Early Twentieth Century Infectious Diseases in the Colonial Mediterranean

by

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Abstract

Disease during adulthood can shape the quality of life at both the personal and familial level, interfere with economic productivity, reproductive success and ultimately one's survival. The objective of this research has been to explore the 20th century health of small-scale populations (Malta, Gozo and Gibraltar) in the context of infectious disease using traditional statistical, anthropological, demographic and epidemiologic methods.

This thesis brings us closer to a deeper comprehension of how disease and humans interact. With respect to the differential undulant experience between Malta and Gibraltar, tradition, non-compliancy, along with the scale effect contributed to the persistence of undulant fever in Malta throughout the study period. Other factors were: Gibraltar's effective health-directed policies that dealt with herding and milk consumption, its greater enforcement of policies and higher levels of intra-group compliancy. Gozo's heightened and unique 1918/19 influenza disease experience compared to its sister island of Malta, was shaped by limited exposure to influenza as a consequence of isolation and rurality, along with a community interconnectedness because of the small-scale society, and limited social distancing measures. There were significantly higher

rates of influenza morbidity in reproductively aged women (15 to 44 years) compared to men (z-score=5.28; p <.0001) during the 1918/19 influenza pandemic. Children were significant agents of disease by introducing influenza into households and infecting their female caregivers and infant siblings at disproportionately higher rates. The examination of trends in tuberculosis rates in Malta and Gozo reveals that sex differences in tuberculosis was a result of gendered roles similar to that of the influenza experience. In Malta (urban and rural) tuberculosis death rates was significantly influenced by economics, which explains 61% of the variation in TB death rates. In Gozo, there was no significant impact on respiratory tuberculosis (R=0.23; p=0.25), a consequence of the island's isolation and a self-sufficient economy.

Acknowledgments

I would like to thank everyone who supported me over the course of my journey as a PhD student. Although this document represents the culmination of (some of) the research that I have embarked on over the last several years, it does not showcase my experience with teaching as a teaching assistant and course instructor, and the learning process necessary to undertake research. The sole person who was responsible for teaching me the ropes of academia is Dr. Larry Sawchuk; without his guidance I would not have blossomed as a teacher and most definitely would not have had the courage to pursue a challenging thesis topic that spanned three different infectious diseases. Larry single-handedly fostered my growth from a naïve undergraduate student to a confident graduate student researcher of historical epidemiology and demography in the British colonies of the Mediterranean. In addition, I am appreciative of Prof. Alain Gagnon's (my external appraiser) suggestions for improving the thesis all of which will go a long way for successful future publications of the three papers.

I am also indebted to all those who generously opened the doors to their resources. In particular, Dennis Beiso, the archivists in Gibraltar for granting me access to documents at the Government of Gibraltar Archives. Also, Father J. Bezzina, the head archivist of the Gozo archives for permitting me access to the archives and sharing his knowledge on the history of Gozo. Notably, Charles Farrugia, National Archivist and CEO of the National Archives of Malta, for not only allowing me access to the archives and lending death record micro films, but also showing me the behind the scenes and for his intellectually stimulating discussions about collaborative research on historical health experience in Malta. Last but not least, Margret Gatt, the Senior clerk of Public records registry in Gozo, for allowing me access the vital records, and Frances Grima for her assistance with inputting the Gozo marriage records into excel.

I am grateful for my parents and brother's patience with the slow process of completing this thesis, as I went on multiple field trips and the drafting of the thesis over the last few years. Even without divulging much information about my research, my parents never asked when I would be done my studies, and always supported me in my pursuit of academic endeavours. I am thankful

for my brother, Phillip, for his talent in manipulating numbers especially excel; without him I would not have learned invaluable record (worksheet) linking features in excel.

Finally, I would be remiss if I did not thank my neighbor, Pat Cash, for her assistance with editing this thesis; without her keen eye and excellent language and writing skills, the final corpus of work would not have been elevated to “writing that is lively” (as described by the external appraiser, Prof. A. Gagnon).

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Chapter 1

1 Introduction to Study Populations and Key Concepts

1.1 Overview

This thesis is a collection of work that falls under the umbrella of "Early Twentieth Century Infectious Diseases in the Colonial Mediterranean" offers a detailed exploration of the historical disease experience of three different infectious etiologies. The temporal settings for the three papers is the Colonial Mediterranean in Gibraltar and Malta during the late 19th century and early 20th century. Each paper focuses on a distinct geographical level of population: international (Gibraltar and Malta), national (the Maltese islands) or local (the island of Gozo).

Figure 1-1. Map showing Gibraltar and the Maltese islands

Taken from: (http://www.teara.govt.nz/en/map/890/portugal-spain-gibraltar-and-malta)

1.1.1 The Study Sites

Gibraltar, a flat sandy strip of land that runs nearly due north and south, is a "continental enclave" located at the western end of the Mediterranean and situated at the southern tip of Andalusian Spain. Featuring a single fortress, the relatively small territory just covers approximately 4.22 square miles.

Formerly a British colony (independent since 1964), the Maltese islands, i.e. Malta, Gozo, and Comino, sit in the middle of the Mediterranean Sea. Although it is one of the smallest countries in the world, the archipelago's combined area of approximately 240 square miles together with Gozo, at just 26 square miles, are large compared to Gibraltar. Unlike Gibraltar, the civilian population and the military bases were dispersed across various towns in Malta (Gozo did not

have any active Military/Naval bases during the study period). Comino is largely uninhabitable and was not included in any of the studies.

1.1.2 The Topics

Chapter 2, *Undulant Fever: Colonialism, Culture, and Compliancy,* provides a comparative inter-population study in the epidemiology of undulant fever and reopens the debate over the impact left by colonialism on the health of civilian populations of Malta and Gibraltar[1] during the late 19th to 20th century. I considered both positive and negative consequences of colonialism on indigenous populations where colonialism is viewed as a 'distal social determinant of health.' I argue here that a complex interplay of colonialism acting on cultural milk practices together with the scale effect's[2] impact on the creation, implementation and enforcement of health policy can explain differences in the disease experience between the two colonies.

Chapter 3, *Host Immunity, Children and Gender differences during the 1918/19 Influenza Epidemic in an Island Population***,** examines the heterogeneity of the signature features of the 1918 influenza pandemic in island populations. I discover that limited influenza exposure, the scale effect and social distancing measures as key players in the variation in morbidity and mortality experience between Gozo and Malta. In addition, children were significant agents in introducing influenza into households and infecting their caregivers at disproportionate higher rates. In communities such as Gozo, reproductively and post-reproductively aged women took on the traditional nurturant role and were at greater risk of being infected than men. One of the major salient findings from this localized study, which can extrapolated to other populations, is that pregnancy is not an important factor in increasing morbidity in females.

Last, chapter 4, *Insights into Secular Trends of Respiratory Tuberculosis: The early 20th century Maltese Experience,* delves into the relationship of economics, in particular the cost of living,

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[1] The debate here, refers to whether colonialism can have a lasting positive impact on the colonized. The traditional view is colonialism has always had detrimental health consequences for the colonized civilians.

[2] Population size, density, and dispersion; and their impact on the social determinants of health

and its relationship to the secular trends of tuberculosis mortality in the islands of Malta and Gozo. Notwithstanding the criticism of McKeown's economic hypothesis,[3] we present results that economics is the most parsimonious explanation for the decline of tuberculosis mortality. These reproducible findings are further supported by the fact that, during times of extreme hardship, such as World War I and the 1918/19 influenza pandemic, the bond between high cost of living and high mortality rates was cemented. Further, I ascribed regional differences in tuberculosis rates to variation in economic dependency.

Although the three papers presented in this thesis have distinct topics and findings, there are three overarching themes that permeate and connect the papers: the study period takes place during colonial times; the case study approach was employed in all papers, and the two study locations were similar in geopolitical status and research attributes; the focal diseases were post-first epidemiologic transition that mainly affected the reproductively aged individuals, had major consequences for the general health and evolution of the study populations and had great epidemic potential. The importance of each theme to the foundation of the papers is discussed below.

1.2 Place and Space under Colonialism

To date, the discourse on imperialism recognizes the complexity of the colonized experience (Chricop, 2015) whereby studies on colonialism have focused on economic and political issues, specifically social structures and power relations (Chircop, 2015; Klein, 1994). Equally

[3] Also known as the "McKeown thesis," his hypothesis stipulated that improvement in economics (living conditions, especially diet and nutrition), rather than medicine and public health efforts lead to the decline of infectious diseases and resultant population growth as early as the 18th century (Colgrove, 2002). Critics have argued that McKeown's economic hypothesis hinged on limited data, as publications building on his hypothesis did not present new data nor clear definitions/categorizations of concepts such as "standard of living" and "medical measures". In addition, his hypothesis ignores the importance of fertility rates and its contribution to population growth. He applied his *a priori* beliefs about the ineffectiveness of medical interventions, clouding his interpretations of the historical data, and inadvertently misinterpreted by others as supporting models promoting self-agency as the main cause of illness and subverting the germ theory (Colgrove, 2002; Szreter, 1988).

important is the impact of colonialism on the life conditions (including public health, demography and migration) of the colonial peoples and the largely overlooked possibility that indigenous populations were not simply powerless victims of colonial rule, but were "historical protagonists." In some cases, the natives had shared their concerns and their voices carried (some) weight with the authorities in decision-making, and the subaltern poor often resisted and protested or simply ignored colonial encroachments, policies, and regulations (Chircop, 2015).

