively. The RRs showing the effect of HW 1, HW 2, and HW 3 on mortality in the 15–64 age group were 1.56 (95% CI: 0.50–4.19, $p > 0.05$), 0.43 (95% CI: 0.05–3.30, $p > 0.05$), and 3.35 (95% CI: 1.06–10.54, $p < 0.05$), respectively. High temperatures continued for a total of 27 days in 3 HWs that occurred in 2019. A total of 22 extra deaths occurred during these days. Extra deaths were calculated by taking the difference between the mean death rates of the reference periods and the deaths occurring during the HW periods. Figure 2 shows the increase in deaths during the HWs that occurred in 2019. Of the extra deaths that were estimated in 2019, 18 were aged 65 and over, and 4 were aged 15–64. According to these results, 82% of the extra deaths that were estimated during HW periods occurred in those 65 and over.

The study conducted to examine the effects of HWs on sex is shown in Table 5. The RRs showing the effect of HW 1, HW 2, and HW 3 on male mortality were 2.34 (95% CI: 1.10–5.00, $p < 0.05$), 1.82 (95% CI: 0.76–4.36, $p > 0.05$), and 2.34 (95% CI: 1.00–5.47, $p < 0.05$), respectively. The RRs showing the effect of HW 1, HW 2, and HW 3 on female mortality were 1.38 (95% CI: 0.51–3.74, $p > 0.05$), 2.16 (95% CI: 0.82–5.69, $p > 0.05$), and 1.95 (95% CI: 0.69–5.54, $p > 0.05$), respectively. It was determined that 14 of the extra deaths that were estimated in 2019 were males (64%) and 8 were females (36%).

Discussion

In this study, a total of 3 HWs were detected between May 1 and September 30, 2019. Increases in hospital admissions during HWs were assessed. There was a 9% increase in

Table 2. Hospital admissions during 2019 HW periods

HWs	Starting dates	Ending dates	HW length	Number of hospital admissions	Average hospital admissions in reference periods (2014–2018)	RR	Confidence intervals (95% CI)		*p* value
HW 1	July 05, 2019	July 13, 2019	9	4,833	4,159	1.09	(1.06	1.12)	0.00009
HW 2	August 07, 2019	16/0872019	10	6,327	5,363	1.11	(1.08	1.14)	0.00007
HW 3	August 23, 2019	August 30, 2019	8	5,229	4,342.2	1.13	(1.09	1.16)	0.00004

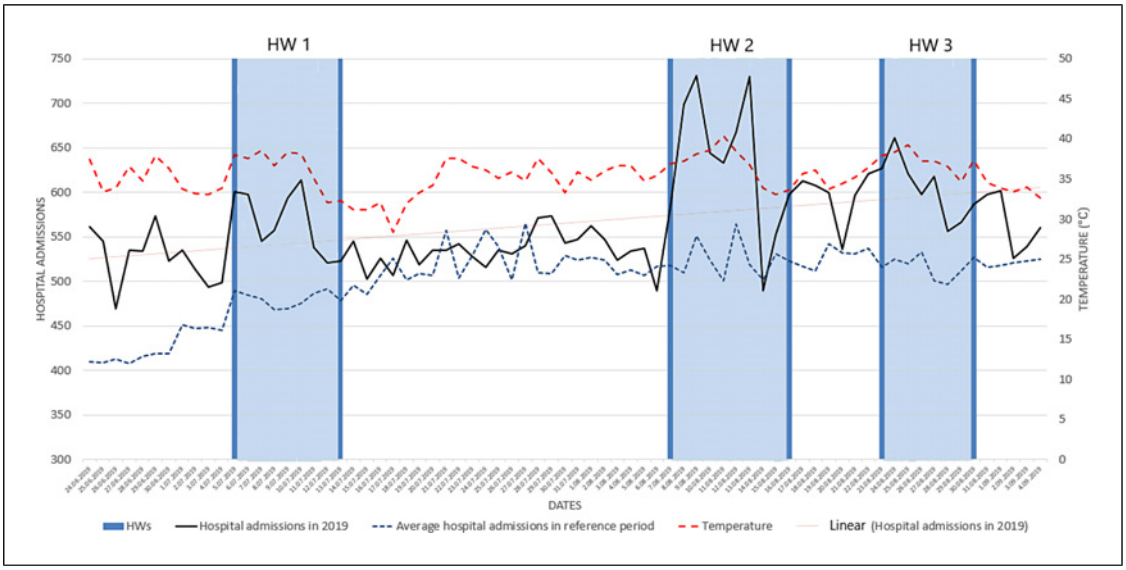

Fig. 1. HWs and hospital admissions in Fethiye Province during the summer months in 2019.

