

Measles, Malnutrition and Mortality: Puerto Rico, 1917-1918

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Objective: Recent measles outbreaks in the United States and Europe have highlighted the threat of the disease. We studied the 1917-1918 epidemic in Puerto Rico to better understand the social and place-specific risk factors and severity of such crises.

Methods: We reviewed medical and government reports, newspapers and private contemporary documents.

Results: The epidemic developed over two years, encompassed the Island, and caused nearly 2,000 deaths among more than 9,000 registered cases (with much underreporting). During the first six months, 59% of fatalities were children under 2 years of age. Officials recognized poor nutrition and living conditions as an important determinant of epidemic severity. Responses came from different social sectors before the central government mobilized to help. In San Juan, Catholic and Protestant churches and philanthropic women from both Spanish and English-language communities joined to provide free milk to needy children and create a temporary Infants' Hospital. Despite food scarcity and wartime conditions, central and municipal governments established hospitals and milk stations.

Conclusion: Studies that examine the impact of reemerging diseases in a time and place-specific context look at disease severity together with the socioeconomic conditions of patients and health care systems. This type of investigation also suggests avenues into the history of pediatrics, the use of epidemiologic methods, the utility of historical statistics, nutritional history, and the history of disaster response. Historical and recent outbreaks show the need for health care professionals and public health systems to be prepared to confront measles epidemics. [*P R Health Sci J* 2020; 39:20-27]

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In large population groups today, fear of measles infection has been replaced by fear of the vaccine. Most people in the United States, including physicians, have never seen a case because of the introduction of vaccine in 1963, mandatory immunization, and the elimination of endemic measles in 2000. Outbreaks in 2019 put that “elimination status” in jeopardy (1). Measles can be life-threatening in its acute phase and may also increase the risk of death for years thereafter, due to immunosuppression (2). Vaccination prevents primary measles infection and may also help prevent other infections. Recent outbreaks in many continents have brought home the threat of the disease, and epidemics in refugee camps show its potential to produce fatalities (3). Historical analysis can assist in the understanding and prevention of potentially recurrent severe crises not seen in recent times. We chose to study the measles epidemic of 1917-1918 in Puerto Rico for three reasons: the lack of vaccine and specific treatment allowed the development of many clinical manifestations; it is mentioned alongside contemporary disasters but has not been studied; and a historian colleague alerted us to a vivid

description of the outbreak in a parish chronicle. The memory of the suffering of the sick and their families may help protect the health of present-day children.

Methods

Repeated inquiries at the Archivo General de Puerto Rico failed to identify documents originating from the Department of Health. Our investigation therefore focused on the review of published medical and government reports, newspapers, and private contemporary documents. An article by Antonio

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Fernós-Isern (1928) provided important additional epidemiologic data (4).

Findings

Measles and medical care, Puerto Rico 1917-1918

Pediatric textbooks of the time described measles as an infectious disease which mostly affected children. It produced low mortality “except in infants and delicate children” (reaching 30-40%) (5). High infectivity and symptoms such as fever, rash, cough, coryza, conjunctivitis, and Koplik spots were explained in detail. The cause of the disease was suspected to be a virus. The most frequent and fatal complication, “lobular pneumonia,” was attributed to secondary infection by “strepto or other cocci”. The prognosis was known to depend on multiple factors such as age and social condition, with higher mortality among the poor (6). The only necessary treatment for uncomplicated measles consisted of “a well-ventilated room and a light diet with abundance of water” (7).

The Department of Health in Puerto Rico paid careful attention to childhood diseases. Children under ten years of age accounted for approximately 30% of the population (versus 10% now). Infant mortality (deaths in children under a year of age per thousand live births) was 152 in fiscal year 1915-1916 (FY 1916) (7.1 in 2014, 6.3 in 2019). It then accounted for 26% of all deaths (less than 1% in 2014) (8).

In the twenty years after the United States’ invasion (July 25, 1898), Puerto Rico changed in almost every aspect of its governance and organization. The last years of that period were especially eventful. On March 2, 1917, the Congressional Jones Act granted U.S. citizenship to Puerto Ricans, instituted military service, provided for a referendum on the prohibition of the sale of alcoholic beverages (approved by voters), and changed the local government structure. The act transformed the Sanitary Service into a cabinet-level Department of Health. In the following months, a series of crises affected the Island: entry in World War I; blockade by German submarines; food scarcity; Armistice; demobilization; earthquake and tsunami; epidemics of measles, typhoid, meningococemia, and influenza (9).