As British colonies in the Mediterranean, Gibraltar and Malta were ruled by authorities from abroad and were western nations in their own right. With little available land and marginal quality soil quality, however, the colonized in these locations did not experience many of the traditional negative health consequences of colonialism: the disruption of the local ecology via the forced adoption of new subsistence strategies; the alterations of settlement patterns that frequently led to unhealthy environments with overcrowding, and poor sanitation conditions; the establishment of transportation systems that aided in the rapid and widespread diffusion of disease bearing microbes; and the introduction of westernized foods that promoted malnutrition and, in turn, greater susceptibility to infectious disease (Crosby, 1986).

Because of the unusual geographical characteristics of the two locations, the civilian populations experienced a number of additional colonial pressures which could have compromised the health of the communities, but also allowed for control of these potential confounders between the two communities. First, owing to importance of the colonies as strategic locations for naval and garrison settings, the civilians were at risk of exposure to new pathogens from distant locations. Second, due to the intermingling of both civilians and military personnel, the health of both populations were intertwined and, as such, the health of each population could impact on the other. (Anderson, 1998). Last, because the civilian community co-existed with a garrison presence, civilian needs were deemed to be less important than those of the colonizer and the military. The subordinate position of the indigenous civilian population was manifest in numerous ways that culminated in the "fortress mentality" of the civilian population: civilians were expected to provide and supply the needs (such as food, sex, and housing accommodations) of the military (Finlayson, 1991). Those not deemed to be a benefit to the fortress were encouraged to leave the colony. This harsh and demanding stance on the expectations of the duties and obligations of the civilians to the British Empire was associated primarily with

Gibraltar because the island of Malta was the home to many military bases during the study period. It is not unreasonable to assume that certain subsets of the Maltese population were also under similar expectations. The relationship, however, was, in some cases, reciprocal: patronage was a fact of life, and some civilians benefitted greatly from their association with the military/navy. Such practices contributed to the great disparities in wealth among the civilians. As a consequence, the British authorities exercised tight control of population demography for many years, especially through immigration into the colonies.

1.3 The Case Study approach

A case study is defined as "The detailed examination of a single example of a class of phenomena," (Flyvberg, 2006) or as "a research strategy which focuses on understanding the dynamics present within single [or multiple] settings…and can involve numerous levels of analysis" (Eisenhardt, 1989). The case study approach in social sciences is a method of research that, until recently, has been regarded as inferior to large-scale population studies or survey methods. Case studies were erroneously thought to be inherently limited in value. They were beneficial for preliminary studies or hypothesis generating, but not hypothesis building. They were not generalizable and, consequently, could not contribute to scientific development. It was difficult to summarize the findings from case studies and develop general proposition and theories. Last, they were biased toward verification. In other words, they confirmed the researcher's preconceived notions (Flyvberg, 2006).

Today, there is little doubt that the aforementioned concerns are misunderstandings, and the case study approach is a useful research tool because it is conducive for hypothesis testing and theory building, generalizable to other case studies and easily summarized for contributions to scientific development (Flyvbjerg, 2006). In fact, some argue that any discipline without case studies is ineffective because it is/would be "without systematic production of exemplar." (p. 219).

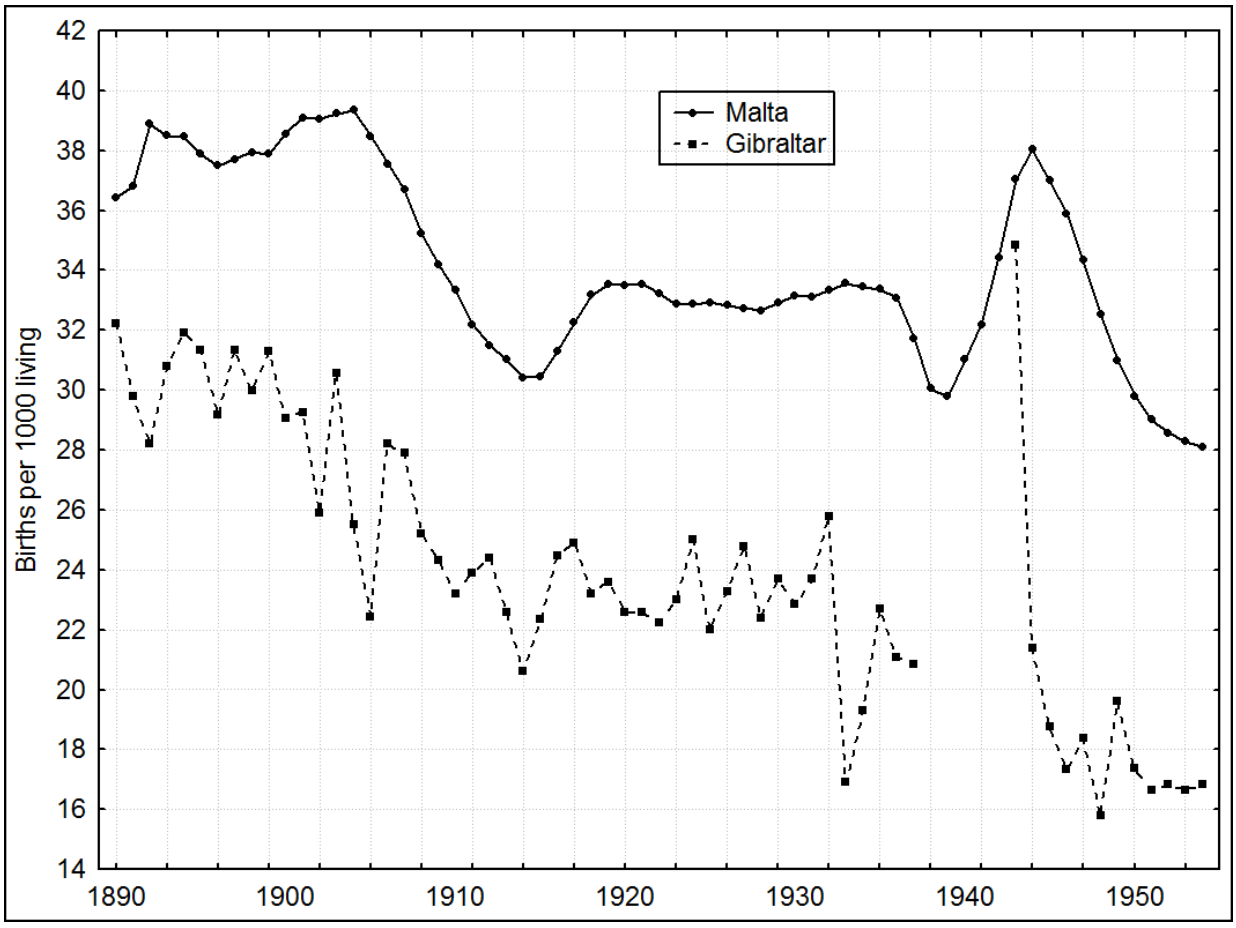
The papers presented here utilize three different case studies from small-scale societies, which facilitate generalizability of the findings to each population and to other small size populations

(approximately 300 0000 individuals or less). In addition to their similar colonial experiences, Malta and Gibraltar shared a number of commonalities in geography and living conditions that, superficially, would put them on an even footing in terms of health during the 19th and early 20th centuries: a Mediterranean climate with protracted hot and dry summers acting as a powerful ecological stressor; an overcrowded population; a deficiency in even the most rudimentary sanitary infrastructure, and public and domestic hygiene, particularly in the urban centers; and a marginal setting largely incapable of providing sufficient food and other necessities of life so that the Maltese and Gibraltarians were economically dependent on imports of food. Even with the numerous similar qualities between Gibraltar and Malta, there were glaring differences in overall health between the two locations.

As shown in Figures**Figure 1-2** and **Figure 1-3**, two proxy measures of population health[4] indicate that, for 60 years, overall health differed considerably between the two locales. The Maltese islands had significantly higher birth and infant mortality rates than Gibraltar. Other scholars support the importance of infant mortality rate as a general measure of population health: "…an important indicator of social health, such that when a community is under stress from nutritional or water insufficiency, social inequalities and unequal access to resources, or endemic disease…" (Hallman, 2012 p. 44; Moffat & Herring, 1999; Galley & Shelton, 2001). For more information on the general health of Gibraltarians and Maltese over time and the health disparities between the two populations, see Sawchuk et al., 2013.

[4] Infant mortality and births rates are just two of many proxy measures of health, others include: life expectancy, miscarriage and stillbirth rates, childhood mortality rates (under 5), under 15 mortality rates (pre-reproductive rates), and maternal mortality rates.

Figure 1-2. Crude Birth Rates: Malta and Gibraltar – 5 year Moving Averages



Taken from: (Sawchuk, Tripp, Damouras & Debono, 2013)

Figure 1-3. Infant Mortality Rates: Malta and Gibraltar – 5 year moving averages

Taken from: (Sawchuk, Tripp, Damouras & Debono, 2013)

The differences in overall health of the two populations can be attributed, in part, to scale differences in geographical area and population size. Because of the relatively larger area in Malta, a dispersed population potentially added to the issue of prevention and control of disease in Malta. Be that as it may, the population density within the fortress of Gibraltar may have increased susceptibility to infectious diseases, whereas the dispersed population of Malta may have acted as a protective factor in preventing infectious diseases from entering towns or urban areas (Grob, 2002) and in reducing transmissibility within and across regions.

