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Tertian Fevers in Catalonia in the Late Eighteenth Centuries: The Case of Barcelona (1783–1786)

A Methodological Proposal to Develop Studies over Endemic and Epidemic Malaria in Past Societies

Kevin Pometti

Additional information is available at the end of the chapter

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Abstract

In this chapter, we propose a broad perspective of the sources available for the development of studies of endemic and epidemic malaria in past societies. The complexity of malaria as a disease is related to a variety of elements (environment, climatic oscillations, and human production and cultivation patterns). Historically, the study of malaria was integrated into the study of fevers in general. Indeed, malaria is a protean disease that interacts in positive, negative, and synergetic ways with other eukaryotic, viral, and bacterial diseases. Because of that, the word “fevers” conflates a wide range of diseases and symptoms that can also help us to detect the prevalence of malaria and relationships between the disease and environmental factors. Terms such as fevers, intermittent fevers, agues, and marshland fevers can be easily found in historical sources, print sources, and a large amount of documentation produced by state-municipal authorities, by physicians, and found in burial records. In sum, these represent the diversity of points of view involved in our research. Using as an example the case of Barcelona in the late eighteenth century, we show some results based on a methodology with a strong interdisciplinary basis.

Keywords: malaria, environment, Spain, Barcelona, disease

1. Introduction

In the late eighteenth century, we find a general context in Catalonia in which institutions, sanitation, and society adapted to political changes marked by the application of the “Real

Decreto de Nueva Planta” [1], one of the most important consequences of the Spanish Succession War. This law was elaborated and applied in 1717 by Bourbon authorities to control traditional Catalan institutions, modify the pre-existing legislation, and also reshuffle the pre-existing structures to create a new assembly according to the interests of the new monarchy. At the same time, the “Principado” political model was introduced in Catalonia. This model was similar to that prevalent in the majority of European countries, in which the sovereign could formulate laws separately from the political community [2]. In this sense, throughout the eighteenth century, the Audience regent in conjunction with the Intendent and the General Captain were the authorities that presided over political decisions throughout the Catalan territories [3].

The city of Barcelona was not an exception concerning the application of the new laws. From December 1718 [4], the consequences were felt in urban structures, the city council, the society, and all sanitation institutions and sanitation professionals. The city fall on 11 September 1714 implied the suppression of the traditional city council (known as “Consell de Cent”), and the construction in 1715 of Ciudadela fortress. This fortification was built to keep the city population under military control (**Figure 1**).



Figure 1. MOULINIER. Plano de la ciudad y Puerto de Barcelona. 1806. ICGC, RM. 19425.

The construction of the Ciudadela fortress also changed the traditional morphological distribution of the city. In fact, 17% of the total urban area [5] was occupied by the fortress,

causing 6380 people to be displaced to the most crowded city area, the quarter of Sant Pere i Santa Caterina, and changing the traditional morphology of the “artisan house.” The ancient structures were adapted to the necessities of accommodating the displaced population, “There are not so many houses in the city constructed in the present century that don’t have three or four rooms, or flats, more of them four, and some even five flats. The referred houses are actually taller than they were in the past. Their interior structures owe more to economics than to health. It is common to form a flat with the essential rooms, including a kitchen, saloon and bed, and a little room. This is seen in places that were commonly used as one room, which now present too many subdivisions. The majority of these rooms have a water well very close to the latrines” [6].

In 1753, a new quarter, designed by the military engineer Jorge Próspero de Verboom, was constructed to take in the population surplus of a crowded city center in which people’s quotidian life was quite marked by coexistence with textile industries, stagnant water channels (Rec Comtal), and the unhealthy sanitary conditions of commercial activities. Just 4.2% of the citizens moved to the new Barceloneta. This fact stunned travelers and visitors such as Arthur Young in 1787. “A quarter, called Barceloneta, it is entirely new and regular; their streets cross at right angles. Now: because of the absence of sailors, small businesses and artisans, the houses are low and small. One of the sides faces the docks. The streets are brightened up, but due to the high amount of dust, by a special attention to the wider streets, I cannot say that all of them are provided with flagstone pavement” [7].

The stagnant agriculture patterns of Catalonia in 1750–1760 pushed people to transfer to cities: cities that offered the possibility of importing wheat and export the surplus wine production to maintain the prices [8]. Between 1717 and 1787, the city population increased from 35,928 to 100,160 inhabitants, a 180% enlargement that translated into a population of 114,100 by the end of the century [9]. In consequence, cities like Barcelona saw a considerable increase in and a conflict with infrastructure not adapted to the process of intensive agriculture based on irrigation. Agricultural intensification and specialization had their negative effects in directly favoring the proliferation of unhealthy areas “*We face, as Young noticed, in one of the most advanced agriculture of Europe a dark side: the growth of unhealthy areas with delta fevers as a consequence of irrigation patterns*” [10].

At the end of the century, we find a city adapted to the Bourbon reforms and urbanized with new spaces concerning the construction of Ciudadela and the Ramblas development. The city council from 1784 managed the regulation of the new spaces in which textile industries could be placed—outside the city walls—as we see in the message contained in the Royal Chord of 22 May 1784 “*in attention to the multiplicity of cotton and wool factories that have been built inside this city in recent years, which is currently excessive, and is starting to affect the everyday lives of the citizens and residents of this city*” [11].

The urban reshuffle such as the construction of a new sewage system and the extension of hydraulic infrastructure was considerably restricted due to the reduction of the annual city council budget to a quarter of its previous value [12]. One of the worst consequences was felt in the quality of water, which for the most part was contaminated due to bad insulation conditions of latrines and cesspits. This issue was a common preoccupation for the physicians

of the city due to the constant obstruction of an outdated sewer system “*But we have to be very sorry that those sewers have not been continued with the spirit of the first builders. Because of the limited capacity that those sewers currently present, in most streets they cause the presence of stagnant areas in which we often see accumulated a high variety of material and water. In consequence the pollution builds up and all along the vents and particularly the sewers emerge occasionally the putrid vapours that fill the houses and streets with stinking air; and other times the same material overflows, causing an insupportable stench*” [13].

The progressive intensification of the manufacturing activity meant that by 1806 Barcelona took in more than 104 industries with a total of 12,000 workers [14]. These industries crowded Barcelona in the late eighteenth century, particularly in the “*prados de indianas*” [15] that were placed around the most important rivers. Especially near the Besós [16] River, where in 1784 alone, those industries employed an additional 8638 people [17].

1.1. The pursuit of a medical academy in Barcelona

Sanitation institutions are one of the most important aspects on which we will focus our attention because of the importance of physicians as the principal observers of weather, environment, and diseases of past societies, more importantly in the late eighteenth century. Indeed, sanitation professionals had a strong social position, high importance, and an ancient tradition concerning the application of epidemic prevention policies in Barcelona during the sixteenth and seventeenth centuries [18]. Since the latter half of the sixteenth century, the prestige acquired by the Estudi General—the medical school of Barcelona—signified the inclusion in the citizen oligarchy of the physicians attached to the Col·legi de Doctor en Medicina de Barcelona, the professors of Estudi General, and the ancient Hospital of Santa Creu.

In a more general perspective, the Real Tribunal del Protomedicato [19], founded on 30 March 1477, prevailed as the central state institution to control public health, to regulate medical practice, and to verify the quality of drugs and remedies dispensed by the apothecaries. One of their institutional competences was to collect taxes from exam fees and fines to administer them and the investment of the funds thus obtained. In fact, since the sixteenth century, in the Crown of Aragon, those exposed competences were administered by the traditional institutional structures. Furthermore, an important objective of physicians from Barcelona was to obtain the title of Royal Protomedico.

This institutional position allowed physicians to profit from an important social protection and to maintain the public presence of a medicinal profession open to the arrival of new methods and ideas for the renewal of medicine. The arrival of the new scientific medicine, based on the resurgence of Hippocratism, was the starting point of a change in the way in which epidemics in the latter third of the seventeenth century were confronted and understood [20]. Physicians started to displace the theoretical teaching of medicine to incorporate Hippocrates’ aphorisms. From then on, the medicine became an effort to understand nature, naturae conamen, and to expel from patients’ bodies all infective material. Physicians had to note carefully all the symptomatology, symptomatum concatenatio, to increase the knowledge of the diversity and variety of illnesses that medicine must face [21]. Physicians Herman Boerhaave or Thomas

Sydenham emphasized the construction of a medical knowledge based on an historical perspective of illnesses. The context of scientific exchanges led to a progressive evolution of medicine to hygienists' policies of the late eighteenth century. These, however, had to face new problems derived from the confluence of supporters and detractors of the new medical improvements, especially at the beginning of the eighteenth century [22].

The consequences of the application of Royal Decrees to sanitation professionals and medical institutions caused the regression of Catalan medicine. The most important effects of these Decrees were the suppression of institutions like the "Estudi General" and the creation of a new university in Cervera [23] (1714–1717). This university did not gain the support of those physicians associated with the former "Estudi General," due to its failure to provide any kind of improvement in medical studies. Debauchery and the loss of institutional control over medical practice drew to Barcelona a considerable number of unlicensed practitioners. This together with the loss of productivity in medical literature, the lack of proper control over medical studies, the decline of medical presence in municipal institutions, and the decline of the social importance of physicians were the principal impulses for physicians to try to recover control of medical practice. Their goal was to instate a medical practice in which professional schools of surgeons and apothecaries prevailed, with the consequent continuous conflicts due to the overlap of institutional competences.