Epidemiologic description of the outbreak

In the middle of its reorganization, the new Department of Health was faced with “an unusually persistent and virulent epidemic of measles which originated in San Juan” (Figure 1). A measles epidemic had not been reported since 1910, when there had been 396 deaths (but deaths due to measles are noted in the Department’s annual reports for FYs 1909 to 1911). In January 1917, cases were reported from Puerta de Tierra (San

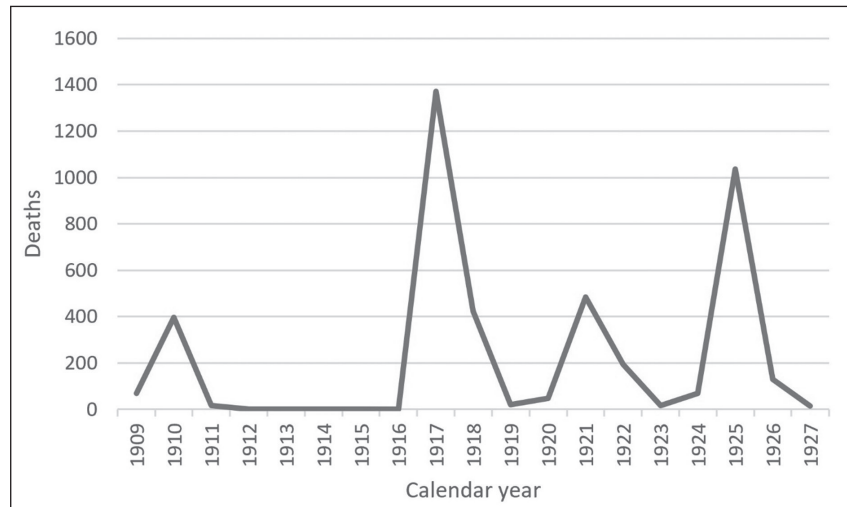


Figure 1. Deaths attributed to measles, by calendar year, Puerto Rico, 1909-1927. Source: Fernós-Isern A. Measles in Porto Rico. *Porto Rico Review of Public Health and Tropical Medicine*. 1928; 4:149-154.

Juan); by the end of June and the fiscal year, 3,670 cases from 70 municipalities and 615 deaths were registered. In FY 1918, measles was made a notifiable disease: 5,233 cases and 1,096 deaths were recorded. The apparent increase in cases over the previous year may reflect physicians’ obligation to report. During FY 1919, only 82 cases were reported; however, 91 deaths were attributed to measles, one of many numerical discrepancies found in the government’s health statistics (10).

An epidemic curve by month for 1917-1918 (Figure 2) shows a two-year process (most likely the summation of local outbreaks) with a steep increase from January 1917, a peak in July, and a slow descent during the following 18 months. Transmission may have continued in the following year, diagnosed as dengue, which produces a rash very similar to that of measles. Many dengue cases (345) were reported for FY 1919, while very few were reported during the measles epidemic, and only 7 for FY 1920 (11).

Relatively early in the epidemic (1917), which he considered controlled (“dominada”), Dr. José Gómez Brioso, director of the Department’s Division of Transmissible Diseases in FY 1917, published a statement titled “The measles” in the journal of the Puerto Rico Medical Association. He summarized the situation indicating the disease had “exploded” in San Juan and extended to other important towns but had assumed “extraordinary proportions” in Puerta de Tierra and Santurce (also part of the municipality of San Juan). In some areas of the former, “where it entered, it left no healthy child” (due to crowded living conditions) and mortality had “obeyed conditions of organic debility prior to the illness”. In Santurce, transmission was less intense, most likely due to the lower density of population, but in San Juan (now called old San Juan) it had not been as severe, despite its crowded living conditions (12).

Measles spread to most municipalities (Figure 3) (13). All geographic regions included municipalities in the lowest and highest range of reported rates. Municipal details (e.g., timing