1.3.1 Human Populations as Living Laboratories

Populations that meet the requirements of a living laboratory allow us to unearth controlling factors that may be responsible for differences in the disease experience that might exist among populations. For instance, the investigator may wish to focus on groups that are ethnically the same to minimize differences in diet or other cultural factors that contribute to inter-population variability. The differences in exposures or risk factors that remain are usually limited in number, highly recognizable and, in some cases, can be "methodologically removed" by the researcher.

From a research perspective, Gibraltar and Malta share a number of desirable attributes that mark their populations as "living laboratories." The following are six of these major characteristics: (1) The population was clearly demarcated in physical and socio-political space and thereby subject to minimal ambiguity in terms of group identification over time and space; (2) An insular and/or island setting which discourages large mass and permanent immigration of foreigners into the colonies[5]; (3) The inhabitants were under the care of health professionals who adhered to the same medical paradigm ensuring that death registrations were not subject to idiosyncratic classifications of death; (4) A long-standing tradition of reliable record keeping; (5) A temporal depth for the study period that is sufficient to minimize short-term aberrations; and (6) An extensive narrative of information covering the study period. With these conditions in place for our study in the real-world settings of Malta and Gibraltar, we can control for factors that may be responsible for the differences that might have existed between the two populations (for additional living laboratory features found in Gibraltar, see Sawchuk, Tripp & Melynchenko, 2013).

[5] It should be noted that although the military base was a constant presence on the Rock, the personnel were not, as there were frequent turnover of the soldiers. They were not viewed as foreigners as they too were British subjects.

1.4 Post-"Age of Pestilence and Famine" Diseases

The time periods of analysis of the papers presented here, started at approximately the end of the 19th century (1896 for the undulant fever paper, 1910 for the tuberculosis paper and 1912 for the influenza paper) and ended in 1953.

This work builds on the earlier study of Sawchuk et al., 2013 where trends in mortality can be divided into a series of phases that are characterized by the following fundamental demographic properties:

1. Phase 1 is characterized by high rates of mortality and demographic instability fueled by dramatic increases in death associated with epidemics.

2. Phase 2 is marked by a slow, gradual decline in mortality with a limited number of sporadic epidemics that significantly affect health.

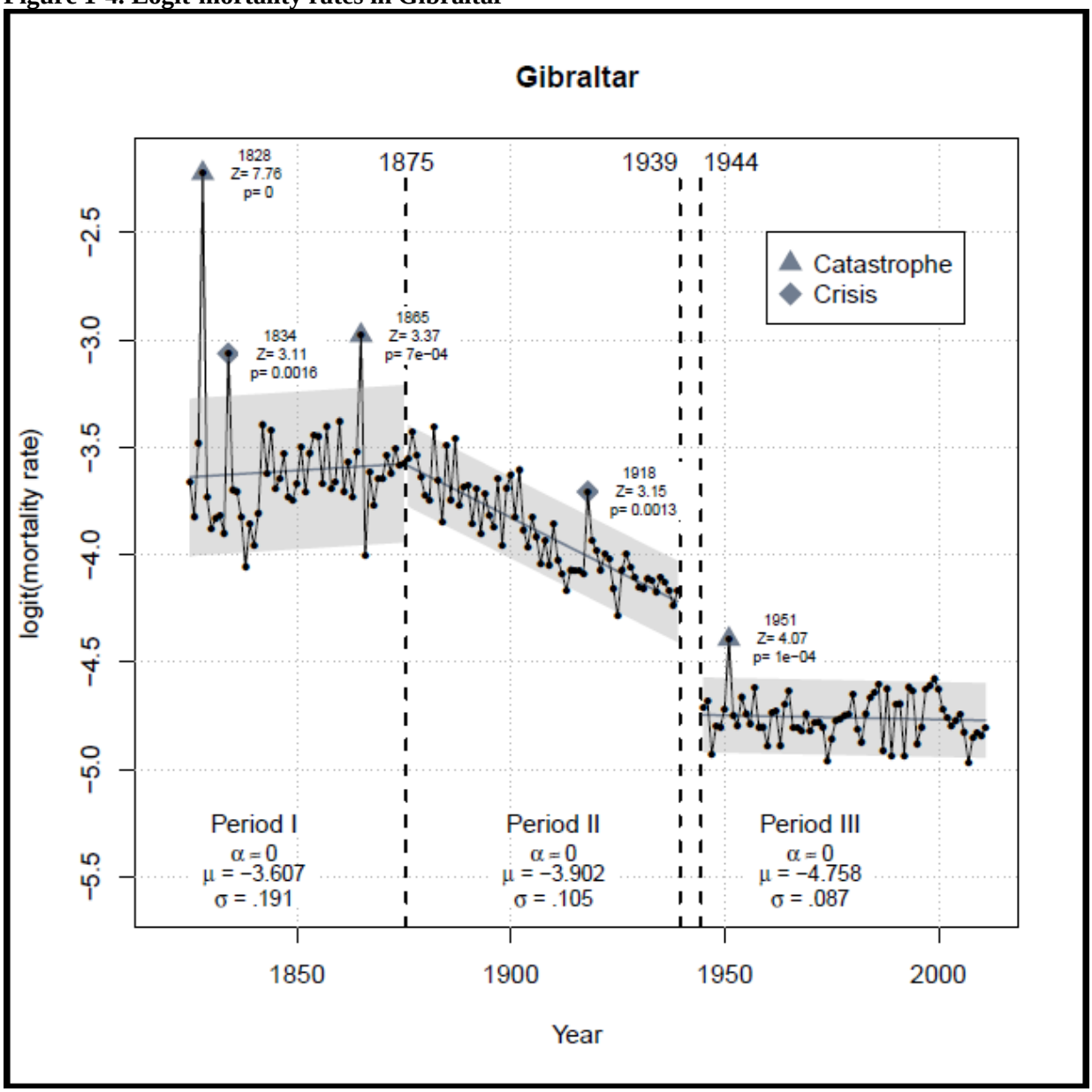
3. Phase 3 and/or 4 is characterized by a sharp fall in the mortality rate, and epidemics play a very limited role in shaping the life expectancy.

To put the Malta and Gibraltar studies in context, we can draw from Omran's epidemiologic transition because the time period of study covers the latter part of the second stage and the early part of the third stage of the epidemiologic transition.

"The age of receding pandemics" (second stage) was a period marked by a decline in mortality rates, a decrease in frequency of epidemics, an increase of life expectancy from 30 to 50 years of age and an exponential growth in population as mortality rates of infectious diseases declined, particularly that of tuberculosis near the end of the stage (Omran, 1971; Omran, 1998). The timing of the stages of transition under the classic model for western nations varied so that some countries entered the second stage as early as the beginning of the 18th century (Omran, 1998) or as late as 1850 up to about 1920 (Omran, 1977). In Gibraltar and Malta, mortality rates indicate the second stage of transition began approximately in 1875 and 1894 respectively. As shown in Figures Figure **1-4** and Figure **1-5**, the logit-crude mortality rates show that, following these