The Junta de Morbo of Barcelona—an institution dedicated to the prevention of epidemics—was also brought under the new institutional laws. In fact, the arrival of the Plague in Marseille in 1720 prompted a reshuffle of the epidemic prevention institutions in the central Superior Council of Sanitation of the Kingdom [24]. This institution, since its foundation on 28 August 1720 by the administration of Felipe V [25], had assumed the local functions of the pre-existing epidemic prevention bodies. In this sense, the diversity of the range of functions of those bodies was, in the case of Barcelona, extremely diversified. The jurisdiction of the Superior Council was considerable, covering Barcelona and the rest of Catalonia at the same time.

This broad purview is explained by the need to build an elaborate network based on the communication of the provincial territorial subdivisions that formed the Superior Council of Sanitation. In the case of Barcelona, the same Royal Audience that proposed city hall members acted as a communication medium between the Superior Council of Sanitation and the municipal city council [26].

In fact, as we can see in the documentation, the communication between physicians, surgeons, and municipal authorities was the principal point that helped to keep an effective prevention system in the city and to apply epidemic prevention laws and observe their effects throughout the territory. At a more local level, the drastic municipal budget reduction of the Bourbon City Council caused serious difficulties and limitations in relation to the executive capabilities of the institution.

The impact of the institutional changes discussed above revealed the importance of the historical trust in physicians and in university medicine as a legitimization of the collective of medical professionals who took part in the public health system. This was one of the

objectives of a new generation of physicians, primarily trained at Montpellier University, who arrived in Catalonia in 1740. In the program of the Academia Médico-Práctica de Barcelona, these physicians sought State support and the recognition of the utility of medicine [20].

Philip V's death in 1749 signified a more opportune time to request the reestablishment of University of Barcelona with the consequent opposite interests of the recently founded University of Cervera and the interest of Real Protomedicato. Barcelona in 1760 and 1770 was subject to an institutional impulse that crystallized in the origins of two scientific academies, the Academia Médico Práctica and the Academia de Ciencias y Artes [27]. The origins of both academies were immersed in a context in which European academies were under Royal or manorial protection to develop studies linked to the political interests. The constant failures concerning the reestablishment of the Medical College in 1754, 1769, and 1770 together with the necessity of a medical corporation with teaching responsibilities forced the authorities to suppress those aspects that could present friction or an overlap of competences with the Real Protomedicato [20]. However, the existence of a medical hospital in Barcelona to observe diseases and to collect medical reports brought about the study of the anatomical effects of illnesses by means of dissections. This inclination was one of the pillars of the program of the Academia Médico-Práctica de Barcelona that we can see reflected in the inaugural speech of Dr. Jaume Bonells: "It is not enough to know the causes of illnesses without healing them; only the Government can remedy the origins of those diseases, and it is necessary that the magistrates and physicians work together" [28]. Moreover, Bonells refocused the interest in medical studies over the general interest of a society immersed in a constant development. Those interests included agriculture, cattle raising, and those "useful sciences" from which the economy could profit.

The program elaborated by Bonells is of principal interest for our research in that it concerns the need to observe the relationship between illnesses and the environment and climate [29]. This is in line with the studies proposed by Sydenham and Baglivi, in which a necessary point of observation was the precise moment at which epidemics originated and spread through the territory: *"With the collection of meteorological records of each town, we could have already the medical history of every time and region, and through this medium, Medicine would be in a degree of perfection in which today remains considerably remote"* [28].

This program of the Academia Médico-Práctica was formally proposed by Joan Esteve, lieutenant of the Protomedicato, and Pere Güell, first examiner of Protomedicato, in Catalonia on 29 April 1770. Their proposal obtained the approval of the Royal Audience on 2 July 1770 and was ratified in the first assembly of the Academia Médico-Práctica of Barcelona [30]. The most important recognition is seen in the Royal Decree of 21 September 1786, delivered by Charles III, in which the statutes of the Academia were approved and placed under Royal protection. This recognition gave the Academia the right to use the Royal printer to publish their statutes. Finally, in February 1797, the monarchy granted the chair in Medicine [31] to the Real Academia Médico-Práctica de Barcelona; as a consequence, instruction in medicine was officially re-established in Barcelona.

2. Malaria and environment

Malaria and its strong relation to environment becomes one of the most interesting points in relation to develop studies centered on epidemics and their impact over past societies. Paludism is a disease which kept a strong link with landscapes of the past, human productive facilities and agricultural patterns, climatic oscillations, temperature, rainfall, and wind direction [32]. In consequence, we find necessary to offer a general approach to his ethology and symptomatology but, especially, in the particular ways in which the illness interacts with another diseases.

In 2015, *World malaria report*, shows us a regressive impact of the illness in comparison with the estimated values given for the year 2000 (262 million cases of malaria globally — 214 million in 2015 — and 839,000 deaths — 438,000 deaths in 2015) [33]. However, malaria is still present as a resistant illness to vector control measures (insecticides) and to antimalarial treatments (particularly *Plasmodium falciparum*). In fact, malaria is one of the most ancient illnesses known by the humanity with references in China on 2700 BC, Mesopotamia 2000 BC, and Egypt 1570 BC, and in Hindu texts from sixth century BC [34]. An illness whose symptomatology was well known and his relation with environment well specified, as an example, like shows us Hippocrates in 410 BC “Passed the dog days the fevers became sweat, but behind him did not disappeared; the fevers came back again, with a moderated duration, difficult to attach and without giving to much thirst. In too much patients the fevers stopped in seven and nine days but in others after eleven days, fourteen, seventeen and twenty-two days” [35].

The link between stagnant waters and malaria is a traditional causal relation present in medical records of the eighteenth century, which worried physicians and authorities by the same way. As an example, Francisco Cerdán said in their *Discursos physico-medicos, politico-morales que tratan ser toda calentura hectica contagiosa, essencia del universal contagio, y medios para precaverlo* (published in 1752) that “Juan Maria Lancisi, Physician of Clemente XI, testified, that being Aquileya one of the most important cities of Italy... could not to tolerate too much epidemics, caused by the putrid exhalations that came from the stagnant waters” [36]. In words of Mary Jane Dobson, “These were the ‘silent’ fevers creeping from house to house, along the channels of contamination, but eventually revealing their impact on the seasonal, annual and secular graphs of mortality peaks” [37].

In the case of Barcelona, before and after the epidemic of 1783–1786, we found many proclamations given by the authorities focused in the prevention of flood impact and in the control of marshlands and lagoons, especially, in the two principal rivers that surrounded Barcelona — Besós and Llobregat rivers. In this sense, we have selected three examples in which the first is the proclamation published by order of Jacinto Pazuengos y Zurbarán, Governor of Barcelona, on 8 April 1780 [38]. The principal message transmitted by the Governor was focused on the establishment of preventive hygienist policies to promote the systematic clean of fields, paths, river banks, and stream flows. Due to the constant floods, the necessity to keep river bank boats in good conditions was also mentioned, and building irrigation ditches, building new houses on Besós-Llobregat river banks, and building up embankments on marshlands were specifically prohibited.

On 16 May 1784, Manuel de Terán, General of the Royal Army in Catalonia, [39] published a new proclaim that reminded the authorities about the observations published in the past proclaim of 1780 because *"It is quite common, that the extraordinary rains, and other irregular and violent accidents cause notable injuries to the road paths (...) this happens due to the failure to follow some useful orders to prevent those situations"* [39]. The new and most important measure improved in the municipal proclaim concerns the prohibition to build new cane cultivation rafts. In spite of the efforts of the authorities, it will be problematic to follow the proposed hygienic policies.

On 31 March 1787, Manuel de Terán [40] again published another proclaim. An advice that this time will consist to improve a systematic planting of trees to keep water stream controlled on Besós and Llobregat rivers. However, as we can see through the testimony of Francisco de Zamora the planting of trees was not completely applied in 1789, *"The River banks of the referred rivers and torrents, creeks, streams that run over the center of Barcelona's area, generally, are not planted with trees. There are only few trees planted by the land proprietors of some parts of Besós and Llobregat river bank areas"* [41].

In fact, the relation with malaria and some agricultural patterns based in irrigation has been a common problem all along the sixteenth to eighteenth centuries as we can find in many bibliographical references or through the sources. Especially in the eighteenth and nineteenth centuries, malaria was associated with the rice cultivation [42–44]. This was due to the proliferation of artificial flooded areas that ensured the production of an alimentary resource that could offer a high quantity of food with reduced cost: *"In Europe, rice cultivation areas have been, since their implantation, responsible of the endemics of malaria and also their epidemic forms; although the authorities had tried to limit and avoid this kind of agricultural practice. However the restrictions have been frequently broken, in some cases totally disobeyed because of rice culture was a source of high incomes"* [42]. Unhealthy flooded areas all along peninsular Mediterranean basin that became famous over ages and countries as exemplifies the testimony of Pierre Pauly in his work published in 1874: *"The Mediterranean area of Spain it's all along his basin an important source of epidemics: Intermittent fever, the bilious remittent fever they are common from one side to another, more or less, naturally, by the pass of years; and where a unfortunate meteorological constitution (overcast, cloudy, frequently calm) conjuncts with the active local causes, and epidemic took place, finding a terrain prepared for its development"* [45].

Concerning the etiological aspects of the illness, there are more than 200 types of malaria [46], only four affects to humans: *Plasmodium Falciparum*, *P. Vivax*, *P. Ovale*, and *P. Malariae*. Malaria is a eukaryotic disease transmitted through the bite of an *Anopheles* mosquito that starts the infectious process in the human host. However, there are secondary infection forms especially in endemic areas which consist, for example, in mother-to-child transmission [47] causing newborn's weight loss, injuring his immunological system and being children the principal victims of a high range of diseases [46]. Malaria's infectious life cycle starts with an initial stage in which sporozoites flow through the blood circuit until they are installed in liver cells and complete the initial infectious cycle. In the liver cells, sporozoites reproduce themselves through asexual reproduction and through the *lysis*, process in which liberate new merozoites —more than 30,000 merozoites [48]. This is the fact that causes the progressive destruction of

blood cells each 24 hours (*P. Falciparum*), 48 hours (*P. Vivax*), and 72 hours (*P. Malariae*) [46]. This process causes malaria's paroxysm in which the most severe fever episodes [49] causing the traditional symptomatology of a malaria infection (chill, fever, and sweat) are concentrated. Malarial fevers can be continuous (if there are no fluctuations higher than 0.5°C in 24 hours), remittent fevers (if the temperature keeps over 1°C or more in 24 hours) or intermittent (if the temperature comes back to normality one or two times in 24 hours) [50].