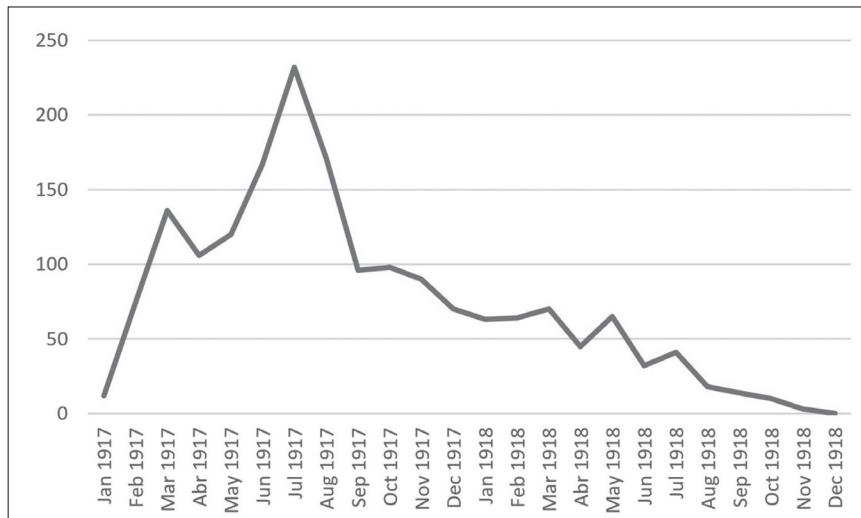


Figure 2. Deaths attributed to measles, by month, Puerto Rico, 1917-1918. Source: Fernós-Isern A. Measles in Porto Rico. Porto Rico Review of Public Health and Tropical Medicine. 1928; 4:149-154.

of outbreaks, quality of disease surveillance, living standards and health care access for affected populations) are needed to explain the geographic distribution of rates. For example, we do not have information to examine the possibility of urban to rural spread. The epidemic seems to have started in the capital and spread to other towns, but disease notification was based on the municipal jurisdictions, which combine an urban center and many rural barrios.

The only information reported concerning personal characteristics of cases is the number of deaths among those under 2 years of age. The proportion was 59% for FY 1917 (the first six months of the epidemic, which corresponded to January-June 1917) and 40% for FY1919 (the corresponding data for 1918 were not published). Infant mortality increased markedly, from 152 in FY 1916 to 193 in 1917, then 173 the following year, and 143 in FY 1919 (14).

Clinical description

Dr. Gómez Brioso considered that measles, in itself, had shown a customary mildness in the acute stage, but the causes of fatal outcome were observed during convalescence. As the only description we have found of concurrent clinical entities, it is quoted at length:

“A notable number of cases are due to enteritis, gastro-enteritis, entero colitis, diarrheas, etc. which have influenced the fatal outcome of the illness, joined to catarrhal involvement of the mucosae [() bronchial, auditory, nasal()] and their sequelae[,] maladies by disorders of nutrition, that have made

easier the presence of certain parasitic or bacterial elements which must be blamed for having contributed to the figure of one and forty hundredths percent [1.40%] estimated for mortality in this epidemic.”

In contrast to the pediatric textbook quoted above, which warned against “lobula+r pneumonia” as the most frequent fatal complication, Gómez Brioso blamed mostly gastrointestinal disorders (12).

Social impact

There is an account of the epidemic’s social consequences in a community affected early on (January 23 to April 22, 1917). Puerta de Tierra, (Figure 4) the densely populated working-

class district east of old San Juan, was by then notorious as an epidemic focus: plague in 1912, tuberculosis and smallpox in 1916 (15). No government attention was perceptible in the first three weeks. A newspaper article on February 15 (saved for posterity by transcription into the San Agustín Catholic parish chronicles) described shacks made of boards and tin cans, open sewers, and standing pools of filth. With the price of food so high that people went hungry, “children with [...] bony little arms and legs, hollow cheeks and chests” were “dying so fast that it has been difficult to provide burial for them”. Storekeepers had run out of boxes, donated to make coffins. The author called for help: “These children are not all dying from measles. They are dying for want of care, nourishment[,] and food for their mothers” (16).

The satirical weekly *Pica-Pica* did not mention the epidemic, in contrast to the plague outbreak in 1912. Plague alarmed the public but caused only 36 deaths; measles, however, was familiar, and high mortality among children proved to be a difficult subject for satire. In the weekly *Porto Rico Progress*, mention of measles practically disappeared after the end of March 1917 (17). Although the onset of war (April 2)