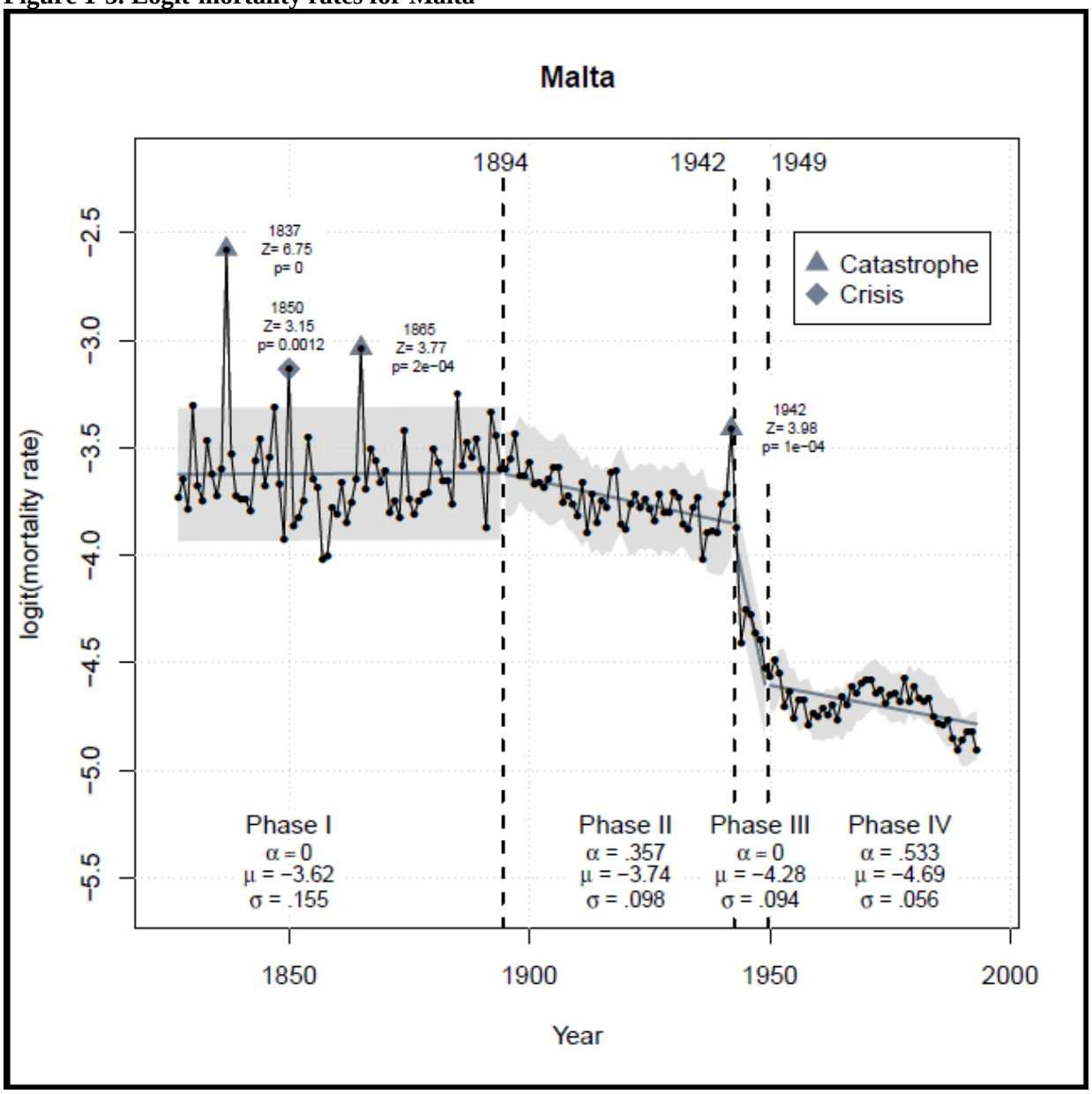
onset years, there was a steady decline in mortality rates and, unlike the previous stage of "The Pestilence and Famine" where shock diseases or "Grand Epidemics" such as the plague, yellow fever and cholera were commonplace, there were few to no infectious diseases of crisis or catastrophic effects during the second stage (see Sawchuk and co-workers, 2013, for a detailed discussion on crisis mortality). Although mortality may not have risen to first stage levels and rarely incited repeated devastating cycle of epidemics (sometimes manifested on the global stage as pandemics) several infectious diseases were still ubiquitous, (Omran, 1998) and significantly affected the daily operations of localized populations.

Figure 1-4. Logit-mortality rates in Gibraltar



Taken from: (Sawchuk et al., 2013)

Figure 1-5. Logit-mortality rates for Malta



Taken from: (Sawchuk et al., 2013)

As shown in **Table 1-1**, in early 20th century Malta, the top notifiable disease events where annual deaths exceeded 100, were mainly infectious diseases that struck children, such as whooping cough and measles. The leading causes of death in Malta were diarrheal diseases, a fact which most likely accounted for the exceptionally high infant mortality rates as shown in **Figure 1-3**. As these diseases were not notifiable, (and hence not reliable data), the numbers are

not shown here. A similar disease profile was observed in Gibraltar during the 20th century. Progression from stage one to three was a result of the improvements in survivorship of children and young and reproductively age women (Omran, 1977).

Table 1-1. The major notifiable infectious diseases of early 20th century Malta

Year	Disease	Cases	Deaths
1911	Measles	2882	144
1913	Enteric Fever	549	104
1916	Measles	5586	235
1917	Whooping cough	3146	166

Precisely when the third stage, "Age of degenerative and man-made diseases", occurred is difficult to discern. In most western societies, this stage began circa 1900, and life expectancy at birth increased to between 50 to 75 years of age or older (Omran, 1998). In 1920s Malta, however, life expectancy at birth did not exceed 45 years and, with high birth rates, that persisted as such until the early 1940s (see **Figure 1-2**), it was very likely that Malta remained in the second stage well into the latter part of the 20th century. On the other hand, Gibraltar, with muted birth rates, and a much smaller population size and life expectancies of at least 50 years, most likely entered the third stage at the beginning to middle of the 20th century. In any case, there was considerable overlap in the occurrence of the stages 2 and 3, when infectious diseases were still more common than degenerative diseases.

1.4.1 Infectious diseases in the reproductively aged and Evolution[6]

Since the work of geneticists (e.g., Haldane, 1949), human biologists (e.g., Motulsky, 1960), and anthropologists (e.g., Allison, 1956), research into the question of the potential for infectious diseases to have long term evolutionary consequences has been the subject of ongoing investigations. In some cases, pathogens can evoke long-term change to the biological properties of a population through natural selection (for example, malaria and the sickle cell gene).

While the subject of biological fitness and infectious disease is complex and beyond the scope of this thesis, a brief overview of the subject in relationship to the diseases considered in this work is warranted. A central question here is whether an infectious disease that affects an individual during the reproductive period (i.e. 15 to 44 years) can or has the potential to affect evolutionary change.[7] The three diseases considered here targeted those in their reproductive prime, for example in the 1920s to1930s in Gozo, the average age for males who contracted undulant fever was 30 years, and 32 in females.

There are a number of conditions in both the host and in the micro-organism required for evolution to take place. First, there must be genetic variation in a population for a genotype that confers increased resistance or susceptibility to the infectious agent (Molnar, 2002). In general terms, the rarer the gene(s) that confer resistance, the longer it will take for an increase frequency of the particular genotype in the population. Second, since selection is the primary factor evoking evolutionary change, the infectious disease must be present in the physical environment for extended periods of time (Molnar, 2002). This is based on the principle that the virulence and the host immunity must remain stable over time. From an epidemiological perspective, the disease should be endemic, in other words, present in the population on a continuous basis. Finally, the micro-organism has to affect the reproductive fitness or reproductive success (Molnar, 2002): the

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[6] I acknowledge that diseases that target the pre-reproductive also have the potential to impact reproductive fitness or success if they impact on the ability to survive or reproduce.

[7] Diseases that target the pre-reproductive also have the potential to impact reproductive fitness or success if they impact the ability to survive or reproduce.

latter is defined as the ability to mate, reproduce and produce offspring that survive to reproductive age. In addition to biological factors affecting reproductive ability, there is the dampening effect associated with individuals who fail to reproduce because he/she is perceived as an unsuitable marriage partner by virtue of their unhealthy state, or their linkage to a highly stigmatized disease. Most human mating systems foster the view that an unhealthy state or the perceived lack of wellbeing is a constraining feature (Tybur & Gangestad, 2011). An indirect effect could also occur as the individual's ability to provide proper caregiving and economic wellbeing for the children is compromised.

Respiratory tuberculosis in 20th century Gibraltar and Malta, for example, had the potential to promote evolutionary change because of several reasons. (1)There are genes that can confer resistance while others that increase susceptibility (Berrington & Hawn, 2007). (2) Westernized industrialized countries had had a history of this disease for centuries. (3) It affected reproductive performance by killing people during their reproductive period. (4) Respiratory tuberculosis could have acted as a powerful deterrent to mating/marriage, and the stigma associated with the disease could have prevented individuals from carrying out social and economic duties associated with family life. In Malta and Gozo, brucellosis was endemic, and at times, attain epidemic proportions, one's ability to hold gainful employment and to preserve household security was acutely and adversely affected.

1.4.2 Epidemics

Through illness and death, diseases such as tuberculosis, influenza, and undulant fever could compromise the health of individuals, and the nation state, as each disease had the potential to rise beyond the norm and attain epidemic proportions. Disease events are categorized, so there is a universal understanding among disease researchers about the extent, in terms of geography and severity, of the disease impact on the population socio-demographic. The task of identifying an epidemic, however, can be fraught with ambiguity. The most common definition for *epidemic,* originally proposed by Benenson (1980): "the occurrence in a community or region of a group of illnesses… of similar nature, clearly in excess of normal expectancy" (Mausner & Kramer, 1985; p. 23). One variant of this definition that I use here is "a marked rise in the frequency of a

specific infectious disease in a community over a limited period, beyond the frequency considered normal for the population under investigation" (Sawchuk, 2010; p. 95). The problem lies in determining exactly when there is an "excess of normal expectancy" or baseline number of disease cases or deaths in a population. As aptly noted by Green et al. (2002), epidemics can be quantitatively defined for some diseases, "in which an arbitrary threshold is selected above which the term 'epidemic' is applied" (p.4). For example, in 1996, the United Kingdom's threshold for an influenza epidemic was achieved when there were 400 flu cases per 100 000 in one week. In the United States, however, the threshold for influenza epidemic was determined by pneumonia and influenza death rates as set out by the Centre of Disease Control and Prevention. This means that each epidemic is context specific and must be situated within space, place and time (Green, Swartz, Mayshar et al., 2002). Furthermore, to define a specific epidemic more accurately, information on the nature of the spread, number of cases, case-fatality and area affected (localized or widespread) should also be reported.