After that, sexual gametocytes circle along human host blood vessels until another mosquito bites. Inside mosquito's stomach, gametocytes will start the sexual reproduction generating Oocysts if the minimal ambient temperatures are higher than 17°C for *P. vivax* or up to 20°C to *P. falciparum*. This process closes the infectious life cycle when new sporozoites are released into the salivary glands of the mosquito ready to start another asexual reproduction cycle in the human host.

One of the most important consequences of malaria is that it causes the progressive destruction of human blood cells, generating a state of anemia. However, the most common symptomatology of the disease can be similar to less aggressive virus diseases causing abdominal pain, diarrhea, discomfort, fatigue, fever, headache and respiratory disorders in patients. There are also some physical and most appreciable symptoms such as jaundice and splenomegaly. In which the last one appears in adults after a series of malarial relapses but it is faster and easier to detect in kids.

However, the most interesting aspect is the immune system suppression that signifies a high risk of coinfection. A question that should be studied in detail in past societies paying attention to the pathocenosis concept introduced by Mirko G. Grmek. Pathocenosis means that the frequency and distribution of every disease depends, on another endogenous and ecological factors, on the frequency and distribution of all other diseases [51]. In consequence, further studies were developed in ancient societies to better know how malaria interact with other diseases causing a considerable decrease in the health status and interact with the constant flow of history. In words of Eric Faure "*Historically, malaria was probably one the diseases with the greatest opportunity to interact with other diseases because of the extent of the malarious areas, of the level of endemicity and of the fact that humans could be infected during all the duration of their lives*" [52].

Malaria can produce positive or negative effects over the diseases in which the illness interacts in direct or indirect forms. As an example, malaria has been applied as a treatment for syphilitic patients. Moreover, Malaria also interacts with tuberculosis (*Mycobacterium tuberculosis*). In this last example, malaria exacerbates the infection and the last one modulates the host response to malaria. It is also important for this research to focus on positive and synergistic interactions of malaria along other diseases that could have deleterious effects in endemic areas. And positive relations with malaria along illnesses that could have a considerable impact on malarial epidemics along diseases such as virus: flaviviruses as dengue or yellow fever; winter respiratory diseases: influenza or smallpox virus. In addition, malaria can interact in positive forms with bacterial diseases such as cholera (*Vibrio cholerae*), plague (*Yersinia pestis*), shigella, and typhus [46] (*Salmonella enterica* serotype Typhi) [52]. In words of Eric Faure, "*Data from the*

pre-antibiotic era suggest that malaria increases the host's susceptibility to invasive bacterial infections" [52].

Finally, in relation to malaria transmission the most complex environmental aspect is found in two principal areas: in *Anopheles* mosquitoes and in sporogonial development inside mosquitoes' stomach. In fact, the link between temperature and oocysts development [53] is essential to know malaria seasonal behavior. As Gustavo Pittaluga said, "*It is not the annual average ambient temperature which determines the degree of endemic (along other conditions), it is more concretely the summer average ambient temperature, the thermal average values of summer, what allows the presence of endemic focus of malaria in temperate climate regions areas*" [54]. In this sense, as mentioned below, through the methodology applied to analyze instrumental meteorological records it varies from minimal temperatures of 17°C for *P. vivax* to 20°C for *P. falciparum* [55, 56]. Our objective is to detect in which years or months malaria epidemics could have a more favorable ambient factor to develop in epidemic forms.

The current problematic for historians' remains in the exactitude to define the variety of *Anopheles* mosquitoes present in Catalan territories along eighteenth and nineteenth centuries. As a reference, we considered works developed in the first half of the twentieth century such as the Comisión para el Saneamiento de Comarcas Palúdicas (1920–1924) and Comisión Central Antipalúdica (1924–1934) [57]. These works gave us knowledge about the varieties of *Anopheles* that were more common in the Peninsular level until the application of the Proyecto Oficial de Erradicación del Paludismo en España (1959–1962). The works of the zoologist and entomologist Juan Gil Collado inside the campaign led by Gustavo Pittaluga and Sadí de Buen show that from the five varieties that form the complex *Anopheles maculipennis* the variety *labranchiae* was present in Alicante and Murcia. While *Anopheles atroparvus* was the most distributed over Europe [58]. In consequence, we found that our exploratory study focused on examining the relation with environment and *Anopheles* sp. based on the general conditions for "*maculipennis* complex" [59]. Moreover, we analyzed the "superinfection phase" through instrumental meteorological data treatment [60]. The superinfection phase consists of a phase of maximum density of *Anopheles* sp. from April to June. The objective of the study was to focus on those months which present more days with average temperatures less than 25°C [61] and a humidity higher than 40% (fact that was common in all Barcelona area).

One of the possible applications of this historical analysis of malaria over selected Mediterranean areas, regions and cities was to elaborate more precise mathematic models that could help historians to better understand the behavior of the illness in the past. Also, and more important, this analysis could help to develop preventive epidemical models in relation to the current climatic change in which "*Vector-borne diseases are highly sensitive to global warming and associated changes in precipitation*" [62].

3. Sources and methodology

The first question that come to us when we plan to develop studies that involve a high variety and diversity of sources is in relation to which is the most suitable methodology that we must

apply. The second question concerns what kind of sources we can manage to achieve our objectives. In fact, due to the variety of names that surrounds endemic and epidemic fevers on past societies (terms such as fevers, intermittent fevers, agues, and marshland fevers), we proposed a methodology to study epidemics, from a historical point of view, that would be open to interdisciplinary approaches from history, biology, geography, demography, and climatology. A proposal that reminds us the work of the team lead by Jean-Paul Desaiue [63] or the study developed by Vicente Pérez Moreda [64] with a more demographical perspective. Moreover, we can refer to some works published by authors such as Pablo Giménez-Font [65] from the University de Alicante and Mary Jane Dobson [37] from the Oxford Wellcome Unit for the History of Medicine. In addition, the most recent study conducted by an interdisciplinary team from the Aix-Marseille University [55].

Concerning sources, we parted from a general and specified bibliography (papers, monographs, and theses) that allowed us to focus on compiling the highest and possible amount of information.

The amount of sources and their varieties were relatively large: private sources (diaries and memories), public sources (medical reports, contemporary mortality, and morbidity records), municipal sources (books of acts, municipal proclaims, public health reports, and works on hydraulic or sanitarian issues), ecclesiastical sources (burial and baptisms series, and community books of acts), public and private sanitarian institutional sources (medical reports), print sources (newspapers, Royal Decrees, and contemporary medical reports), cartographical sources, instrumental meteorological data (temperature and rainfall records, and wind direction), and flood-drought monthly proxy data indexes generated from Rogation ceremonies (1780–1800) [66].

In consequence, we will emphasize on the principal sources that can be useful to develop similar research over different times and countries, and a methodology suitable to reconstruct other epidemical cases.

3.1. Municipal sources

All the documentation produced by municipal authorities in past societies has arrived to our current times in many diverse forms and ways. This means that we can find more or less complete archives. However, the most common and complete sources that we can find in municipal archives are, e.g., municipal chords, municipal proclamations, and sanitation expedients.

First, the answer to this source selection rests in the serial and continuous data that we can extract from municipal chords as a first source in which all the information relative to the city and quotidian life is reflected. That is, a conjunct of information compiled from notes taken for the secretary at every municipal session, which contains a variety of typologies: proclamations, design of infrastructures, and accounting documents. The utility in relation to epidemiology remains in the keyword research through the contemporary indexes of municipal chords. The objective is to detect every political measure applied to contain epidemics: burial of clothes, latrine cleaning policies, wheat importations, prices regulation of products

affected by commercial blocks or as a consequence of climate instability (carbon, bread, and meat), and police measures applied to guarantee the control of population.

Second, municipal proclamations show the researcher what kind of measures and information were published for the common knowledge, in which data such as urban regulations, advices, prices of essential products, and sanitary policies have a direct impact as measures derived from epidemic situations. After comparing the information extracted from municipal proclamations with the data extracted from municipal chords, the researcher will be able to prove if the municipality had concealed evidences at the time of epidemics.

Finally, sanitarian expedients concentrate all the documents generated or received by the municipal Sanitarian Council. As an example, Barcelona is one of the most complete sanitarian series preserved at the peninsular level with 12 series and 271 independent units providing sanitarian information to the researcher from Barcelona, Catalonia, Spain, and the rest of the world. Although some series are fragmentary, we can obtain data from surveys conducted by physicians, medical records, sanitarian patents, and sanitary chords that can be compared with the information obtained from municipal chords and municipal proclamations.

3.2. Public sources

All the documents from medical institutions such as the Reial Acadèmia de Medicina de Catalunya are another point of interests. The high amount of documentation that we can obtain provides interesting data concerning the symptomatology of the diseases observed at the time of epidemics. In other words, medical topographies conducted by physicians in order to be accepted as partners of the Medical Academy of Barcelona provide interesting data about the common habitudes, landscapes of the past, environmental conditions, and hygienic conditions of the cities analyzed in those works.