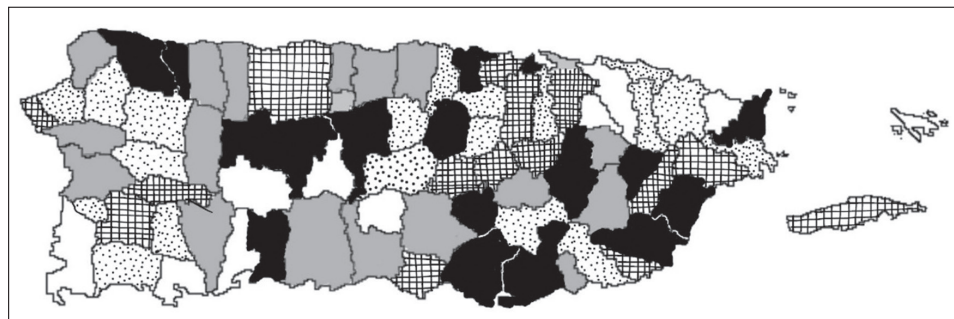


Figure 3. Measles case reporting rates by municipality, Puerto Rico, fiscal years ending 1917 to 1919. Range of reported rates (cases per 1,000 estimated municipal population, 1917): Blank – No cases, no reporting, or municipality not in lists; Dots – 0.23 to 2.46; Hatching – 3.0 to 5.90; Gray – 6.17 to 9.92; Black – 10.27 to 25.64

produced no outright press censorship, there was considerable self-inhibition of officials and newspapers due to “patriotism” (to support civic morale in wartime), fear (of a new federal law on disloyal or critical language about the government of the United States), and a misguided attempt to control panic (which is usually provoked by lack of accurate information) (18).

Government explanations for the severity of the outbreak

Puerto Rico’s agricultural output was devoted almost exclusively to sugarcane, so the island’s food supply depended on importations from the United States. The situation was made worse by a 1916 hurricane that destroyed plantain groves, and then a drought. Officials recognized poor nutrition and social conditions as an important determinant of epidemic severity. For example, regarding the first months of the epidemic: “The young children specially suffered from lack of nourishment, and a very high rate of mortality occurred, particularly in San Juan, from diseases indirectly produced by measles. [...] An investigation of the conditions, however, showed that only a small number of these children would require hospital treatment, the majority only needing proper food” (19). Gómez Brioso, possibly the author of the statements just quoted, concluded in his article that measles had been mild, but “greatly diffusible”. It caused great damage because it descended upon a “racially depauperized population with low resistance to external poisons”, and because of collaborating causes such as “irregular and perverted diet”, poor quality food, and lack of hygienic and protective lodging against the weather (12). In the town of Isabela, the few deaths that occurred were “due to defective feeding” (20). The following year, the majority of the 1,096 deaths reported were considered “due to condition in life and to complications[,] rather than to the virtuality [essence, potential] of the nosological entity [disease]” (21).

Wartime restrictions contributed to a food shortage that governor Yager described on February 23, 1917, as “perilous,” that “may at any time become more severe.” He stated that “food prices are so high that the poor man can scarcely live” and called on sugar planters to sow for home consumption in order to reduce food prices. Two weeks later, a newspaper summarized the opinion of the Commissioner of Health as follows: “Poverty makes big death rate in measles epidemic” (22).

Social and government response

On February 9, the Board of Health reported that cases did not require quarantine, and “malignant cases” were most often due to neglect, lack of cleanliness, “alimentary transgressions,



Figure 4. Puerta de Tierra (San Juan, PR), partial aerial view, 22 March 1923. Source: Wall display at Hogar Nuestra Señora de la Providencia, Puerta de Tierra, San Juan.

individual circumstances such as cachexia and organic impoverishment, and misery.” The governor’s report indicated that government could not act until funds were appropriated (which did not happen until March 26!) (23). Response to the crisis therefore came from a variety of religious and civic sectors: the priests and nuns of San Agustín, Protestant denominations, and philanthropic women from both Spanish and English-language communities in San Juan. They formed a committee called the “Fondo de Leche” or “Milk Fund” to provide free milk to the needy of the district. They also established a temporary Infant’s Hospital with the help of the municipality. Milk distribution at the local medical dispensary was ongoing by March 7 (24). There is mention of a milk and food station operating from April 1 to May 15. The Quarantine Hospital received 582 contagious cases; 90 convalescent cases (still requiring care) were admitted to a temporary hospital (Figure 5) on the “new government dock,” which closed on June 15 (25). Perhaps that location was chosen to assure the good ventilation recommended for the care of persons with measles.