Adding to the confusion about what constitutes an epidemic is the simple fact that the general population or lay perception of an epidemic varies greatly from the epidemiologists' definition: namely, an infection that spreads rapidly and affects many people in a defined region at the same or particular time. In addition, because epidemiologists use the term "outbreak"[8] instead of "epidemic", a population may not recognize the nature of the situation and fail to take the necessary precautions to protect itself against an epidemic.

The need for a greater understanding of the impact of disease on communities is grounded in the unfortunate fact that epidemics have in the past and continue in modern times to decimate populations, to paralyze industry and trade, and to cause human despair. "Archaeo-epidemiology"[9] (Simonsen, Viboud, Chowell et al., 2011), the method of studying historical epidemics of infectious disease, analyzes / discerns the pattern in the waves of cases and deaths. These findings/ such knowledge, in turn, helps researchers of contemporary epidemics to address

[8] Epidemiologists use the terms *epidemic* and *outbreak* synonymously, however, sometimes an outbreak is used to refer to a localized epidemic.

[9] A term coined by the Editors of the journal *Vaccine*, describing interdisciplinary study of pandemic influenza primarily using archival data.

public health concerns with counter measures such as effective vaccinations. The great epidemics have appeal as "defining moments" or flashpoints, through inducing periods of terrible stress, by which aspects of a community's social, medical and sanitary structure are brilliantly revealed (See, for example, Morris, 1976; Pelling, 1978; Evans, 1987; Snowden, 1995; Watts, 1997). Furthermore, epidemics can also elicit the deep-seated characters of community identity where the best and the worst human qualities are exposed, either through deeds of public and private charity or acts that ostracize minority groups or the powerless. Power relationships invariably surface as the majority controls, silences and casts blame upon the powerless or minorities. On the other hand, epidemics can shock institutions into implementing costly and widespread reform to the sanitary and social infrastructure as well as bringing about changes in the very perception and treatment of the society's underprivileged.

1.5 Materials & Data Collection

The beginning of the study period of this thesis in the late eighteen hundreds, coincides with the emergence of public health movement when prophylactic measures were put in place to contain the spread of infectious diseases. To implement effective health policies it was necessary to collect information systematically on the state of the health of population. By the end of the 19th century, colonial health officials (in Malta) began to report, in a coherent and systematic way, information on deaths by age, sex and cause. By the 1890s, information on morbidity began to be collected and reported through infectious disease notifications: influenza was made notifiable in 1890, undulant fever in 1906 and tuberculosis in 1908. I draw on this body of information (both primary and secondary sources) to reconstruct the state of health of the people through traditional epidemiological and demographic methods. The bulk of the sources were collected (via photographs) from the National Archives in Kew (London), the Government of Gibraltar Archives, the National Archives of Malta (Rabat), the Public Registry Office in Gozo (Victoria), the Archives of Gozo (Victoria), and the Wellcome Library in London. All of the government-administered reports collected for this thesis were at least 75 years old. They fall within the Maltese 75 year rule of open access to government records and, do not present a breach of

confidentiality of personal material. The information from the sources was transcribed into excel or SPSS. See Table 1.2 for information on dates and locations of field trips as well as the types of the data collected.

Table 1-2. Time Table of Fieldwork Activities related to Doctoral Thesis and other Research Projects

Date	Location	Fieldwork
July-Aug 2009	National Archives, London	Preliminary trip to archives to scout out research opportunities
July-Aug 2011	Government of Gibraltar Archives, and National Archives, London	Collected data on immigration to begin research on minority communities in Gibraltar including documents on AOC (alien order in Council) and Colonial Office (CO) reports
June- Aug 2012 (spent a month in Gibraltar)	Government of Gibraltar Archives, National Archives, London, and Malta Archives	Collected files on health reports and on the Hindu community of Gibraltar; conducted health survey of Gibraltarians, and other miscellaneous correspondence reports by commissioners on sanitation, Malta Gazette (Health reports), Guyana influenza 1918
July- Aug 2013	National Archives, London, and Wellcome library (London)	Collected files on CO reports on undulant fever, Guyana (health reports); leprosy, Health Reports on the Maltese islands (from the Malta Gazette)
Sept- Oct 2014	National Archives, London, Wellcome library (London), Malta Archives, Public Registry (Gozo), and Gozo Archives	influenza reports in Malta, polio in Malta, undulant fever, Malta Death records and birth records, marriage records and notification records, Malta Health reports
Feb 2015	Public Registry (Gozo), and Gozo Archives	Collected death records on Gozo

July-Aug 2015	National Archives, London, Public Registry (Gozo), and Gozo Archives	Collected death records, evacuation of Gibraltar during WWII, Malta cholera and Plague, Gibraltar Hindus, Gibraltar macaques, goats and undulant fever in Malta, contraband trade in Gibraltar, and War office reports (WO)

Below I have included a summary of sources explaining where collected and the type of information extracted from each source. The primary sources included the following: Census reports, Annual Health reports of Gibraltar and of the Maltese Islands, Death records of Gozo, Birth records of Gozo, Marriage records of Gozo, the Malta Blue Books, Notification registry, and correspondence reports. Newspaper articles from The Daily Malta Chronicle and The Daily Herald are examples of secondary sources used in this thesis.

1.5.1 Census Reports

Following the long tradition of the British Colonial Office, census material on the Maltese population exists from 1842 and, from 1753 to present day in Gibraltar. The material was used here to reconstruct the population at risk as well as other demographic characteristics such as age and sex distributions of the population. In the case of Malta, the census published materials becomes increasingly more detailed over the years. In particular, the census of 1948 provided new information on fertility. In a series of tables, the female population of 15 years and older, was classified by conjugal condition, age groups, and by number of mothers according to number of children born in the Maltese Islands. New detailed information on housing by location was included as well in the expanded two volume edition of the 1948 census. One of the drawbacks to these records is the inconsistency of what is reported at different times. For example, the 1901 census was unique in that it gave a complete breakdown by age (by year) and sex until age 100. No other census provided that information. In addition, information on age at death for children (by month and year up to 10) was no longer available in 1948. Such information available in the 1911 through 1931 gave the reader the opportunity to precisely assess changes in the age structure of infant and childhood mortality. One measure of assessing of the consistency of

census counts is to compare the population at risk in respective age bands from one census point to the next. Ideally the correlation coefficients should be close to 1 for comparative accuracy of enumerations (Biraben, 1961). A comparison of the 1911, 1921 and 1931 census points by sex and age yield R-values of 0.978 or higher. Demographic analysis estimates along with sensitivity analyses of these estimates are methods I can use in future studies to assess completeness of the census reports (Devine et al., 2012), as well as the other vital statistics employed in this thesis. See Appendix A for a photograph of a page of the census of the Maltese islands, 1911.

1.5.2 Annual Health Reports

These reports provide aggregate monthly and yearly morbidity and death records which began in crude fashion around the late 1890s. At the National Archives in London, the Health Reports of the Maltese Islands are drawn from the appendices of the Malta Gazette. A sample of the material is set out in Appendix B. In addition to providing numerical data, these reports were invaluable as descriptions of diseases, especially for undulant fever in Gibraltar paper and for tuberculosis in Malta. One example of descriptive information on undulant fever from the Gibraltar Health reports comes from page 9 of the 1907 report:

> Four cases were reported and one proved fatal. The first case occurred on the 7th of May. The man attributed his illness to the consumption of fresh cheese made from goats' milk and bought in Linea. He also stated that he had been in the habit of drinking goats' milk daily, obtained from a contractor in the town who received a large consignments from Spain. … The second case occurred on the 19th of November. On enquiry it was ascertained that the man had been living at a farm close to san Roque, and whilst there drank goats' milk daily. …. The third case arrived in Gibraltar suffered from fever. He stated that he had recently visited Malta and during his stay of thirteen days drank goats' milk in the Cafes'. …. During the year under review an examination was made of all the goats living on the rock. Thirty-six goats, viz, 7 Spanish, 11 Maltese and 15 mixed breed, out of total of 251, were found to give specific blood reaction with M. Melitensis. … In order to prevent a number of measures are recommended ….

A description of the importance of rates in Gozo and Malta, stigma, and the notification of tuberculosis is extracted from the 1917 Malta Health reports are as follows:

> Tuberculosis caused 247 deaths in Malta and 11 in Gozo corresponding to a rate of 1.2 and 0.4 per 1000 persons. This marked divergence in the proportion of persons dying from the disease is fairly constant and an index of a much smaller incidence of pulmonary tuberculosis in the sister island, which may very well be due to the more generally agricultural avocations to the inhabitants of Gozo are addicted, the more even and easier existence and the comparatively small density of population.
>
> The winter of 1917/18 was unusually severe and hastened the end of certain phthisical patients, the increased number of deaths must, I am afraid be connected with an increasing morbidity.
>
> The disease is notifiable; but great care must be exercised in dealing with cases in order not to hurt the susceptibility of relatives. The fact is that the disease is one of those knowledge of which is often kept from the friends of the patient and from the patient himself. On notification, the infected premises are visited by a member of the Sanitary Staff, disinfection is effected on change of residence and on removal of the patient to hospital; premises, bedding etc are disinfected also on decease of the patient. Simple instructions to patients and relatives have been prepared and published in the vernacular paper "E; Habib", to the editor of which the thanks of this department are specially due; they have been also printed in leaflet form which may be obtained free on application to the Connaught Hospital or to the Public Health Office.

