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Association between meteorological factors and hepatitis A in Spain 2010–2014

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ABSTRACT

Background: There is growing concern of how climate change could affect public health, due to the increase number of extreme climate events. Hence, the study of the role that climate events play on the distribution of water-borne diseases, like Hepatitis A, could be key for developing new prevention approaches.

Objective: To investigate the association between climate factors and Hepatitis A in Spain between 2010 and 2014.

Methods: Weekly Hepatitis A cases between 2010 and 2014 were obtained from the Spanish Epidemiology Surveillance Network. Climate variables (weekly cumulative rainfall, rainy days, storm days and snow days) were obtained from National Climatic Data Center (NOAA satellite and information Service of USA). Each municipality was assigned to the nearest weather station ($N = 73$). A Mixed-Effects Poisson regression was performed to estimate Incidence Rate Ratios (IRR), including a time lag of 2, 3 and 4 weeks (most probable incubation period for Hepatitis A).

Results: Rainfall higher than 90th percentile (extreme precipitation) was associated with increased number of Hepatitis A cases 2 weeks (IRR = 1.24 CI 95% = 1.09–1.40) and 4 weeks after the event (IRR = 1.15 CI 95% = 1.01–1.30). An extra rainy day increased the risk of Hepatitis A two weeks after (IRR = 1.03 CI 95% = 1.01–1.05). We found higher risk of Hepatitis A two weeks after each extra storm day (IRR = 1.06 CI 95% = 1.00–1.12), and lower risk with 3 and 4 weeks' lag (IRR = 0.93 CI 95% = 0.88–0.99 for lag3; IRR = 0.94 CI 95% = 0.88–0.99 for lag 4).

Conclusions: There is an increased risk of Hepatitis A 2 weeks after water-related climate events. Including meteorological information in surveillance systems might improve to develop early prevention strategies for water-borne diseases.

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1. Background

Hepatitis A is a self-limited liver disease caused by the infection of Hepatitis A virus (HAV). HAV is transmitted via the fecal–oral route, directly from person-to-person or indirectly by ingestion of feces-contaminated food or water (Previsani and Lavanchy, 2000). The disease is a typically food–waterborne disease because HAV is abundantly excreted in feces and it can survive in the environment for prolonged periods of time (Previsani and Lavanchy, 2000). Direct person-to-person dissemination is common under poor hygienic conditions. Its incubation period varies between 14 and 28 days, but it can last 50 days (Desenclos et al., 1991).

Infections occur early in life in areas where sanitation is poor and living conditions are crowded. With improved sanitation and hygiene, infections are delayed and consequently the number of people susceptible to the disease increases. Under these conditions, explosive epidemics can arise from fecal contamination of a single source. In most industrialized nations, where hepatitis A is no longer considered a childhood disease, infections with HAV are increasingly contracted by adults. According to The European Surveillance System (TESSy), the notification rate in the EU/EEA has fallen between 1997 and 2011, from 10.0 to 2.5 per 100,000 population (Gossner et al., 2015).

In Spain, Hepatitis A is a compulsory notifiable disease and individual cases are reported to the National Epidemiological Surveillance Network (Red Nacional de Vigilancia Epidemiológica, RENAVE). All Spanish Regions recommend selective HAV vaccination for the people at highest risk, following the recommendations of the Spanish Ministry of Health; moreover, Catalonia Region and the Autonomous cities Ceuta and Melilla include systematic HAV vaccination in their calendars

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(Domínguez et al., 2003). In 2014, the annual incidence of Hepatitis A was slightly >1 case /100,000 population according to the latest reports of RENAVE (Centro Nacional de Epidemiología, 2016). There is high space-time variability in the incidence of Hepatitis A, and it has been hypothesized that this variability could be due to some extent to climate exposure variability (Gomez-Barroso et al., 2012).

Global climate change is expected to affect the frequency, intensity and duration of extreme water related weather events such as excessive rainfall, storm surges, floods, and drought (Semenza and Menne, 2009). During periods of heavy precipitation, local water quality can be seriously compromised via diverse means, a significant one being the cross-contamination of water sources due to infiltration and inflow between sewage and water pipes. The effect of climate and environmental factors (weather conditions, such as temperature, rainfall, and relative humidity), on waterborne disease incidence has been explored in different studies (Cann et al., 2013; Guzman Herrador et al., 2015; Wu et al., 2016). However, the impact of these environmental factors on Hepatitis A incidence remains unclear, as few studies have studied the specific effect on Hepatitis A (Chen et al., 2012), although there are some insights of this associations as different outbreaks of Hepatitis A after water-related weather events have been reported (Guis et al., 2006; Lee et al., 2008; Sowmyanarayanan et al., 2008). Our hypothesis is that there will be an increased risk of Hepatitis A after water-related events (rain, storm, snow), taking into account the incubation period. Thus, the objective of this research is to investigate the association between climate factors and incidence of Hepatitis A in Spain between 2010 and 2014.