As mentioned, the disease struck beyond Puerta de Tierra to reach most municipalities. The rector of San Agustín parish declared to a newspaper, “there has been a death of a child from this epidemic right in front of the governor’s palace” (26). Spread to the central municipalities of Caguas, Cidra and Juncos resulted in the distribution of medicines and milk among the needy and the establishment of a 25-bed hospital in Juncos, attended by its mayor, Dr. José Barreras. Later, the Department of Health opened hospitals in Guayama, Aibonito, and Cayey, with instructions “to furnish free milk to the indigents attacked by measles.” These measures, it was felt, “prevented a large number of casualties and facilitated the cure of the majority of the cases.” The wharf hospital and milk stations in San Juan provided six different milk formulas; there is no mention of specific medications. The government seems to have considered



Figure 5. “One of the five departments of the wharf [Malecón] hospital, which houses 64 children convalescing from measles”. Source: *La institución salvadora de los niños, Puerto Rico Ilustrado*. 1917 April 28, unnumbered page.

necessary to explain that, although it was customary to appoint men as hospital superintendents, “trained nurses [i. e. females] were placed in charge of each hospital” and food station. Miss Margarita D. Rivera was their overall superintendent (27).

The Department of Health reported expenditures for “suppression of measles” amounting to \$15,449.23 in FY 1917 and \$11,653.45 for 1918, a total \$27,102.68, about 12% of an annual budget of the Department, or approximately half a million dollars in 2016 (28). Compared to the 425 deaths caused by measles in 1918, only 20 were reported the following year (Figure 1). Large outbreaks recurred three times in the next decade.

Discussion

The epidemic extended for two full years, encompassed the Island, produced thousands of cases and close to 2,000 deaths, while officials recognized that many cases went unreported. An evaluation of the efficacy of the government health effort must start with a look at the quality of information collected and used to define and address the problem. Contemporary experts bewailed the poor quality of government health statistics (29). Indeed, the health data presented in the governor’s annual reports for FYs 1917-1919 are often not correct, congruent, consistent, or complete (30). In addition, the interpretation is often confusing and expressed in ambiguous and even contradictory statements, such as: “The epidemic of measles of 1917-18, though well controlled, has continued to give rise to more or less intense outbreaks in towns thought to be immune” (31). The ambiguity may be due to poor quality of expression in English by local officials (or poor translation of good Spanish), neglect of statistics which should have been used

for analytical purposes, or may even be due to intentional dissimulation, especially in the report for FY 1919, which celebrated the achievements of two decades of American government. Some imprecision may also reflect contemporary standards, rather than local practice. We found erroneous column totals in the 1910 census of Puerto Rico carried out by the US Department of Commerce (32).

The government response to the outbreak was slow (Puerto de Tierra reportedly received no help during the first three weeks of the outbreak, and government funds for “measles suppression” were appropriated only on March 26, after three months). Community and religious philanthropy filled the gap. Nevertheless, we must acknowledge

that government officials announced the problem early in February, consistently recognized the association between severe disease and malnutrition, and provided some relief despite confronting enormous difficulties.

Most countries, at this time of infrequent use of pasteurization and refrigeration, also faced the problem of poor-quality milk (often the cause of infantile diarrhea), through commercial production and household handling. The establishment of “milk stations” addressed the distribution of good-quality milk for poor children (33). In our day’s treatment and preventive interventions, administration of vitamin A supplements would be considered a priority. Since 1987, vitamin A supplementation has been shown to greatly reduce infant mortality, and subsequent studies have shown particular efficacy in areas where diarrheal disease and measles were a frequent cause of death (34). Just like Puerto Rico in 1917!

A brief account of sanitary affairs in Puerto Rico published in 1923 decried the epidemic’s impact on child mortality, but there is no mention of this in our later synoptic histories of medicine (35). Our search did not locate concurrent measles epidemics in the Caribbean region, nor in communities in the United States (except US Army camps). Lack of mention may be due to a high tolerance for the disease, or the restrictions on wartime communications (36). Antonio Fernós Isern, Assistant Commissioner of Health in 1928, stated that measles was one of the most important diseases affecting the health of children. His review of measles activity on the Island, using data for 1921-1925, showed that the mortality rate due to measles among people under 15 years of age was much higher in Puerto Rico than in the United States (57 vs. 19 per 100,000) (37). The 1917 all-age mortality rate for measles in Puerto Rico (111.7 per 100,000) can be compared with the highest death rates reported by states in 1916: 21.8 (Rhode Island), 18.2

(Virginia) and 11.1-11.3 (Minnesota, Connecticut, Michigan, New Jersey) (38). Comparison of rates among dissimilar areas is often misleading, but the rate in Puerto Rico was five to ten times that of states with the highest rates.