Table 3. HWs and death rates during the summer months of 2019

HWs	Starting dates	Ending dates	HW length	Number of deaths in HW	Average deaths rates in reference periods (2014–2018)	RR	Confidence intervals (95% CI)		*p* value
HW 1	July 05, 2019	July 13, 2019	9	15	7.4	1.90	(1.04	3.46)	0.0361
HW 2	August 07, 2019	August 16, 2019	10	13	6.2	1.96	(1.03	3.75)	0.0409
HW 3	August 23, 2019	August 30, 2019	8	13	5.6	2.18	(1.13	4.20)	0.0206

hospital admissions in HW 1, 11% in HW 2, and 13% in HW 3. A total of 2,524 extra admissions were reported during these three HW periods. These results are consistent with previous studies. In a study conducted in Izmir, Turkey, a 19% increase in emergency service admission was reported during HW periods [13]. In a study conducted in Brisbane, Australia, a 14% increase in emergency service admissions was reported during HW periods [17]. In a study conducted in Sydney, Australia, a 2% increase in emergency service admissions was reported during HW periods [9].

As shown in Table 3, RRs of 1.90, 1.96, and 2.18 were observed, demonstrating increases in deaths during HWs that occurred in 2019. A total of 22 extra deaths were estimated in the 3 HWs in 2019. These results are consistent

Table 4. Age-specific mortality rates due to HWs during the summer months in 2019

HWs	Starting dates	Ending dates	HW length	Number of deaths in HW	Average deaths rates in reference periods (2014–2018)	RR	Confidence intervals (95% CI)	*p* value
Elderly (≥65 years)								
HW 1	July 05, 2019	July 13, 2019	9	11	5.0	2.06	(1.01 4.19)	0.0456
HW 2	August 07, 2019	August 16, 2019	10	12	4.0	2.81	(1.37 5.75)	0.0046
HW 3	August 23, 2019	August 30, 2019	8	8	4.2	1.78	(0.79 4.03)	0.1630
Adult (15–64 years)								
HW 1	July 05, 2019	July 13, 2019	9	4	2.4	1.56	(0.50 4.84)	0.440
HW 2	August 07, 2019	August 16, 2019	10	1	2.2	0.43	(0.05 3.30)	0.414
HW 3	August 23, 2019	August 30, 2019	8	5	1.4	3.35	(1.06 10.54)	0.039