On the one hand, medical records were works ordered by municipal authorities in which physicians did an environmental analysis of all the illnesses observed during a concrete chronology. The most interesting aspect we find it in that physicians, following the principles of medical topographies, did a complete study of weather, illnesses, and environmental conditions in every case searching the focus of the illness and the exact time in which epidemics appeared in the cities and villages. A complete work over the urban infrastructures and common people's habits had been corrected through sanitation policy applications.

On the other hand, demographic records collected by physicians in collaboration with ecclesiastic and municipal authorities at the time of epidemics can provide demographic movement of parishes to our research data whose archives are actually inexistent due to the course of history. Another analysis possibility that provides us those demographic tables is to contrast the results with ecclesiastic demographic sources.

Print sources include a high typological diversity and currently the most part is easily accessible through digital repositories. In this sense, the most interesting sources used to complete the information extracted from municipal archives are the medical prescriptions at

the time of epidemics and published medical records. In their conjunct, these kinds of print sources (considered as primary sources that were coetaneous published to the period of study) can contribute to better understand the social repercussions of an epidemic and the institutional measures applied to spread the information between common people, authorities and physicians. The historical compilations of epidemics as, e.g., Doctor Joaquin de Villalba's work—military physician of Aragon—are more important concerns, where his message goes directly vinculated to the medical pursuit of the historical reconstruction of endemics, epidemics, and epizootic illnesses *"to show taking as an example past situations to better affront future cases"* [67].

3.3. Ecclesiastical sources

The study on the abundant and variety that present ecclesiastical archives makes to focus research interests on the sources that can have a more sense of utility. Parish books are one of the most important sources to develop historical epidemiology due to the high level of detail and trustworthy information that we can extract from parish baptisms, and death and burial records. In fact, since the Council of Trento (1545–1562) all parishes were obligated to establish parish books to register baptisms (births), deaths, and marriages. Those records, currently, are the well-known kinds of sources which worked in the research fields of demography, historical demography and genetics [68].

As discussed above, the amount of information that can be extracted is significant. Although parish registers can present variations from one parish to another, they usually follow a contained structure. The solid structure of parish registers allow us to extract, taking as example baptism records, information relative to baptism date, name and surname of the newborn, parents' names, and parental professional data and born place. While concerning death and burial records, we can extract homogeneous information concerning death date, name and surname of the deceased, parental information, parental professional data, born place and burial place. Since the beginning of the nineteenth century, it has incorporated another interesting data that concern directly to the principles promoted by the hygienist medicine; this is the cause of death.

Obituary tables elaborated by physician Francisco Salvà, from the Royal Academia of Medicina de Barcelona, are good examples of the interest of physicians to improve the cause of death in parish registers to better study the seasonality of illnesses and detect those epidemics that caused elevated mortality levels. In fact, the latter is a good example in which physicians presented the obituary tables. The problematic work in tables was to exactly delimitate the age group through parish registers, *"Must be necessary that from now on in burial records will be expressed the age of deceased, because otherwise it would follow what currently happens with the name of infants must be understood all those that die until the age of 12, 14 or more years, whatever executed with all the other observations from your H.E. of this illustrious city council obituary tables may again be formed same as those currently made in London, Paris or in other places"* [69].

In fact, the problematic work was the precision of the age group qualified in parish sources as infants continue promoting an intense discussion between historical demographers. It is necessary to refer to the studies developed by Vicente Pérez Moreda, especially, mentioning

infants as a collective population comprised of a group of ages from 0 to 7 years old. Moreover, the age group of infants is susceptible, biologically and physically, to succumb to an illness (Figure 2) [64].

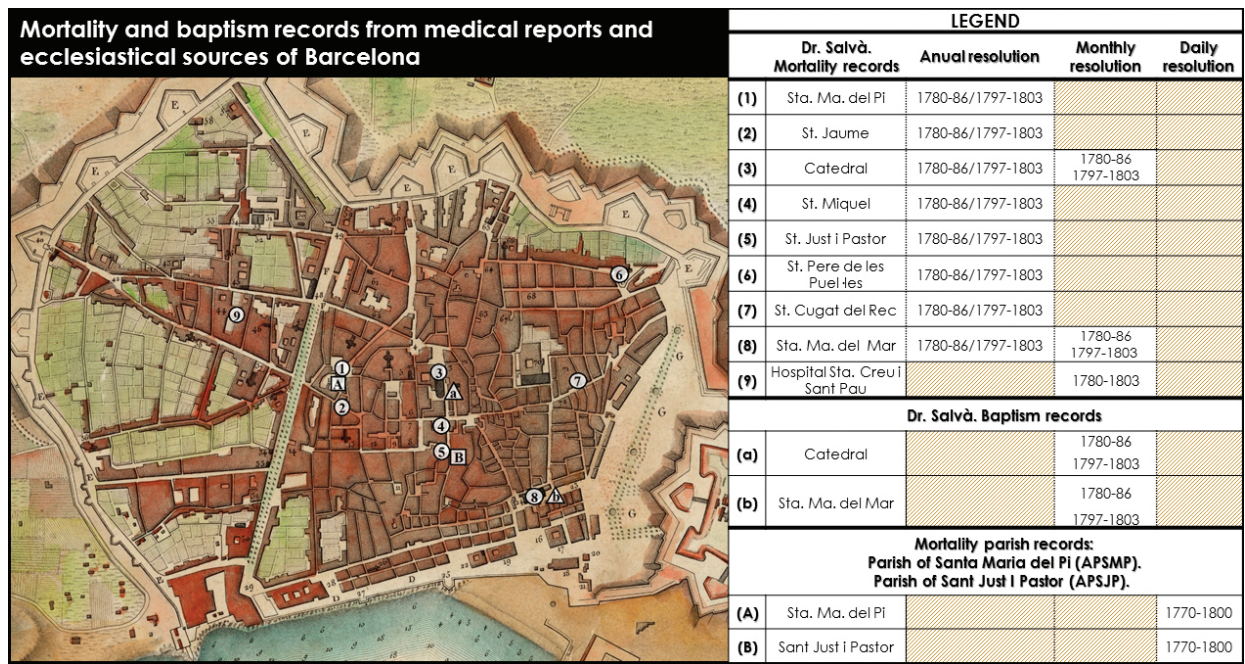


Figure 2. Chronologic extreme dates of demographic sources extracted from parish of Santa Maria del Pi, parish of Sant Just i Pastor, and from the Medical Obituary tables created by physician Dr. Francisco Salvà.

As mentioned above, our interest was to focus on obtaining continuous and detailed data series digitized in excel to realize further analysis that will provide us some interesting information about the seasonality of deaths and the age group that was most affected. As an example, we propose to digitize the information extracted from parish records differentiating sex and age in daily resolution to obtain standardized series in monthly or annual resolution through typification statistical process [70] – among other analytic procedures. Other analytic processes such as seasonal mortality patterns can be of great utility to exactly precise in which season’s mortality fall in children or adult population. On the other hand, seasonal movements of mortality can be put in relation to the medical records to have a more complete perspective of the diseases present along with detected mortality peaks.

Finally, parish records in spite of their possible discontinuous or fragmentary preservation can be complemented through obituary tables compiled by physicians. Another possibility to sort the disappeared information from some parish archives lies in coetaneous census conducted by state authorities. As an example, the census conducted by Count of Floridablanca in 1787 shows us in the preface that the scrutiny of Catalonia’s population was done “*after three years of an epidemic almost general of tertian fevers and putrid fevers, especially in the two Castillas, Aragon Kingdom, and principality of Catalonia, that has resulted in a considerable diminution of their habitants*” [71].

3.4. Instrumental meteorological records

Maldà Oscillation [72] becomes the climatologic context that will have a direct impact on the environmental context generating unhealthy area. A process of climatic instability appeared since 1760 until the end of the eighteenth century. A process of climatic oscillation was marked by the simultaneous emergence of droughts, floods, temperature oscillations, and storms. This phase of climatic change, that reminds us of the current climate problematic, as discussed above, has had repercussions over biological and ecological aspects: proliferation of flooded areas and consequences over the hydraulic resources. This phase also had repercussions over the economy: bad harvests, increase of basic product costs because of bad harvests, and effects on the economic resources.

The relation between climate oscillations and the spread of epidemics was one of the principal interests of physicians because of following the principles of hygienist medicine. Even more, as we observed, the pursuit to elaborate a historical relation of epidemics, to observe and measure the weather, to analyze the environment, and the elaboration of accurate compilations of symptomatological descriptions (clinical histories) fructified into a scientific approach of medicine to another sciences were among other interests. This approach encouraged physicians to develop systematic meteorological observations.

Meteorological tables elaborated by physician Dr. Francisco Salvà i Campillo [73] have denoted a great interest to climate reconstruction [74]. In fact, Dr. Mariano Barriendos together with “Team of Climate Change” from the Climatological Area of the Meteorological Service of Catalonia has digitized those tables in a project of three years of duration. The information contained in those meteorological tables, e.g., atmospheric pressure, temperature (measured each day at 7–14 and 22 hours), and precipitation, has a high potential to develop more accurate predictive models due to the current climate change dynamics through initiatives such as MEDARE (MEDiterranean DATA REscue) or ACRE (Atmospheric Circulation Reconstruction over the Earth) [75].

What is even more interesting is the inclusion of medical observances that are focused on the epidemical constitution of every month. In those observations, Dr. Francisco Salvà included an accurate description of the symptomatology observed in their patients. Moreover, the physician searched all the references, at the time of epidemics, to find equal epidemic cases in different countries. This completed some information from contemporary sources in relation to reconstruct the specter of endemic and epidemic fevers at European level.