Although we have investigated only the first of the epidemics considered by Fernós in the two decades he reviewed, we can propose some explanations for his identification of measles as a significant threat. The almost 2,000 deaths, mostly in children, were attributed to factors extraneous to the infection, and government officials, newspapers, and members of the clergy also stated clearly that malnutrition was the principal cause of the deaths. Actually, the Island was suffering an undeclared famine. Alongside the measles mortality reported for 1918-1919 there were also reports of beriberi among military recruits, and pellagra in the municipalities of San Juan and Fajardo (39). The acute scarcity and high prices of food aggravated the chronic malnutrition of the laboring population. The high rate of rejection (30%) among potential military draftees undergoing physical examination evidenced what a local physician called a “physiologically naked” population (40). This may be what Dr. Gómez Brioso meant by “racially depauperized”, referring not to skin color, but to a “race” (population) physically impoverished by malnutrition and disease.

Analyses of measles epidemics of the past have examined multiple factors for severity, such as virgin populations, concurrent bacterial epidemics producing pneumonia, and poor physical condition from undernourishment (41). The first does not apply to Puerto Rico in 1917, but malnutrition in the population was evident to the contemporaries. Gómez Brioso mentioned “parasitic or bacterial elements”, and measles-induced immunosuppression likely contributed to severity through secondary infections, but he made no specific mention of pneumonias. As he stressed and was mentioned (probably also by him) in the Department’s report for FY 1917, many children died not “from measles per se, but from diarrhea following the lowered resistance caused by the disease” (42). Fernós, in his multi-decade review, specifically found a correlation between the cyclical pattern of measles deaths and mortality from bronchopneumonia and diarrhea (43).

Historical studies such as ours, which examine the impact of reemerging diseases in a place-specific context, look at disease severity together with the socioeconomic conditions of patients and health care systems. Our investigation has been limited by the scarcity of documents, and by the administrative rather than clinical focus of government reports. Nevertheless, this type of investigation also suggests avenues into the history of pediatrics, highlighting the work of proto-pediatricians such as Fernós, Gómez Brioso, and others; the development of epidemiologic methods in the Department of Health; the utility of historical statistics, the nutritional history of the Island; and the history of disaster response.

Our examination of this widespread, high-mortality measles outbreak is a reminder of the threat that the disease poses to unimmunized and immunosuppressed persons in our

community. Vaccination has removed many diseases from the public sphere for decades, but we are in an era of emerging and reemerging infections. Historical and recent outbreaks show the need for health care professionals, public health systems, and the public to be prepared to confront measles epidemics.

Resumen

Objetivos: Brotes recientes de sarampión en Estados Unidos y Europa recalcan la amenaza de la enfermedad en el presente. Estudiamos la epidemia de 1917-1918 en Puerto Rico para entender los factores de riesgo específicos en cuanto a lugar, sociedad y severidad en crisis parecidas. **Métodos:** Revisamos informes médicos y gubernamentales, periódicos y documentos privados contemporáneos. **Resultados:** La epidemia duró dos años, cubrió la Isla y causó casi 2,000 muertes entre más de 9,000 casos registrados (con un alto grado de subregistro). Durante los primeros seis meses, 59% de las muertes ocurrieron en menores de 2 años de edad. Los oficiales gubernamentales reconocieron que la nutrición insuficiente y las condiciones de vida eran determinantes en la severidad de la epidemia. Diferentes sectores sociales respondieron antes de que el gobierno central se movilizara. En San Juan, las iglesias católicas y protestantes, y mujeres filantrópicas anglo e hispanoparlantes se unieron para proveer leche gratis a los necesitados y crear un hospital infantil temporero. A pesar de la escasez general de comida y las condiciones bélicas, los gobiernos central y municipales establecieron otros hospitales y estaciones de leche. **Conclusiones:** Al estudiar el impacto de las enfermedades reemergentes en un contexto específico de tiempo y lugar se percibe la severidad clínica junto a las condiciones socioeconómicas de los pacientes y los sistemas sanitarios. Nuestra investigación sugiere nuevas avenidas en la historia de la pediatría, la epidemiología, la nutrición y la respuesta a desastres. Los brotes de sarampión antiguos y recientes recalcan la necesidad de que los profesionales de salud y los sistemas sanitarios estén preparados para confrontar estas epidemias.