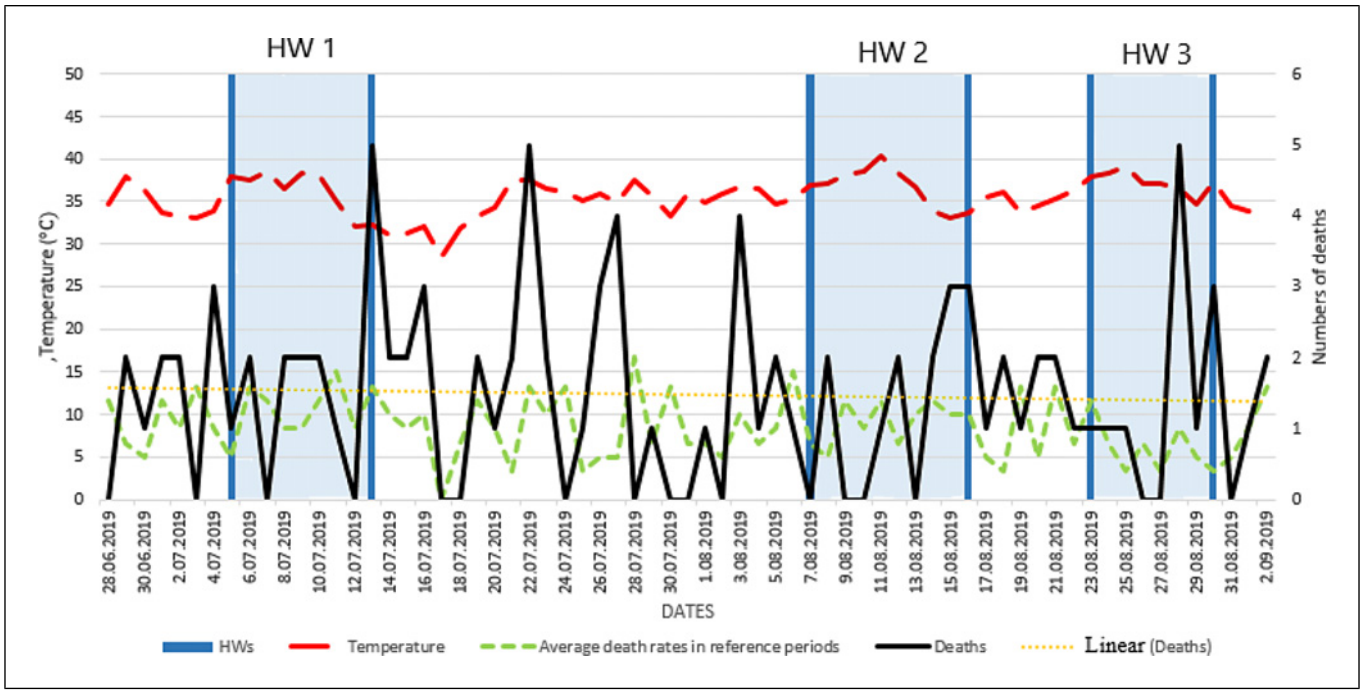

Fig. 2. HWs and death distribution in Fethiye Province during the summer months in 2019.

with previous studies. In a study investigating deaths due to HWs in 9 French cities, RRs were found to be 2.37 in Bordeaux, 3.22 in Lyon, 5.0 in Paris, and 2.0 in Strasbourg [3]. A study examining deaths due to HWs in 15 European cities investigated how a 1°C increase in daily Tmax affected deaths [26]. This study determined that a 1°C increase in the daily Tmax above the threshold value caused an average of a 3.12% increase in death rates in the Mediterranean region and 1.84% increase in the northern regions. A study conducted in Belgrade, the capital of Serbia, examined the effects of HWs on public health (Bogdanovic et al., 2013). This study found that 167 extra deaths were estimated due to HWs. A study conducted in France in 2006 found that 2,065 extra deaths occurred during HWs [7].

The effects of HWs on mortality were examined by sex. A total of 22 extra deaths occurred during HW periods. Eight of the deaths were females, and 14 were males. This shows that males were the more affected group than females during HWs. Previous studies found that women were more affected than men during HWs [14, 27]. However, it was found in some studies that men are the most affected group than women during HWs. For example, in a study conducted at Izmir Dokuz Eylul University, men were more

Table 5. Gender-specific mortality rates due to HWs during the summer months in 2019

HWs	Starting dates	Ending dates	HWs length	Number of deaths in HW	Average deaths rates in reference periods (2014–2018)	RR	Confidence intervals (95% CI)	*p* value
Male								
HW 1	July 05, 2019	July 13, 2019	9	10	4.0	2.34	(1.10 5.00)	0.028
HW 2	August 07, 2019	August 16, 2019	10	7	3.6	1.82	(0.76 4.36)	0.180
HW 3	August 23, 2019	August 30, 2019	8	8	3.2	2.34	(1.00 5.47)	0.049
Female								
HW 1	July 05, 2019	July 13, 2019	9	5	3.4	1.38	(0.51 3.74)	0.530
HW 2	August 07, 2019	August 16, 2019	10	6	2.6	2.16	(0.82 5.69)	0.120
HW 3	August 23, 2019	August 30, 2019	8	5	2.4	1.95	(0.69 5.54)	0.210

affected than women in HWs [13]. The results of this study seem to be consistent with the results of our study.