1.5.3 Death Records

Individual records extracted from Deaths Registers, which began in 1865, are housed in the Malta Archives (Rabat) and Gozo Public Registry (Victoria); cause-specific information was

added in 1885. These records provided the following particulars: Place of Registration and Officer in Charge; Date of Registration; Reference number in Death Register; Name and Surname; whether married, or unmarried, widower, widow; Profession, trade or other status; Age; Place of Birth, Place of Residence; Name and Surname of Parents whether Living or dead; Cause, place and time of death and place of burial; Two witnesses: Name and Surname, Profession, Name, Place of Birth, Place of Residence; Name and Surname of the Father and Whether living or dead (See Appendix C). The death records were used to establish the general mortality pattern in the influenza paper. To assess completeness of death records, it would be ideal to cross-reference with parish records and notification records (Gozo only). A sophisticated approach to assessing incompleteness relies on the relative completeness of two census enumerations and inter-census registered deaths (Hill, 1987). It is a modification of The Growth Balance Equation developed by Brass (1975) to estimate the completeness of death registration relative to the completeness of census enumeration for stable populations. There is little doubt that the completeness and accuracy of the vital death registry is an important element in this research but at this moment this is an endeavour that will be done as future research.

1.5.4 Birth and Marriage Records

As with the death records, the Gozo birth registry provides individual information on Place of Registration and Officer in Charge; Date of Registration Reference number in Birth Register; Place of Registration and Date, Place of Birth; Hour, Day, Month, Year; Sex; Name, Name or names by which the child is to be called; the father of the child, profession, trade or other status, birthplace, place of residence, Name and Surname of the Father and whether living or dead; the mother of the child, profession, trade or other status, birthplace, place of residence, Name and Surname of the Father and whether living or dead; the person making the declaration; Two witnesses with information of Name and Surname, Profession, Name, Place of Birth, Place of Residence; Name and Surname of the Father and Whether living or dead. The marriage registry provided the following information: Place of Registration and Officer in Charge; Date of Registration Reference number in Marriage Register; Groom: Name, Surname, Marital status, Profession; Age; Birthplace; Residence; Name and Surname of Parent and living or dead; Bride:

Name, Surname Marital status, Profession; Age; Birthplace; Residence; Name and Surname of Parent and living or dead; Two witnesses with information of Name and Surname, Profession, Name, Place of Birth, Place of Residence; Name and Surname of the Father and Whether living or dead. The Birth registry was used extensively along with the marriage records to confirm pregnancy status for the influenza paper because the wife's forename and surname, and place of residence in the marriage records was linked to the mother's name and location of birth found in the birth records. The linkage was achieved using excel, in particular the index and match functions to match wife's characteristics with those of mothers' found in the birth registry. Manual verification of matches was used to minimize failure to match forenames because of discrepancies in spelling of forename or because of nicknames. Likewise, excel was used to link births and notification to confirm if sick women. In addition to linking names, and location, age was also linked for mothers who gave birth from 1913 to 1918. Appendix D shows one page of the Birth Record.

1.5.5 Malta Blue Books

Each colony in the British Empire was responsible for sending information back to the Colonial Secretary on a variety of subjects which included the following: commercial goods, wages, expenditures, imports and exports. The Blue Books also contained demographic information that dealt specifically with population size, births, marriages, and deaths. Since the information provided in these records, however, did not contain individual specifics, such as age and sex, it was used primarily to estimate the cost of imported foods, specifically for the fisher index, a measure of inflation, from 1910 to 1938 for the tuberculosis paper. The fisher index was calculated by J. Falzon using importation information for each imported commodity to estimate house consumption and unit price of goods. The unit prices were calculated by dividing the total value of imports by the total quantity imported (Falzon & Lanzon, 2011).

1.5.6 Notification Records

The Gozo infectious disease notification register was an important source for chronicling cases of infectious disease on a daily basis. Gozo's disease notification registry of zymotic diseases included the following: nature of disease; street and house number of infected individual; name of patient; age of patient; date of report; result and date of disposal of case; and reporter. Notification returns of "contagious diseases" required the sick to report their illness to health authorities or face summary conviction and a fine under Malta's Fourth Sanitary Law, Article 7. There were also small financial incentives in place to encourage physicians to report notifiable diseases and penalties if specific diseases were not reported to the District Health Officer. Despite the pre-existing legislation and financial incentives, it is likely that there was under reporting and possibly registration bias. Unfortunately, the only means by which I can directly assess the magnitude of incompleteness of the records is to cross-reference the total number of cases by month with those reported in the annual health reports. Because information on age and sex was not reported for cases in the health report, we must assume that there were no systematic biases with respect to at least age and sex. An example of notified cases of influenza recorded in the registry is given Appendix E. This source was used extensively for compiling data for the influenza paper.

1.5.7 Correspondence Reports

Authorities in Malta and Gibraltar and the Colonial Secretary exchanged a multitude of letters, and these reports provide important information about how the colonial authorities dealt with issues such as diseases, epidemics and public health. Housed at the National Archives Kew, (London), National Archives of Malta, and Government of Gibraltar Archives, these sources informed the narrative basis for all three papers. Correspondence reports often provide first-hand knowledge of health related issues such as undulant fever in Gibraltar and Malta. One such example, on milk supply in Gibraltar written by the Governor General of Gibraltar can be found in Appendix F.

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Chapter 2

2 Colonialism, Culture, and Compliancy: A case study of Undulant Fever

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Author Contributions: I designed this project. Sawchuk and I were both responsible for the collection of data. I wrote manuscript along with L. A. Sawchuk, however I was the sole contributor to conceptual framework and design of the epidemiological triad, the background section, presentation of figures, the conclusions, and to the final overall presentation of the manuscript.

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2.1 Abstract

Undulant fever (also known as Maltese fever, or brucellosis), originated in Egypt around 1600 BC and is currently a re-emerging disease that threatens both the health of the working poor in Central Asia and the Middle East.

This paper provides a comparative intra-colonial study in the epidemiology of undulant fever, and reopens the debate over the impact left by colonialism on the health of civilian populations of Malta and Gibraltar during the late 19th to 20th century. Consideration of both positive and negative consequences of colonialism on indigenous populations is explored, where colonialism is viewed as a 'distal social determinant of health.'

We ask the question, why did the undulant fever experiences of Malta and Gibraltar differ drastically despite a known etiology? Through an exploration of how the disease was modified during a complex process that involved colonial action taken on cultural milk practices and the scale effect's impact on the creation, implementation, and enforcement of health policy, we argue that Gibraltar's experience with the disease was distinct from that of Malta. We propose the new concept of the scale effect, as a multifaceted construct that embodies the demographic properties of size, density and dispersion together with its impact on the social determinants of health. The difference is attributable to Gibraltar's having: (1) a culturally entrenched tradition of goat-herding, but not an exclusive tradition of consuming raw goats' milk; (2) effective health-directed policies regarding herding and milk consumption; and (3) greater enforcement of policies and higher levels of group compliancy.

2.2 Introduction

Colonialism can be viewed as a distal social determinant of health where colonial relations of the indigenous population and colonizer are shaped by historical, political, social and economic exchanges.[10] The distal determinant acts on the health of the colonized through a complex pathway of the intermediate and proximal social determinants of health.[11] To date, much of the discourse on colonialism and health has focused on the negative consequences. For example, colonialism's hegemonic actions and imperialistic goals[12] have resulted in increased disease experience. Exposure to new pathogens arises from direct contact with infectious agents or their hosts by means of an efficient global transportation system. Indirect health inequalities proceed from colonial actions forcing the adoption of new economic strategies that disrupt the local ecology; from land and property dispossession; from the creation of overcrowded environments with poor sanitary conditions; from the construction of colonial mentalities and 'othering' through economic, educational and social marginalization; from the introduction of westernized foods that promote malnutrition and, in turn, result in poor physical and mental development as well as greater susceptibility to infectious diseases; and finally, from the ineffective quarantine measures that foster a downturn in the local economy, an increase in unemployment and a general state of helplessness, and heightened anxiety.

By contrast, comparatively few studies have shown how colonial authorities contributed positively to the wellbeing of the indigenous population through benevolence, or altruism or imperialistic motives.[13] Such actions have included: (1) the implementation of specialized

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[10] Karina Czyzweski, "Colonialism as a Broader Social Determinant of Health," *The International Indigenous Policy Journal,* vol. 2, no. 1, Spring 2011, 1-13.

[11] Proximate determinants are those controlled at the individual level and intermediate are those organized and maintained at the community level.

[12] The impact of colonialism should not be viewed as monotonic as they vary in accordance with changing actors and their policies.

[13] Muhammad Umair Mushtaq, "Public Health in British India: A Brief Account of the History of Medical Services and Disease Prevention in Colonial India," *Indian Journal of Community Medicine,* vol. 34, no. 1, Winter 2009, 6; It is also possible for colonial powers to have benevolent imperialistic agendas, see Simone Azopardi, *Imperial Policy in Malta, 1934-1939: Britain's Need for Benevolent Despotism (*Master of Studies in Global and Imperial History thesis), 2012, 1-80.

commissions[14] to inquire into matters related to health and the sanitary infra-structure[15]; (2) the establishment of hospitals and other institutions for the care and cure of the sick; (3) the implementation of sanitary and scavenging services; (4) the production of annual health reports[16] that provide accurate counts of sickness and deaths as well as identifying health problems that warrant attention; (5) the regulation of vaccination procedures; (6) the creation of legislation[17] to monitor, control and police a wide array of health related issues[18]; and last, (7) the broad-based educational reform partnered with selected propaganda that encourages people to adopt practices which support the wellbeing of the individual, the family and society.