2. Methods

2.1. Setting

According to the Spanish Statistical Office Municipal registry (Instituto Nacional de Estadística, INE) Spain had a population of nearly 47 million people in 2014, distributed in 8116 municipalities. The population varies from municipalities with 1 inhabitant to municipalities with over 3,000,000 inhabitants. The average population density was 93.51 inhabitants/km². These municipalities are aggregated into 52 provinces which in turn are aggregated in to 17 autonomous regions and two autonomous cities. The area of Spain is 504,645 km².

The climate of Spain is extremely spatially variable. According to the Köppen classification, Spain has Dry Climates (type B) in the southeast of the Peninsula Iberica as well as the Ebro Valley, and some parts in the southern central plateau region, Extremadura and the Balearic Islands; temperate climates (type C, where the average temperature in the coldest months is between 0 and 18 °C) covers almost 40% of the country, including the majority of the southern central plateau region, and the Mediterranean coastal regions, with the exception of the arid zones in the southeast, Cold Climates (type D) are located in small areas of the mountainous regions at higher altitudes in the Cantabria Mountains, the Iberian Mountain Ranges, Central Ranges and the Sierra Nevada (Agencia Estatal de Meteorología, 2011).

2.2. Data collection

All individualized cases of Hepatitis A reported to RENAVE for the period 2010–2014 were initially included (aggregated epidemiological data is available through the surveillance report in: <http://www.isciii.es/ISCIII/es/contenidos/fd-servicios-cientifico-tecnicos/fd-vigilancias-alertas/fd-enfermedades/enfermedades-declaracion-obligatoria-informes- anuales.shtml>). Each case includes information of age, sex, municipality of case assignment, reporting week and case classification data. We excluded from our analysis cases with incomplete or non-existent information about age, sex, municipality, or notification week. Total population for each municipality stratified by age and sex was obtained in the continuous municipality census track in 2014,

provided by the INE. Each case was assigned to the UTM coordinates, datum 50 (x,y) of the centroid of the municipality.

Climate daily data over the same period were obtained from National Climatic Data Center NOAA (US Department of Commerce NS and IS, 2016). Daily data were grouped weekly to obtain weekly cumulative rainfall, weekly rainy days, weekly storm days and weekly snow days. Storm day is defined as a day with electrical activity as thunders (Agencia Estatal de Meteorología, 2015). As the NCDC report climate data by weather station, each municipality was assigned to the nearest weather station. Therefore, 73 meteorological regions were created (Fig. 1). We only took data from stations that have, at least, 95% of the daily climate data completed. Where a day was found to have missing data, this was replaced by a four-day moving average centered on that day.

2.3. Statistical analysis

First, descriptive statistics were calculated for Hepatitis A and climate data, providing incidence estimates of Hepatitis A by sex and year. Mean, standard deviation and quartiles are provided for weekly cumulative rainfall, weekly rainy days, weekly storm days and weekly snow days. Due to the distribution of the weekly cumulative rainfall, in the further analysis was treated as dichotomous; thus, we test for “extreme precipitation”, defined as cumulative rainfall higher than the 90th percentile of the weeks.

A Mixed-Effects Poisson regression was created to study the relationship between Hepatitis A cases and climate factors. As the dependent variable, Hepatitis A cases were included. In the fixed part of the

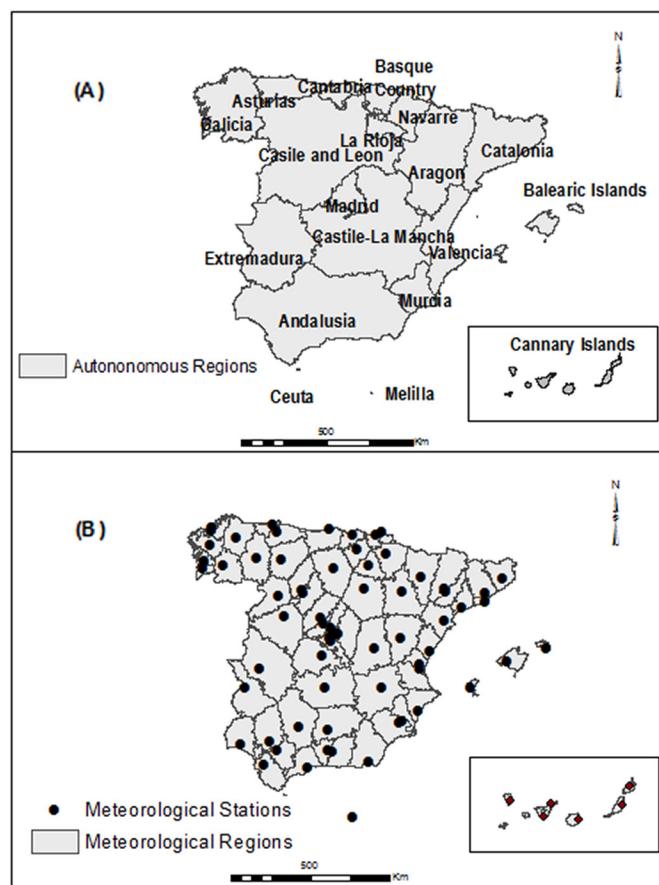


Fig. 1. Map of the Autonomous Regions of Spain (A) and the distribution of the meteorological stations and the meteorological regions created (B).

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