The utility of instrumental meteorological records opens a high range of possible analysis concerning malaria's relation with climate and environment. In fact, the analysis of temperature records will help us to detect which years presented prolonged warm summers or in which months temperature guaranteed a more considerable presence of *Anopheles* mosquitoes. Furthermore, the conjunction of analyzed annual historical indexes of floods and droughts can detect those years in which cities and village's environment was being affected by an irregular succession of floods and droughts that could have reflected a more propitious terrain for the development of a malaria epidemic. These Concern annual-monthly historical indexes those were generated from rogation ceremonies by Barriendos [66].

Although this methodology requires of further detailed analysis methods, we would like to show some analysis to demonstrate the applicability of this sources to help detect the most favorable conditions for malaria development in past societies. Because malaria is a background disease complex to be identified over the sources, we propose to develop analysis from instrumental meteorological records. The objective is to put together all the direct and indirect conjunct of environmental-climatic elements that can be associated with an epidemic of malaria: warm summers, days that present a highest superinfection phase of *Anopheles* mosquitoes (if temperature is less than 25°C between April and June and humidity is higher than 40%, those years present a large number of *Anopheles* sp.), favorable days for sporogony of *P. vivax* and *P. falciparum* based on the minimal daily temperatures of June–October for all the available and monthly minimum temperatures of June–October for all the period observed (1780–1800).

4. The epidemic context in Catalonia (1783–1786)

The report from Real Tribunal del Protomedicato published in 1785 detailed the constant presence of malaria at Peninsular level *“Tertian fevers have been ever in Spain the dominant illness, and for this reason our authors are the most respectable between the strangers, giving us a clear idea to differentiate over all the forms over tertian fevers those that currently are affecting us”* [76]. This epidemic of malaria, since 1783, is identified in epidemic forms outside its hyperendemic areas (Valencia and Catalonia rice fields and marshlands) along other diseases as typhoid fevers. Tertian fevers and putrid fevers were in fact well known through the Mediterranean littoral areas. Even more, contemporary physicians such as Andrés Piquer noted the strong relation between tertian fevers and rice cultivation or irrigation patterns insisting to the authorities to implement the prohibition of rice cultivation to one league of distance from urban areas. However, the high interests of land proprietors to avoid prohibition or reconcile the legislation to make possible the continuation of rice cultivation was a constant problem (**Figure 3**) [25].

However, tertian fevers epidemic of 1783–1786 could not be compared to precedent equal episodes. In fact, authors such as Vicente Pérez Moreda elevate the impact of the epidemic to a one million affected people and a hundred thousand deaths just in 1786. Moreover, epidemic fevers will spread accompanied by a favorable climatic oscillation and scarcity periods. In words of Pablo Giménez-Font, *“it’s possible that a conjunct of favorable conditions, mainly climatic conditions, increased tertian fevers range of impact from hyperendemic areas, such as Valencian ricefields or marshlands close to Cartagena”* [65]. In fact, the relation between the climatic oscillation and the genesis of epidemic fevers was well perceived by contemporary physicians linked to the Real Academia de Medicina de Barcelona as can be seen through the testimony of doctor Juan Tovares *“Too much rain, fogs and snows what they had to give us but rafts, puddles and lagoons, floods, water spills and stagnant waters in embanked landscapes? All this humidity altered vegetation so that fruits, although they were abundant, their quality decreased becoming rot much easier than before (...) propagation of bugs, mosquitoes, and other insects was amazing (...) to this abundance of water in the autumns, winters and springs succeeded the heath of summers, that dissipating the stagnant waters from puddles, lagoons and rafts formed marshes and quagmires filled the atmosphere of vapor and putrid*

miasmas elevated from the high amount of rotten vegetables and putrefied vermin, and those were the remote causes of the referred epidemic” [77].

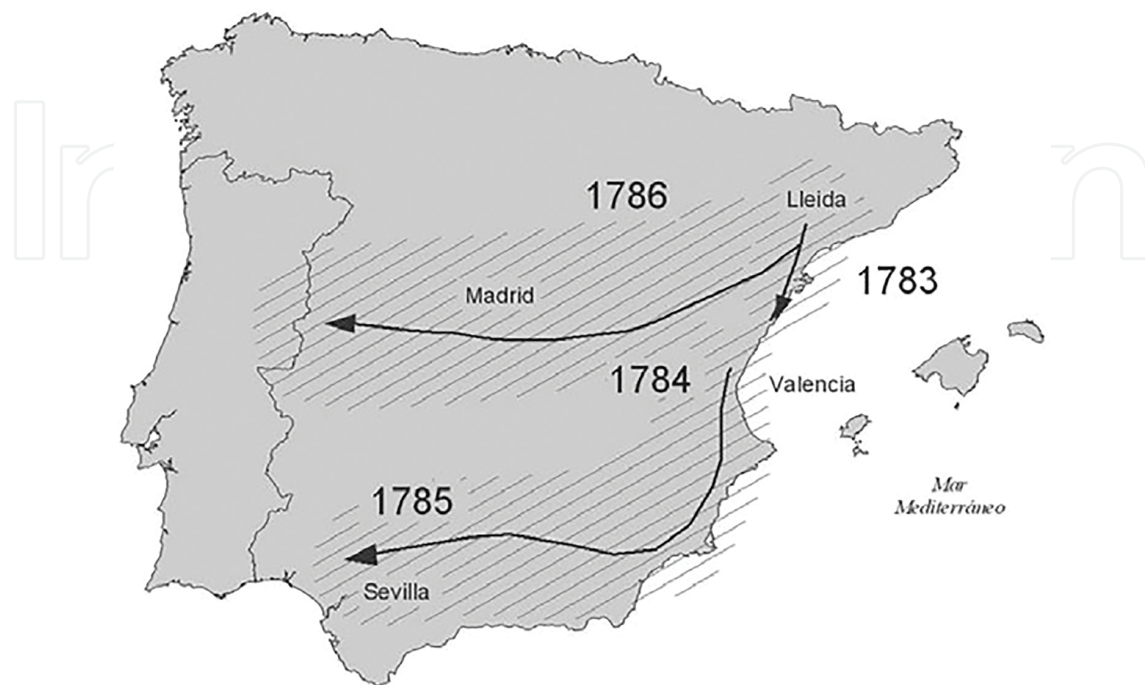


Figure 3. [Extension of tertian fevers epidemic at peninsular level (1783–1786)]. Giménez-Font [65].

Tertian fevers from 1783 onward spread over West, South, and South East of Spain at a peninsular level after being initially declared in Lleida (Catalonia, NE Spain). More importantly, since 1783 until 1785 the principal affected areas were Catalonia, Valencia (SE Spain) and Murcia (SE Spain). While in 1786 the regions that suffered the most damaging effects were Andalusia (South Spain), Castilla la Mancha (South West Spain), and North Sub-Plateau (North center Spain). Once more, physician Juan Tovares pointed that “*by the years 84 and 85 it was especially cruel [fevers epidemic] in 86, devastating the major part of our peninsula; but moreover provinces of la Mancha and Alcarria, leaving some villages reduced to a few habitants*” [77]. Fevers with symptomatology, as can be appreciated through the testimony of doctor Christobal Cubillas from Cafez, were commonly detected as a “*fever more or less high with a day of duration. In some cases fevers were extended to two days, just a very few arrived to the third day (...) the fever regularly finished by sweat, and if afterwards sweating continued, this was the greatest success and the lesser evil*” (**Figure 4**) [67].

On 18 May 1783, the message in the letter sent to the physician Josep Masdevall by Florida-blanca’s Count was explicit. The work entrusted to Masdevall elaborated a memory that contained all the news taken by the physician in relation to the epidemic that spread in Catalan territories since 1783, an epidemic that “*since early past year was discovered in the city of Lérida, spreading through all Urgel plain, Conca de Barberá, fields of Tarragona, Segarra, Manresa, Llusanés, Solsona, until Seu de Urgel and their surroundings, spreading strongly through Igualada, Piera, Vilafranca del Penedès, Martorell and another nearby towns*” [78].

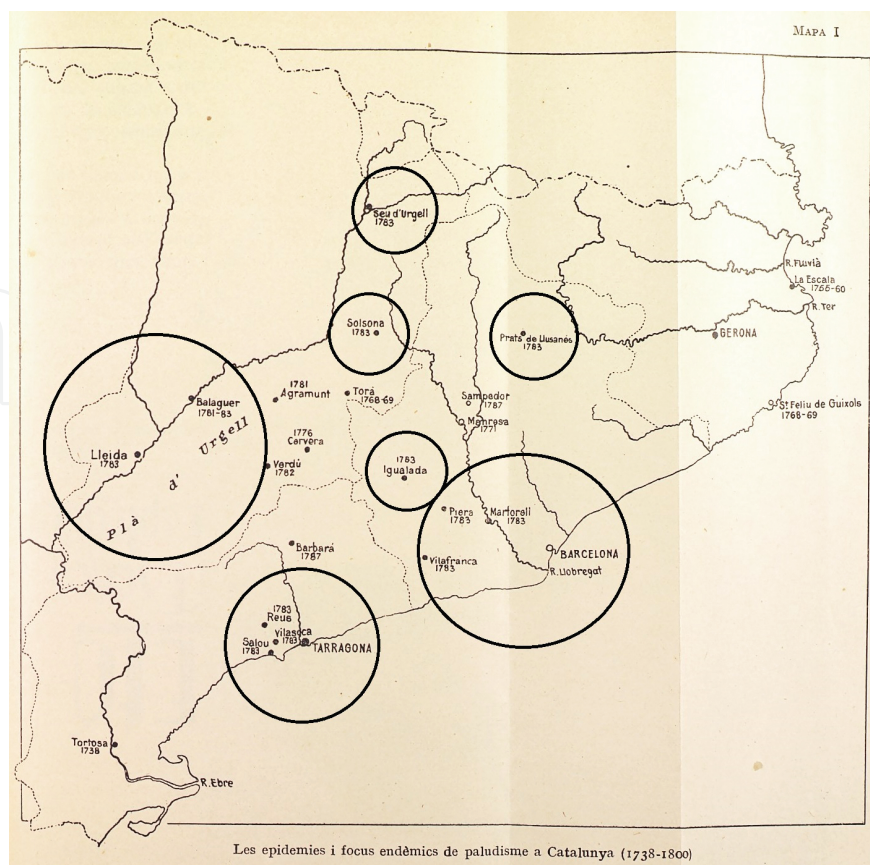


Figure 4. Geographic map elaborated from ancient sources in which is represented the most important epidemical focus of tertian fevers detected in the last years of 18th centuries. Institut de Ciències. Treballs del Servei Tècnic del Paludisme: 1915–1916. Barcelona: Publicacions del Institut de Ciències. 1918, pp. 38–41, 156 p.