The British authorities efforts to manage and control the spread of undulant fever in the British colonies, is one such example of colonial efforts to improve the health of the native population. This paper explores the question, why did the undulant fever experiences of Malta and Gibraltar differ drastically despite a known etiology? Through an exploration of how the disease was modified during a complex process that involved colonial action taken on cultural milk practices[19] and the scale effect's impact on the creation, implementation, and enforcement of health policy, we argue that Gibraltar's experience with the disease was distinct from that of Malta. The difference is attributable to Gibraltar's having: (1) a culturally entrenched tradition of goat-herding, but not an exclusive tradition of consuming raw goats' milk; (2) effective health-directed policies regarding herding and milk consumption; and (3) greater enforcement of policies and higher levels of group compliancy.

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[14] These were commissioned by the colonial Home Office to safeguard their troops with the implicit recognition that health of the military was inseparable from that of the civilian community (e.g., John Sutherland, 1866, The Sanitary Commission). Here the focus could be on the disease etiology and transmission, the sanitary infrastructure and related matters.

[15] disease causation and control, the current state of sanitary conditions and issues of household security of food, housing and water

[16] Such as the Medical Officer's Annual Health Reports, Hospital Returns, and the Surgeon Reports

[17] Through ordinances and byelaws

[18] Such as housing regulation, milk byelaws

[19] Undulant fever is caused by a bacteria, in this chapter focuses on cases caused by the strain B. melitensis, which is the most virulent strain and is commonly found in goat's milk. Although goats are asymptomatic when infected, humans can experience can array of symptoms from drinking affect milk. These include: extreme pain and, 'undulating fevers,' bone and joint complications (40% of cases), chills and weakness, insomnia, headaches, malaise, and weight loss, constipation, nervousness and depression, and sexual impotence.

2.3 Gibraltar: A small-scale society

Gibraltar is an unusually rich ground for studying the interrelationships of colonialism, scale and culture in the development of its medical and sanitary history. Located at the western end of the Mediterranean,[20] Gibraltar's physical setting and the periodic socio-political isolation from Spain have imposed constraints upon spatial and demographic development of its population. As a British colony,[21] Gibraltar has long been regarded by 'outsiders' as a British stronghold[22] governed by a purely military administration.[23] Politically, Gibraltar is also referred to as a continental enclave.[24] As a British colony situated within a fortified garrison post,[25] the civilian population can be regarded as a small-scale community where day-to-day, face to face contact is the norm.[26] We define the scale effect as a multifaceted construct that embodies the demographic properties of size, density and dispersion together with its impact on the social determinants of

[20] It is attached to the southern tip of Andalusian Spain by a flat sandy strip of land 10 feet above sea level. Running nearly due north and south, Gibraltar is 3.2 miles in length, its greatest breadth of 1 mile, and circumference about seven miles. The entire territory covers approximately 1,266 acres or about 3.6 square miles.

[21] While the term colony is used throughout this work, it is important to recognize that there is no unifying definition of what constitutes a colony nor can one make general statements about colonialism. For a recent and thorough discussion on this subject see Robert Aldrich and John Connell, *The Last Colonies* (Cambridge University Press, Cambridge), 1998. It is important to not oversimplify this relationship as the words 'colony' and 'colonized peoples' are often laden with 'specific and emotionally heated connotations.' The 'colony' is often described in the 'rather simplistic vernacular understanding of as distant outpost lorded over by white foreigners who deprive local inhabitants of self-government and extract immense riches for their own profit'(Aldrich and Connell, 3). While Gibraltar exhibits 'the indelible imprint of a colonial past' with the lack of political sovereignty, it does not display other traces of colonialism such as the economic fragility and social cleavages produced by disparities among resident ethnic groups.

[22] Unlike other British colonies in Africa, the Far East and the New World, Gibraltar was known primarily for its strategic location and a place for the seasoning of its troops.

[23] Of the more than two hundred pages devoted to a description of the various Colonies of Great Britain in 1887, Gibraltar received less one page of note; C. S. Salmon, *The Crown Colonies of Great Britain,* 1887.

[24] Aldrich and Connell, 1998.

[25]While much has been written of Gibraltar's military history, there is an unfortunate paucity of information on the history and development of the Rock's civilian inhabitants. Two factors contributing to this lack of interest are: Gibraltar's internal affairs were relatively unimportant compared with its external affairs and second, the colony was never larger than a small market town and its topography made a great increase in population size impossible. See Lawrence A. Sawchuk, *Deadly Visitations in a Dark Time: A Social History of Gibraltar*, 2001, 22-27, for more information on the history of the military in Gibraltar.

[26] Paternalism and patronage were essential tools for the colonial system and, no doubt, operated in Gibraltar. Gibraltar's vast defence works and admiralty dockyards required a large labour force which the colonial officials were able to exploit and control.

health. Gibraltar has an area of 6.5 square km and a fortress, whereas Malta has an area of 316 square km, several thousand people and numerous military bases located in various towns throughout the Maltese islands. Gibraltar's health care needs are thus more easily dealt with than those of the larger colonies with scattered populations.'[27] For example, large-scale populations have inherent logistical problems in creating, delivering and maintaining primary health determinants such as the public sanitary system, the water supply, the scavenging system along with monitoring issues of housing, and overcrowding. Scale effects can also impinge on ease of communication among widely dispersed localities. For example, scaling up the system reduces day-to-day, face-to-face interactions. As such, it figures in 'the mental map' that community members construct for themselves and influences the degree of solidarity and the strength of the traditions they foster. The dissemination of information relevant to health is markedly more difficult in scaled-up populations, particularly in our study period.

2.3.1 Gibraltarians under Colonialism and Military Rule

Unlike other British possessions settled by colonists, the administration considered Gibraltarians:

> not colonists in the true sense of that word. They are substantially part of the garrison that is both British subjects permitted to reside for the purpose of supplying the rest of the Garrison with such necessary provisions and as such are imported from a distance and their employee's domestic servants, camp followers and civil officers.[28]

During the repopulation of Gibraltar after the yellow fever of 1804, colonial officials regarded the manageability or tractability of settlers as the primary factor of settlement in the garrison town. Any opposition to government policy by civilians was viewed strictly in negative terms as 'refractory,' 'insolent,' 'troublesome,' or 'demanding.' To control population growth, initiatives restricted where civilian housing could be located, set stringent limits on the height of buildings and featured direct competition for scarce resources such as housing and water supplies. Free

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[27] Gibraltar Police Archives, *Governor Duddurk Letter to J. Chamberlain*, 1896; See Sawchuk "Deconstructing Colonial Health Differentials: Malta and Gibraltar prior to World War II," in this volume.

[28] Government of Gibraltar Archives, *CO 91/309, Solly Flood to R.S. Baynes, 25th June,* 1870; Henry William Howes, "The Gibraltarian," in *The origin and development of the population of Gibraltar from 1704*, 1950, 189.

movement of the civilians was simply not possible in a garrison town where every movement was carefully monitored by the police and district inspectors. Even the right to be outside at night was regulated by special passes. The subordinate position of the indigenous population and the preferential treatment of 'outsiders' from the British Empire in terms of position, housing, wages and mobility reinforced the process of marginalization among the civilian community. Improvements to local health and sanitary infrastructure typically became a priority only when it became apparent that there could be direct benefits for the garrisoned military forces.[29]

2.4 Early Sanitary Reform in Gibraltar and Malta

While the great epidemics[30] of the early 19th century had a profound impact on death rates, they did not produce substantial initiatives either in sanitary thinking or in understanding disease causation. The first step in sanitary reform came after the Barrack and Hospital Commission of 1862.[31] Led by Dr. John Sutherland and Captain Douglas Galton, an examination into the state of hospitals, the barracks, and the sanitary conditions of civilian dwellings in their immediate vicinity, resulted in an important finding: the principle of inseparability in which the welfare of troops and colonial administrators were linked to the health of the civilian population. On June 16th 1865, another cholera epidemic broke out bringing with it excessive illness and death.[32] Two months after the last case of cholera, a newly constituted body responsible for watching over local health matters came into office on 1st January 1866: Gibraltar's Sanitary Commission. The Commission consisted of five officials and twelve local members. While the governor played a role in selecting the laymen on the committee, this was the first time that members of the civilian population had a direct role or 'voice' in running affairs related to sanitation and

[29] In the absence of an open and free press in Gibraltar, there was little opportunity to criticize colonial officials and their policies.
[30] Epidemics of yellow fever (Gibraltar 1804, 1813/14 and 1828), plague (Malta 1813) and cholera (Gibraltar, 1834; Malta,1837)
[31] No doubt stimulated by an outbreak of cholera in 1860
[32] There was also an outbreak in Malta in June of 1865, see John Sutherland, 1866 for more details.

health matters. In addition to a number of personnel designated as health inspectors, the local police force assisted the Commissioners in their various duties.