The ages at which HWs most affect people were also examined in previous studies. Twelve percent of the Fethiye population was over 65 years old in 2019 [15]. Previous studies have shown that HWs affect older people more. To determine HW and age-specific deaths, mortality data were divided into two groups: adult (15–64 years) and elderly (≥65). When the deaths occurring in HW periods were examined, it was found that elderly people were more affected than those in other age groups. For the 3 HWs that occurred in 2019, there were 22 extra deaths. Of these extra deaths, 18 were elderly, and the remaining 4 were in the ages between 15 and 64. The results of our study are in good agreement with the previous studies. For example, a study conducted in the Netherlands in 2001 determined that HWs mostly negatively affect elderly people, and deaths are mostly seen in people of this age group [23]. A study conducted in California showed that elderly people were found to be most affected group by HWs [8].

Conclusion

In this study, the effects of HWs on hospital admissions and in-hospital mortality were investigated in the Fethiye Province. A total of 3 HWs were detected in 2019, and it was found that there were 9%, 11%, and 13% increases in hospital admissions. In addition, the effects of the 3 HWs on mortality were examined. Deaths during HWs increased by 90%, 96%, and 118%, respectively, resulting in 22 extra deaths. It was found that 82% of the deaths occurred in those aged 65 and over, and 18% of them were between the ages of 15 and 64. In addition, 64% of deaths were males and 36% females. Since very few studies have examined the effects of HWs on human health in Turkey and there is no HW emergency action plan in Turkey, precautions should be taken against HWs that may occur in the future. More research needs to be done in this area to determine the effects of HWs on human health, the environment, the economy, and migrations.

Acknowledgment

We would like to thank Marmara University Scientific Research Projects Unit for the "FDK-2021-10257" project support.

Statement of Ethics

Ethics Committee of Marmara University Institute of Science and Technology decided that ethical approval was not required for this study (44174047-302.08.01-E.2000025213).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

The project support fund "FDK-2021–10,257" was used to finance the study. This fund was used for the transportation, accommodation, and meal expenses of the people who carried out the study between Istanbul and Muğla.

Author Contributions

Yunus OZTURK: Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work. Hakki BALTACİ: Drafting the work or revising it critically for important intellectual content and final approval of the version to be published. Bulent Oktay AKKOYUNLU: Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Data Availability Statement

Hospital data: Hospital data were obtained from the Fethiye State Hospital between 1 May and 30 September in the 5 years between 2014 and 2019. Hospital data included daily hospital admissions and death records and were provided with the permission of the Mugla Provincial.

Health Directorate: Meteorological Data: For analysis, 60 years of daily Tmax data of Fethiye Province were provided by Turkish State Meteorological Service (TSMS) for the period 1960–2019.