In spite of the efforts put by Royal Sanitarian Joint of Barcelona and Royal Sanitarian Joint of Madrid, the efficacy of the lack of practices and remedies stipulated by them did not control the epidemic. Those remedies did not reduce the virulence of the epidemic affected by the illness “*sturdiest people from twenty to fifty years old*” [78]. These epidemic fevers had their origin, following Dr. Masdevall opinion, in the French retry from Portugal in 1764, in the context of the end of the Seven Years’ War “*we must confess, that since the retry of French troops we suffer of more malignant fevers and agues than before*” [78] probably favored by the initial climatic oscillations of 1760. Moreover, the retry of French troops supported the opinion of Masdevall that the increased virulence of a preexistent problematic spread silently from one village to another, “*The communication, commerce, friendship and relationship of people’s from transit of French troops with the remaining in which they didn’t passed, communicated also to them the referred injuries*” [78].

Epidemic fevers that “*started with a sensitive cold, followed by an intense heat, which disappeared through an excessive sweat... Headache was really intense... others presented a bulky abdomen... hand shaking, or convulsions*” [78]. In fact, the epidemic cases detected threatened through the application of the “Antimonial mixture” that caused vomit and increased transpiration, followed by the use of “Opiata” (a chemical remedy in which quine is the principal ingredient).

The relative success of the remedy applied by Masdevall and their efforts were compensated on 30 October 1783 when King Charles III communicated through Count of Floridablanca his promotion as royal physician and Inspector of Epidemics of Spanish kingdom with a salary of 20,000 reals [79].

5. The medical reports of 1783–1786

Through this point, we focus our attention on the interest of physicians to find the origin of epidemic over the most common infectious and proactive areas of Barcelona. Moreover, in both medical reports we find a transition in relation to the search of the environmental cause effect of epidemics and over human productive activities, urban resources... The objective of physicians is to promote a systematic application of hygienic policies to prevent future epidemic situations.

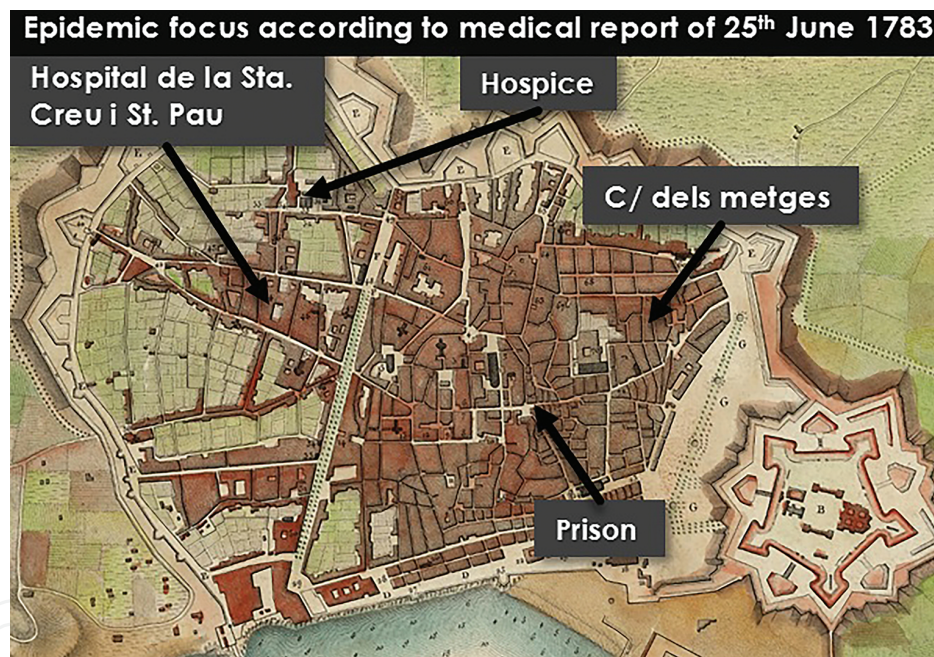


Figure 5. Self-elaborated map from the information provided in the medical report of 25 June 1783. MOULINIER. Plano de la ciudad y Puerto de Barcelona. 1806. ICGC, RM. 19425.

On 19 May 1783, the City Council of Barcelona alerted the presence of tertian fevers in his more immediate areas to the Local Joint of Sanity “With date of the current 19 may [1783], the City Council of this city assembled in Joint of Sanity show: That some of the surroundings of this Capital reign some diseases that we suspect they are similar or maybe the same illnesses that reign in the part of Lérida” [80]. In consequence, physicians Buenaventura Milans, Gaspar Balaguer, Pere Güell (Protomedicate tenant), Rafael Steva (Doctor in Public Health), Pablo Balmes, Luis Prats and Benito Pujol elaborated a medical report following the orders of the Supreme Joint of Sanity and the Local Joint of Sanity of Barcelona. A medical report focused on the continuous fevers

that spread in Barcelona. More importantly, these fevers were specifically detected on “Metges” street, the prison, the hospice, and the Hospital of Santa Creu. In spite of the research effectuated in the most proactive places and areas to be the focus of the epidemic, physicians rejected both houses because before the epidemic was present in the surrounding villages. This illness affected the income of a large number of people of Barcelona’s City Hospital (**Figure 5**).

Continuous fevers that “are currently abundant between poor people of Barcelona, many soldiers, and they become to be present between a few well of people” [81] with an initial symptomatology quite similar to flu or cold. But the major part of fevers became putrid fevers and, moreover, some of them became malign fevers leaving the major part of the patients prostrated in their beds. Succeeding to the first clinical symptoms of the disease sweat and delirium, “they become to be delirious, when we least expect it the major part of patients die” [82]. The relation between tertian fevers and climate-environmental conditions focused on the medical report making reference in the form of benign illnesses that were common in spring and autumn that used to disappear with the summer months. Nonetheless, in 1783, physicians confirmed that these were fevers outside of their seasonal behavior with a considerable preoccupation of doctors who speculated about the possibility of a more increased virulence of fevers during the summer, “in Lerida fevers have been common as well as in cold or hot seasons. We suspect that with the hot of the terrain will grow up illnesses, which had started to be popular at the arrival of hot weather” [83].

The pursuit to detect the epidemic origin was the principal objective for the physicians as was mentioned in the records of the first patient who died in the Hospital of Santa Creu. Felip Pujan, who was a soldier of the Royal Walloon Guards, deceased on 21 July 1783 because of typhoid fevers that suspects the possibly of the coexistence of malaria along with typhoid fevers that is denoted as the virulence of the epidemic in the observed period.

One of the interests of physicians was the will of redirecting the hygienic habitudes of inhabitants especially of poor people “The poor that are abundant in the streets because of the high misery of the Principality. The poverty that can’t be repaired because of the consecutive bad harvests. The poor people have been in the major part the victims of the disease (...) this poor day laborers and artisans, in which is the epidemic is abundant, live in wretch rooms. An only room contains a high quantity of dirty beds, a kitchen, a dining room, and everything. Latrines are a conduct in the same room that is never totally clean of excrement and that throw out an unpleasant smell” [84].

About tertian fever epidemic, physicians proposed the application of a curative methodology essentially based on the systematic application of bleedings, diuretics, emetics, and purges to expel from patients’ body all infective material. The most probable effect of this kind of medical treatment in patients affected by malaria could have a silent impact on the public health of the inhabitants of Barcelona. Although had the knowledge of febrifuge attribute of quine, this remedy was only applied in those cases in which fever was really outstanding or if the previously exposed remedies were not completely effective. Otherwise, the use of bad quality quine could not have the expected effect on the related fever epidemics. Moreover, the discussion between traditionalist physicians and chemical remedies will be a constant problem.

Finally in this first medical report, physicians provided a conjunct of hygienic policies that should be applied to preserve the health status in the city and to face on future epidemic cases. These initiatives were specifically made to increase the healthiness level of the city, e.g., stagnant waters of Montjuic and Besós River should be systematically drained on critic epidemic episodes. On the other hand, doctors will focus their interests in helping the authorities to guarantee a better quality of bread increasing alimentation quality of the city inhabitants.