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 13. A comparison of rates using the total municipal population would only be useful if the proportion of the population at risk (and measles was predominantly a childhood disease) was similar in all towns. We decided the census of 1920 might show peculiar figures from the large mortality of catastrophic events in 1917-1918. In 1910, an average 31% of the population per town had under 10 years of age, with only 5 of 68 towns beyond two standard deviations from the mean: the cities of San Juan, Mayaguez and Ponce (20-25%), and two small towns, Trujillo Alto and Loíza (38-40%); U.S. Census Bureau. Thirteenth census 1910, Statistics for Porto Rico (see note 8). To obtain measles reporting rates, we added the cases reported per town (governor's reports, FYs 1917-1919, to include all of 1918, with the understanding that the total number of cases from January to June 1919 was small), and calculated a municipal rate using the estimated population for 1917 (*PR Gov Ann Rep* 1918:190-191). We ranked the towns by average and grouped them in five categories: no cases reported, and (approximately) the four quartiles around the average (7.34 per thousand).
 14. *PR Gov Ann Rep* 1917:207; *PR Gov Ann Rep* 1919:210, 220-1, 224-5; *PR Gov Ann Rep* 1920:118.
 15. *PR Gov Ann Rep* 1916:96-99; King WW. Smallpox in Porto Rico, 1916. *Public Health Rep* 1916;31:1748-1750. The conditions of Puerta de Tierra and their relationship with recurrent epidemics are examined in Santiago Caraballo J. Los obreros de Puerta de Tierra y la guerra, 1917-1918. In: Gaztambide Géigel A, Álvarez Curbelo S, editors. *Historias vivas: historiografía puertorriqueña contemporánea*. San Juan (PR): Ed. Postdata; 1996:80-84; Partsch J. La crisis de 1898 y su impacto en los institutos de vida religiosa en Puerto Rico. San Juan (PR): Fundación Puertorriqueña de las Humanidades; 2008:107-109; Bird Carmona A. Parejeros y desafiantes (la comunidad tabaquera de Puerta de Tierra a principios del siglo XX). San Juan (PR): Huracán; 2008:135-175; Zulawski A. Urban development, public health, and the environment: a historical case study in San Juan, Puerto Rico and possibilities for the future. *Brown J World Affairs* 2016; 22:197-214; Zulawski A. Environment, urbanization, and public health: the bubonic plague epidemic of 1912 in San Juan, Puerto Rico. *Lat Am Res Rev* 2018;53:1-17.
 16. *Chronica Domus ad S. Augustini* 1:108-119 for the epidemic; 110-111 for "Times" article, but such a local newspaper has not been found, and the text could not be located in surviving copies of contemporary newspapers. The conditions are also described by Fr. Hoff, see \$80,000 fund to fight epidemic of measles. *Porto Rico Progress*. 1917 Mar 23:1.
 17. Rigau-Pérez JG. The work of US Public Health Service officers in Puerto Rico, 1898-1919. *P R Health Sci J* 2017;35:130-139; Good work done by the Day Nursery Association. *Porto Rico Progress* 1917 Jul 6:9; Camp Cayey under way; vaccination first duty [...] Quarantine against measles. *Porto Rico Progress* 1917 Aug 31:1.
 18. Barry JM. *The great influenza: the epic history of the deadliest plague in history*. New York (NY): Viking Penguin; 2004:94, 123-125, 333-341.
 19. *PR Gov Ann Rep* 1917:6, 197.
 20. *PR Gov Ann Rep* 1917:170.
 21. *PR Gov Ann Rep* 1918:171.
 22. Food shortage prompts action of governor. *Porto Rico Progress*. 1917 Feb 23:1; Poverty makes big death rate in measles epidemic. *Porto Rico Progress*. 1917 Mar 9:1.
 23. Sobre el sarampión Nota oficial de la Junta Insular de Sanidad. *La Democracia*. 1917 Feb 9:2; *PR Gov Ann Rep* 1917:45, 197.
 24. *Chronica Domus ad S. Augustini* 1:112-115; Good work done by the Day Nursery Association. *Porto Rico Progress* 1917 Jul 6:9; Negrón Muñoz A. *Mujeres de Puerto Rico*. San Juan (PR): Imp. Venezuela; 1935:188.
 25. *PR Gov Ann Rep* 1917:197, 230; La institución salvadora de los niños. *Puerto Rico Ilustrado*. 1917 Apr 28:unnumbered.
 26. \$80,000 fund to fight epidemic of measles. *Porto Rico Progress*. 1917 Mar 23:1
 27. *PR Gov Ann Rep* 1917:179, 197, 198; *PR Gov Ann Rep* 1918:171.
 28. *PR Gov Ann Rep* 1918:293; *PR Gov Ann Rep* 1917:249; Williamson SH. Measuring worth. Available at: <https://www.measuringworth.com/uscompare/> Accessed September 24, 2018.