References

1 Jones GS, Stott PA, Christidis N. Human contribution to rapidly increasing frequency of very warm Northern Hemisphere summers. J Geophys Res. 2008;113(D2):D02109.
2 Ünal Y, Tan E, Menteş S. Summer heat waves over western Turkey between 1965 and 2006. Theor Appl Climatol. 2013;112(1–2):339–50.
3 Le Tertre A, Lefranc A, Eilstein D, Declercq C, Medina S, Blanchard M, et al. Impact of the 2003 heatwave on all-cause mortality in 9 French cities 2003 heatwave on al-cause mortality in 9 French cities. Epidemiology. 2006; 17(1): 75–9.
4 Hajat S, Armstrong B, Baccini M, Biggeri A, Bisanti L, Russo A, et al. Impact of high temperatures on mortality is there an added heat wave effect. Epidemiology. 2006;17(6):632–8.
5 Layton JB, Li W, Yuan J, Gilman JP, Horton DB, Setoguchi S. Heatwaves, medications, and heat-related hospitalization in older Medicare beneficiaries with chronic conditions. PLoS One. 2020;15(12):e0243665.
6 Robine JM, Cheung SLK, Le Roy S, Van Oyen H, Griffiths C, Michel JP, et al. Death toll exceeded 70,000 in Europe during the summer of 2003. C R Bio. 2008;331(2):171–8.
7 Fouillet A, Rey G, Wagner V, Laaidi K, Empereur-Bissonnet P, Le Tertre A, et al. Has the impact of heat waves on mortality changed in France since the European heat wave of summer 2003? A study of the 2006 heat wave. Int J Epidemiol. 2008;37(2):309–17.
8 Knowlton K, Rotkin-Ellman M, King G, Margolis HG, Smith D, Solomon G, et al. The 2006 California heat wave: impacts on hospitalizations and emergency department visits. Environ Health Perspect. 2009;117(1):61–7.
9 Schaffer A, Muscatello D, Broome R, Corbett S, Smith W. Emergency department visits, ambulance calls, and mortality associated with an exceptional heat wave in Sydney, Australia, 2011: a time-series analysis. Environ Health. 2012;11(1):3.
10 Zhang K, Chen TH, Begley CE. Impact of the 2011 heat wave on mortality and emergency department visits in Houston, Texas. Environ Health. 2015;14:11.
11 Arslan H, Baltaci H, Sahin UA, Onat B. The relationship between air pollutants and respiratory diseases for the Western Turkey. Atmos Pollut Res. 2022;13(2):101322.
12 Baltaci H, Arslan H, Akkoyunlu BO. High PM10 source regions and their influence on respiratory diseases in Canakkale, Turkey. Int J Environ Sci Technol. 2022;19(2): 797–806.
13 Oray NC, Oray D, Aksay E, Atilla R, Bayram B. The impact of a heat wave on mortality in the emergency department. Medicine. 2018; 97(52):e13815.
14 Can G, Şahin Ü, Sayılı U, Dube M, Kara B, Acar HC, et al. Excess mortality in Istanbul during extreme heat waves between 2013 and 2017. Int J Environ Res Public Health. 2019; 16(22):4348.
15 Duties FDPD. Of the district population directorate. Ankara: Fethiye District Population Directorate; 2021. [cited 2 July 2021]. Available from: http://www.fethiye.gov.tr/fethiye-ilce-nufus-mudurlugu.
16 FDMD. Detailed weather forecast for Mugla-Fethiye. Ankara: Fethiye District Meteorology Directorate; 2021. [cited 2 July 2021]. Available from: https://mgm.gov.tr/tahmin/il-ve-ilceler.aspx?il=Mu%C4%9Fla&ilce=Fethiye.
17 Tong S, Wang XY, Barnett AG. Assessment of heat-related health impacts in Brisbane, Australia: comparison of different heatwave definitions. PLoS One. 2010;5(8):e12155.
18 Hansen AL, Bi P, Ryan P, Nitschke M, Pisaniello D, Tucker G. The effect of heat waves on hospital admissions for renal disease in a temperate city of Australia. Int J Epidemiol. 2008;37(6):1359–65.
19 Perkins SE, Alexander LV. On the measurement of heat waves. J Clim. 2013;26(13):4500–17.
20 Anderson BG, Bell ML. Weather-related mortality: how heat, cold, and heat waves affect mortality in the United States. Epidemiology. 2009;20(2):205–13.
21 D'Ippoliti D, Michelozzi P, Marino C, de'-Donato F, Menne B, Katsouyanni K, et al. The impact of heat waves on mortality in 9 European cities: results from the Euroheat Project. Environ Health. 2010;9:37.
22 Nitschke M, Tucker GR, Bi P. Morbidity and mortality during heatwaves in metropolitan Adelaide. Med J Aust. 2007;187(11–12):662–5.
23 Huynen MM, Martens P, Schram D, Weijenberg MP, Kunst AE. The impact of heat waves and cold spells on mortality rates in the Dutch population. Environ Health Perspect. 2001;109(5):463–70.
24 Tam WWS, Wong TW, Chair SY, Wong AHS, AndromedaWong HSBS. Diurnal temperature range and daily cardiovascular mortalities among the elderly in Hong Kong. Arch Environ Occup Health. 2009;64(3):202–6.
25 Huang C, Barnett AG, Wang X, Tong S. Effects of extreme temperatures on years of life lost for cardiovascular deaths: a time series study in Brisbane, Australia. Circ Cardiovasc Qual Outcomes. 2012;5:609–14.
26 Baccini M, Biggeri A, Accetta G, Kosatsky T, Katsouyanni K, Analitis A, et al. Heat effects on mortality in 15 European cities. Epidemiology. 2008;19(5):711–9.
27 Rooney C, McMichael AJ, Kovats RS, Coleman MP. Excess mortality in england and wales, and in greater london, during the 1995 heatwave. J Epidemiol Community Health. 1998;52(8):482–6.