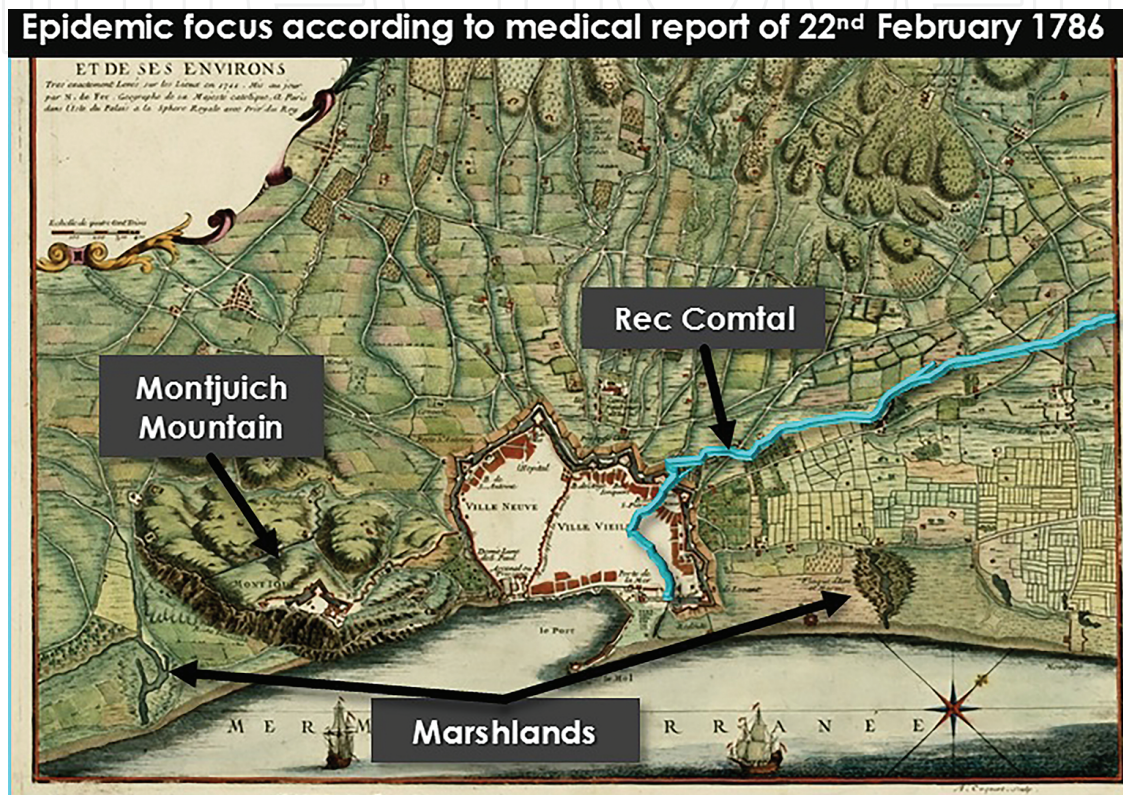


Figure 6. Self-elaborated map from the information provided in the medical report of 22 February 1786. FER, N. Plan de Barcelone et de ses environs, très exactement levés sur les lieux en 1711. Paris: dans l'île du Palais, à la Sphère Royale. 1711. BNF, GED-1695.

The second medical report presented on 22 February 1786 was another point of interest in which we focused our attention on tertian fever epidemics in Barcelona. This time physicians Rafael Steva, Pablo Balmes, and Lluís Prats answered the order given by Count Campomanes who instigated municipal authorities to spread information that could explain the progression of tertian fevers epidemics in 1785. In the first assessment done by the physicians they admitted that tertian fevers were unusual but more common than in previous years “*but being general in this year tertian fevers over all Kingdom, the fevers have been very rare in the city, but more frequent than in other years*” [85]. But the most preoccupant point was tertian fevers that evolved progressively from benign fevers to putrid fevers “*Have been also particular that inside Barcelona have become malign fevers some that were originally simple, and they keep as such, and benign in some cases. The major parte have been putrid, some of them mixt*” [86].

In this medical report physicians explained the origin of the epidemical cases with an emphasized focus on the irregular climatic behavior of seasons. More importantly, physicians denoted the climatic alteration over the usual behavior of months from June to August. As expressed in physicians' words, *"This year has been particular in the irregularity of the seasons, and being the month of June very heat July and August have been very temperate, rather said fresh, being particular the heat diminution that is noted over our meteorological tables, what maybe is the cause of the major frequency of tertian fevers this year"* [87]. But this time, the origin of the epidemic directly searched upon the environment. That is to say, over the immediate unhealthy areas that surrounded Barcelona in the late eighteenth century.

In consequence, physicians declared Ciudadela, Montjuich Mountain, and Rec Comtal (principal water supply of the most crowded and industrial quarter of Barcelona) and the cotton factories in "Prados de Indianas" and marshlands which is consisted of Barcelona's periphery as unhealthy areas (**Figure 6**).

From the areas exposed above, physicians emphasized to focus authorities' attention on the dangers emanated from stagnant waters. As an example, physicians mentioned the case of the suburban area known as "raval." Because this area fall into the urbanized area of the city it was *"actually very healthy, after having given course to waters that used to be stagnant in the pit that goes from the Puerta de San Antonio to Puerta de Santa Madrona"* [88]. Another interesting case was related to the Ciudadela fortress due to the stagnant waters that were present over all their pits *"and will not be hard to understand why Ciudadela is not healthy, being enough maybe that their pits are double sized, and they are extremely flat that the water remains stagnant (...) furthermore we know that inside the fortress there are too much garbage heap which poison the air"* [89].

Moreover, as discussed above, the attention of physicians was focused on the unhealthiest spaces that surrounded the urban area. Insalubrious spaces conditioned the normal development of the city. In fact, Barcelona was a city marked by an infectious suburb in which tertian fevers wreaked upon the civil population generating a constant flow of ill people to the Hospital of Santa Creu. Although there were more the healed than the dead because of the disease, this could have an impact on the presence of indoor malaria between the city walls.

What is a good example are the words that are mentioned in the medical report. Words that denote a high preoccupation of physicians were in fact an illness presented on inhabitants' quotidian life *"Could we look with indifference what means to be surrounded by a source of epidemics in both marines, to be unable to leave to our country estates, to not be able to continue our factories without seeing a constant loose over their offices, their meadows, a high amount of workers. Family men of families that remain orphans. Factories owners that have to rest in the city being not able to go to the offices of their factories when is sometimes interesting to request their presence?"* [90]. In fact, the epidemic focus in this last medical report will be clearly specified on both marines *"It's not difficult to find the origins of insalubrity because both marshlands are insane (...) in those marshlands stagnant waters become corrupt when arrives the dry weather (...) cane cultivation rafts are really numerous as a consequence of not being followed the hygienic measures that we had exposed to H.E."* [91]. Those unhealthy areas were not only a consequence of their environmental particularities, but also reported the anthropic impact, the productive activities such as cane cultivation rafts that confer to these areas the meaning of being insalubrious and dangerous for human health.

Because of the problems discussed above, the preventive hygienic measures stipulated on the study directly focused on the periphery of the city, especially concerning hydric resource management. Thus, doctors emphasized the necessity of building more ditches to reroute the stagnant waters present in the coastal region to make them flow in the sea. More importantly, physicians proposed to completely drain both marshlands that surrounded Barcelona *“But above all should be drained both marshlands Remolà and Port, with what is more probable would be very healthy Montjuich”* [92].

Finally, physicians agreed on to follow the medical prescriptions given by the Real Tribunal del Protomedicato. From now on, bleedings were totally avoided in favor of a treatment related to fevers based on the administration of consistent doses of quine and laxatives.

6. The obituary tables from Medical Academy of Barcelona (1783–1786)

Because this is an ongoing research, we would like to show some results of the analyzed mortality series of Barcelona. Due to the fragmentary mortality series obtained through obituary registers from the two of the three currently preserved parish archives of Barcelona (Parish of Santa Maria del Pi and Parish of Sant Just i Sant Pastor), we use as an introduction the mortality records extracted from necrological tables created by physicians of the Real Academia Médico-Práctica de Barcelona. Through this analysis we would like to show some detailed annual results especially focused on detecting parishes that concentrate on the most outstanding children mortality peaks (**Figure 7**).

Through the displayed graph from 1783–1786, we can clearly appreciate the years that presented an anomaly concerning mortality peaks, specifically 1781, 1783, 1785, and 1786. In 1781, in general, burials increased with respect to the previous year. In fact, child mortality exceeded adult mortality in eight Barcelona parishes. In this sense, Barcelona’s Cathedral reflects 893 children in contrast to 159 adult people deceased. Moreover, it will be the traditional commercial-artisanal area that will remain the second most elevated value of childish mortality. More importantly, it is the parish of Santa Maria del Mar with 500 children versus the 208 adult bodies registered.

On the other hand, in 1782, mortality over all eight parishes of Barcelona was still being elevated (2724 deceased). In fact, the mortality increment in all parishes of Barcelona is clearly noticed, including the Cathedral, with respect to the previous year. In fact, in the Cathedral child mortality peaks were clearly high with 853 child faced to 168 adult. The conjunction of catastrophic flood events along elevated minimum temperatures and a large number of favorable days for plasmodium development maybe the possible explanation to this continuous over mortality. The constant increase in adult mortality culminates in 1783 with a value of 1.26 standard deviation with respect to the rest of corpses deceased for this series of mortality recovered data. However, although the general lines of mortality are less than in 1781 and 1782, this is because of child population which led the deceleration of the general mortality in 1783. In fact, in 1783 adult corpses surpassed child mortality in all Barcelona’s parishes. The exceptions were the parish of Sant Pere (103 adults and 137 children), the Cathedral (192 adults

and 700 children), and the parish of Santa María del Mar (299 adults and 308 children). The adult mortality and children mortality that could be in a strong relation to the impact of typhoid fevers together with the presence of endemic and epidemic malaria could have been entered to the city by the affluence of ill people from the suburban areas.

A new minimal mortality peak reappeared in 1784 (2340 total deceased) with almost one standard deviation less than the rest of the mortality values—typical deviation of minus 0.95. The values that proceed after a diminution of childish mortality—typical deviation of minus 0.97—in conjunction with adult mortality—a typical deviation of minus 0.01.

The year 1785 concentrates the maximum conjunct of the absolute mortality values (3276 deaths) with adult and children manifesting the same upward trend in mortality. In this sense, the intensity in which children mortality exceeds adult corpses due to the negative maximum typical deviation of 1784 in 1785—typical deviation of 1.75—is especially noticeable.