29. Font y Guillot E. Sanitary development; Legislation; Board of Health. In: Fernández García E, Hoadley FW, Astol E, editors, *El libro de Puerto Rico. The Book of Porto Rico*. San Juan (PR): El Libro Azul Publishing Co.; 1923:286-304, esp. 301.
30. Other examples in PR Gov Ann Rep 1917:197: The total number of cases registered on the island distributed in 70 towns was 3,670, of which 415 (sic – 615) died; 210-211 The table of reported transmissible diseases by municipality lists towns out of alphabetical order and is not complete, missing Adjuntas, Aibonito, Culebra, Lajas, Trujillo Alto, Villalba. The total for measles is given as 3,670, but the numbers add to 3,810; PR Gov Ann Rep 1918:190-191 The table of reported transmissible diseases by municipality lists towns out of alphabetical order and is not complete, missing Guaynabo and Las Piedras. The total for measles is given as 5,233, but the numbers add to 4,977. The report omits the tables of cause-specific mortality in children aged under 1, 1-under 2, provided in other reports); PR Gov Ann Rep 1919:200-201 The table of reported transmissible diseases by municipality lists Guaynabo and Las Piedras out of alphabetical order. The total for measles is given as 82, which coincides with the addition, but the total number of deaths by measles is 91.
31. Quote from PR Gov Ann Rep 1919:164; other examples in PR Gov Ann Rep 1918:27 “There were no serious epidemics during the year, except a widespread development of measles”; 171 “This epidemic has been diminishing from day to day, thanks to the measures adopted”; but in page 214 (Dr. Pedro Malaret) “measles epidemic increased during the current year, terminating of its own accord when there was no source of infection”; 221 (Aguadilla) “Measles had a period of great dissemination, but the few victims of the disease were caused by the complications during convalescence”.
32. U.S. Census Bureau. Thirteenth census 1910, Statistics for Porto Rico (see note 8): 31-45 (the sums of municipal populations and of persons 10 years old and over do not coincide with the printed totals.)
33. Koplik H. Historia del primer Depósito de Leche o Gotas de Leche asociado a un consultorio en los Estados Unidos de América. *Bol Asoc Med P Rico* 1914;10(104):15-20; Markel H. For the welfare of children: The origins of the relationship between US public health workers and pediatricians. *Am J Public Health* 2000;90:893-899, esp. p. 896.
34. Packard RM. *A history of global health: Interventions into the lives of other people*. Baltimore (MD): Johns Hopkins University Press, 2016:319-320, 322.
35. Font y Guillot, 301-302; Quevedo Báez M. *Historia de la medicina y cirugía en Puerto Rico*. 2 vols. San Juan (PR): Asociación Médica de Puerto Rico; 1946-1949; Costa Mandry O. *Apuntes para la historia de la medicina en Puerto Rico*. San Juan (PR): Departamento de Salud (mimeographed); 1971. Hostos A de. *Tesoro de datos históricos de Puerto Rico*. San Juan (PR): Editorial UPR; 1990-1995.
36. Moll AA. *Aesculapius in America*. Philadelphia (PA): WB Saunders; 1944; Williams RC. *The United States Public Health Service, 1798-1950*. Washington (DC): Commissioned Officers Association of the United States Public Health Service; 1951, available at: <https://archive.org/details/unitedstatespubl00will>; Public Health Reports published numbers of cases of measles by city or state, without indication of epidemic level, e.g. Measles – reported prevalence for the year 1918. *Public Health Rep* 1919;34:2980-2982, which provides a ratio of fatalities per 100 cases.
37. Fernós, p. 149.
38. Fernós, p. 151; Measles. Recorded prevalence by states, 1916. *Public Health Rep* 1917;32:1186-1187.
39. PR Gov Ann Rep 1919:159-161.
40. Puerto Rico Office of the Adjutant General [Major John A. Wilson]. Report of the Adjutant General to the Governor of Porto Rico on the operation of the military registration and selective draft in Porto Rico. San Juan (PR): Bureau of Supplies, Printing, and Transportation; 1924:11, 101, 154; Martínez Álvarez A. *El tiempo y yo*. San Juan (PR): Ed. UPR; 1972:310 quoting Dr. Salvador Giuliani: “Estamos desnudos fisiológicamente.”
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42. PR Gov Ann Rep 1917:151.
43. Fernós, pp. 151-154.