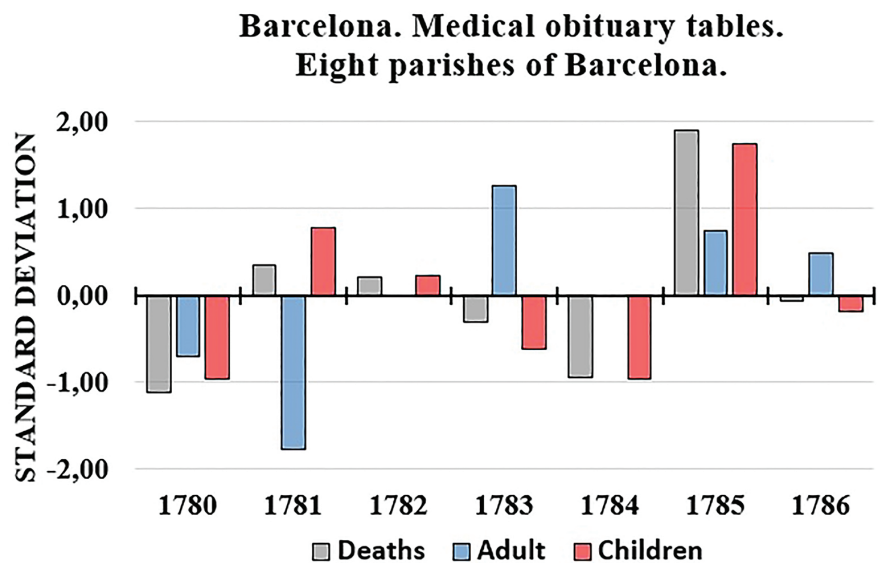


Figure 7. Mortality records of Barcelona in which are reflected the adult and childish mortality from the eight parishes of the city since 1780 until 1786. ARAMC, “Papeles del Dr. D. Francisco Salvà,” legajo XII, num 1, “Notas para las tablas necrológicas...,” doc. 9. “Muertos en Barcelona, por parroquias, años 1780 a 1786, 1797 a 1800 y primeros meses de 1801, 1802 y 1803.”

Childish mortality in 1785 is uniform in all the parishes of the city. However, the most noticeable parishes where mortality wreaked havoc upon the civil population were the Cathedral (160 corpses, 959 children), and the parishes of Santa María del Mar (291 corpses, 528 children), parish of Santa María del Pi (267 adults, 319 children), and Sant Pere de les Puel·les (100 corpses, 222 children). The conjunction of minimal monthly temperatures higher than 22.5°C, a high number of favorable days for sporogony of both analyzed plasmodium, and the critical rain episodes that succeeded since 1782 and 1785 could explain the anomaly in childish population as a consequence of a more favorable environment to the development of malaria. This disease could have been presented in a more prolonged seasonal pattern until the autumn months. In 1785, in the month of July physician Dr. Francisco Salvà noticed a transition based

on a more aggressive presence of putrid fevers: *“In the month of July, the constitution was less inflammatory but more putrid than in the previous month (...) tertian fevers were very common this month. Were also detected colic pains and convulsions that were attached by the use of narcotics. In August the epidemical constitution didn’t changed, with the exception of some small-poxes, and tertian fevers, there were not more noticeable diseases; but were common diarrrheas, dysenteries”* [93].

Finally, a significant high values of child mortality is observed in 1786 in all parishes of Barcelona. In fact, the only exception was Sant Jaume parish (43 adult, 26 children). Children who had the more reduced opportunities to survive due to the combination of malaria along with gastrointestinal diseases *“Those weaning children had the less favorable time. Some of them were affected by a universal weakness after which they died”* [93].

7. Discussion and conclusions

Malaria is a protean disease very sensitive to changes in precipitation, temperature, and wind direction. As shown above, the strong relation between the disease and environment is linked by the principal vector, *Anopheles* female’s mosquitoes that give to the disease a high range of territorial affection. Since the progressive disappearance of the plague from European countries, endemic malaria plays a role as a background illness due to the synergic, positive, and negative interactions among other sicknesses such as smallpox, flu, cholera, yellow fever —among others— generating a constant oscillation in mortality peaks. However, historians usually have not paid the merited attention to an illness that was anchored in the quotidian lives, troop movements, the economy, and the landscapes of past Europe since the sixteenth century until the systematic eradication of malaria in the second half of the twentieth century. This illness caused deleterious effects on the health status of peoples of the past, being the children, the newborns were the principal affected collective. This sickness was indirectly fed by those parents who fought for the systematic construction of irrigation trenches to ensure a good alimentation and guarantee a minimum salary for their families.

Malaria is a complex disease with multiple facets and symptoms. In fact, the complexity of the illness resides in the high range of aspects in which it can have an impact on ancient societies. In consequence, the problem to develop historical studies focused on the detection of endemic and epidemic malaria that can only be solved with an interdisciplinary research that will involve a high variety of research fields. One of the most problematic aspects that we usually find in our research was to correctly identify each disease. Due to the above reason, the methodology that we propose is based on to conjunct and compare the most complete range of sources that we can manage. As shown above, from the bibliography we can part a solid basis for the problem to later investigate our corpus of sources. A first step would be the in-depth study of a selection of municipal sources, essentially, municipal chords and municipal proclaims. This step will provide us a rich documentation of quotidian life, hygienic policies, and essential product supplies, all the negative consequences derived from climatic instability and the economic status of the city and the repercussion over the economy as a consequence of the epidemic context. The information extracted from municipal chords can be reinforced

with the help of sanitation sources, such as sanitation expedients. The fact to cross and conjunct all the information extracted from municipal sources will provide us an exact chronology of the effects and the perception of epidemics in the past societies.

Public sources such as the documentation extracted from Reial Acadèmia de Medicina de Catalunya show the potential to realize deepest research over medical archives. In fact, from medical records and instrumental meteorological data we detect a high range of interesting sources such as medical topographies, which in their conjunct and confronted to the municipal sources or the information contained in print sources can contribute to an exact description and analysis of the symptomatology detected in epidemics and hygienic measures proposed by the physicians to municipal authorities and state institutions related to epidemics. Instrumental meteorological records open a high range of possible analysis concerning vector or virus diseases. In fact, one of the current problems is to develop precise mathematical models that cannot help historians to better detect the territorial affection of the diseases but also their seasonal behavior. One of our personal interests is to develop the analysis of instrumental meteorological data with the support of mathematics, physics, entomologists, and biologist to further develop the most detailed analysis in our next studies.

Ecclesiastical sources, more importantly baptism records and burial records, deliver to the researcher the possibility to contrast the information with the corpus sources. More important is the possibility to detect mortality peaks that go unusually high and far from their seasonal patterns of mortality. These mortality peaks can also contradict the symptomatology detected by contemporary physicians for a concrete time lapse and can also be put in relation to the resultant analysis of the environmental requisites for vector-borne diseases such as malaria. As an example, unless we cannot say that all childish mortality peaks are clearly caused by malaria, we can undoubtedly detect the presence of the illness associated with gastrointestinal diseases, typhoid fevers or smallpox, among other diseases.

In the late eighteenth century, we found an interesting conjunction of socioeconomic conditions, environmental conditioners, and urban structures that were, in their conjunct, submitted to the historical context derived from the Spanish Succession War. Since the new political order resultant applied the “Real Decreto de Nueva Planta,” the pre-existent Catalan sanitation and political institutions were reshuffled to respond to the interest of the Bourbon monarchy. At the end of the eighteenth century, cities such as Barcelona adapted to political changes but were also submitted to the consequences derived from the new political order. In this sense, Barcelona was under a massive income of population that arrived to the city due to the stagnant agricultural patterns of Catalonia in the middle of the eighteenth century. This city offered the possibility to export agricultural surplus due to the important commercial flow and also the opportunity to have a job in the industrial-artisanal areas of the city. The hygienic repercussion of the city with almost 114,100 population fell over the hydric structures that could not be properly adapted.

On the other hand, municipal authorities could not guarantee an appropriate hygienic management of hydric resources due to the drastic reduction of the City budget and the lack of municipal competences. Water that flows through the city carries the miasmas, all the residues of the industrial areas, and the mix of fecal matters with drinking waters. Moreover,

the water that came from the Besós River through the channel known as Rec Comtal was the principal cause of contamination due to the traditional presence of legal and illegal cane cultivation rafts.

The relation between stagnant waters and the presence of tertian fevers was well known by physicians and municipal authorities. Barcelona is a good sample that can clearly appreciate through the medical reports presented about the tertian fevers epidemic context that took place between 1783 and 1786. In both medical records, it is clearly detected that the physicians searched the relation with environment and diseases, first inside the city but thereafter doctors refocused their research on the suburban areas of the city and more importantly in both marshlands.

In fact, in the late eighteenth century sanitation institutions were clearly a reminiscence of the pre-existent health structures before the sanitarian institutional reshuffle that took place in 1720. Physicians, in spite of the consequences of the new Bourbonic order, had a considerable impact on the decisions in hygienic policies applied by the municipal authorities. We found a good example which shows that many proclamations detected between 1783 and 1786 focused on the management of marshlands and lagoons that surrounded Barcelona.

However, the dramatic loss of prestige and control over medical studies would be the principal incentive in the constant pursuit of a medical academy in Barcelona. The medical academy since its foundation on 2 July 1770 will rigorously apply and follow the principles of hygienic medicine instigating all the physicians of the medical academy to develop historical medical studies to better understand the causes of illnesses, the relation with environment, the weather, and the sickness.

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Author details

Kevin Pometti

Address all correspondence to: kevin.pometti-benitez@univ-amu.fr

LabexMed, MMSH, CNRS UMR 7303, TELEMME, Aix-Marseille University, Aix-en-Provence, France

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