The newly formed administrative health body coincided with a shift in attitude towards sanitation and public health in England, and some medical men were pointing at the Army's neglect of the soldiers and civilians, a combination which precipitated an 'era of reform.'[33] The Home Office realized that the cost of caring for afflicted soldiers and training new recruits to replace the dead was far greater than the cost of sanitary and health-promoting measures.[34] Concerns held by the War and Colonial Office translated into the principle of inseparability where the welfare of its troops and colonial administrators were linked to the health of the civilian population.

Notwithstanding the change in attitude, colonial officials still had misgivings over the state of sanitation of the garrison near the end of the 19th century. In a confidential memorandum to Governor Harding, the Attorney General voiced concern for the 'garrison of 5000 in the midst of a densely crowded and naturally uncleanly civil population of over 18,000, liable at any moment to become, on the outbreak of an epidemic, a source of extreme danger to the Garrison, which cannot in any way be effectively segregated from the civil community.' [35] Fresh stimulus to amend Gibraltar's sanitary predicament arrived with the publication of the Tulloch report on the 15th of May 1890. While Tulloch remarked extensively on the 'existing evils' in Gibraltar, he was clearly dismayed because, '… it will scarcely be believed that, up to the present and during the long existence of the Commission, only one solitary bye-law has been passed, and that one has reference to cases of infectious diseases in common lodging houses…'[36]. Accordingly, he

[33] Sir Neil Cantlie, *A History of the Army Medical department, vol. 2,* (Churchill Livingstone, Edinburgh and London). 1974; For more information on the history of sanitary reform in Gibraltar see, Sawchuk, 165-173, 282-290.
[34] Sumit Guha, "Nutrition, Sanitation, Hygiene, and the Likelihood of Death: The British Army in India c. 1870-1920," *Population Studies*, vol. 47, no. 3, Fall 1993, 389.
[35] Gibraltar Government Archives, *Henry J. Burford Hancock to Sir. A. Harding, 24th November,* 1887.
[36] Major Hector Tullock, *Report on the Water Supply and Sewage System of Gibraltar,* (Waterlow and Sons Limited, Printers, London Wall, London), 1890. The spelling of 'bye-law' is as in the source.

recommended the immediate introduction of legislation embodying a comprehensive code of byelaws that recognized that both military and civilians alike would benefit. [37]

2.4.1 The Mediterranean Fever Commission

The health of the garrison forces in the Mediterranean improved once again when the Secretary of State for the Colonies proposed to the Admiralty and the War Department the appointment of a Joint Commission to investigate cases of Mediterranean Fever.[38] Created to represent the Navy, Army and the Malta Government, a sub-committee of the Tropical Diseases Committee of the Royal Society was formed in 1904. [39] Arguably, the stimulus for this inquiry was fueled by concern for the health of garrison forces and only indirectly for its civilian inhabitants. The foundation of this inquiry was grounded in economics rather than concern over human suffering and sickness. [40]

The primary objective of the Commission for the Investigation of Mediterranean Fever was to eradicate the disease from the garrison personnel: the military and the navy. The concern among the Military officials in Malta was a valid one, considering the incidence of the fever reached an alarming rate of 25.6 cases per 1000 per year among the garrison. The navy was as acutely interested as the military. Because of its prolonged course and high invaliding rate, undulant fever was undermining the strength of the 25,000 soldiers and sailors in Malta. In fact, in 1891, calculations showed that, on account of undulant fever alone, the Malta garrison was costing the

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[37] Major Hector Tullock. *Correspondence respecting the Amendment of the Gibraltar Sanitary Order in Council to Crown Agents (*Presented to both Houses of Parliament by Command of Her Majesty in May1892), (Eyre & Spottiswoode, London) 1892, 2.

[38] The first part of the reports was published in March 1905, followed by the second part a few months later. This sophisticated set of recommendations, if followed and enforced, would have effectively rid the population in Malta of undulant fever.

[39] Under the chairman Colonel David Bruce, a number of members were appointed to the sub-committee: Major William Heaton Horrocks, Staff-Surgeon E.A. Shaw; and Dr. Themistocles Zammit, Government analyst Malta. Later Dr. Ralph W. Johnsone joined and acted as epidemiologist. Captain James Crawford Kennedy and Staff Surgeon Gilmour, joined towards the end of the year during their spare time; *Malta Colonial Report,* 1904*,* 47*.*

[40] As has been demonstrated in Gibraltar, the vector of colonial health-work was not always routed purely from what Anderson has termed a "centre" to a "periphery", but was rather strongly influenced by military concerns; Warwick Anderson, "Where is the Postcolonial History of Medicine?" *Bulletin History of Medicine*, vol.72, no. 3 1998, 524.

state an expense equal to that of a whole regiment: one thousand strong in hospital for twenty five days.[41] While the Commission made numerous recommendations that were effective prophylactic measures against the disease, they were, simply put, recommendations. [42] There was no means by which these recommendations could assume legislative status that would result in the mandatory control of undulant fever.

2.5 Overview of Undulant fever experience in both Colonies

Undulant fever is a disease of some singularity, because the discovery of the goat as the vector of *B. melitensis* is considered one of the greatest advances in epidemiology.[43] Known primarily for its debilitating consequences rather than a high mortality rate, brucellosis[44] has the potential to create significant economic consequences for the individual, family and community. This fact was not lost on the Maltese health authorities who noted:

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[41] Paul Cassar, The Pattern of disease in Malta, in *Medical History of Malta*, ed. F. N. L. Poynter (William Clowes and Sons Ltd., London and Beccles), 1964, 242.

[42] The report of the Commission in 1907 provided "Recommendations for the Prevention of Mediterranean Fever," which included an elaborate set of recommendations that detailed an economically viable system that would balance costs and profits associated with the process of managing the disease, especially in the goat. These steps included: mandatory disease notification; control of goat travel both within the colony and to and from other locations; education on disinfection of goat sheds, infected human excrement, and on the practice of boiling milk; provision of condensed/tinned milk to the garrison, where consumption of raw milk was prohibited, and to the civil hospital; regular bi-weekly testing of goats at special laboratories; a system of segregation and slaughter of infected goats where goat meat was sold; and the selective breeding of valuable animals or good milkers so yearlings could be sold to defer costs and compensate goat herders for their lost revenue. It was also suggested that a new Ordinance, 'Infectious Diseases (Mediterranean Fever) Ordinance of 1907,' should be introduced for the purpose of stamping out Mediterranean Fever from the goats of the Maltese Islands.' There are no records, however, to indicate that such a law was ever created; Dr. Eyre, Major McNaught, Capt. James Crawford Kennedy and Dr. Zammit,"Bacteriological and Experimental Investigation, 1906", in *The Reports for the Investigation into Mediterranean Fever Commission Report*, 1907, part VI, 136-137; Major McCulloch, Major Weir and, Staff-surgeon Clayton, "Epidemiological work in 1906," in *The Reports for the Investigation into Mediterranean Fever Commission Report*, 1907, part VII, 260-261.

[43] H. Vivian Wyatt, "How Themistocles Zammit found Undulant fever (brucellosis) to be transmitted by the milk of goats*," Journal of the Royal Society of Medicine,* vol. 98, no. 10, Fall, 2005, 451; Brucellosis is both a disease of great antiquity as well as a newly emerging zoonotic disease. Here zoonotic disease is defined as an infectious disease that can be transmitted between humans and wild and domestic animals, J. Singenbergh, M. Gilbert, K. de Balogh, and W. Wint, "Ecological Sources of Zoonotic Disease," *Journal of Review of Scientific and Technical Off. International Epizoonotics*, vol. 23, no. 2, 2004, 467; With respect to undulant fever, the goat is typically the natural reservoir and the vector that passes the micrococcus to humans via its milk.

[44] Also colloquially referred to as Malta fever, Gibraltar fever, Rock fever, or Mediterranean Fever because of its associated presence or origins in these two locations and the Mediterranean in general

> The large yearly expenditure for the hospitalization and care of the sick, with which the Government is faced every year, and the financial loss in wages through the illness and the more or less protracted disablement and consequent distress, would be materially reduced if the Government were to undertake the pasteurization of milk and make pasteurized milk easily obtainable at a cost that would compete with raw milk.[45]

Today, it remains a disease of marked geographic diversity found predominantly in areas with similar agricultural environs along the coast of the Mediterranean where a 'poverty of the grazing land'[46] gives scant opportunity for cattle breeding, but favours the breeding of small ruminants such as goats.

To set out the conditions necessary for undulant fever to achieve epidemic or endemic status, we set forth three domains that represent the epidemiological triad: agent, environment, and host (**Figure 2-1**). As most cases of *M. melitensis* are contracted primarily from consumption of unpasteurized dairy products, and to a lesser extent a results of close contact with infected animals, we assume all cases were foodborne or zoonotic in nature, rather than rare person-to-person transmission (Seleem, Boyle, & Sriranganathan, 2010). Framed within the epidemiological triad, we will show how brucellosis was expressed differently in the two sister British colonies. Effective colonial actions in Gibraltar significantly altered the interaction of the conditions for the chain of infection and interrupted the process of transmission of undulant fever from the agent to the host through environmental conditions.

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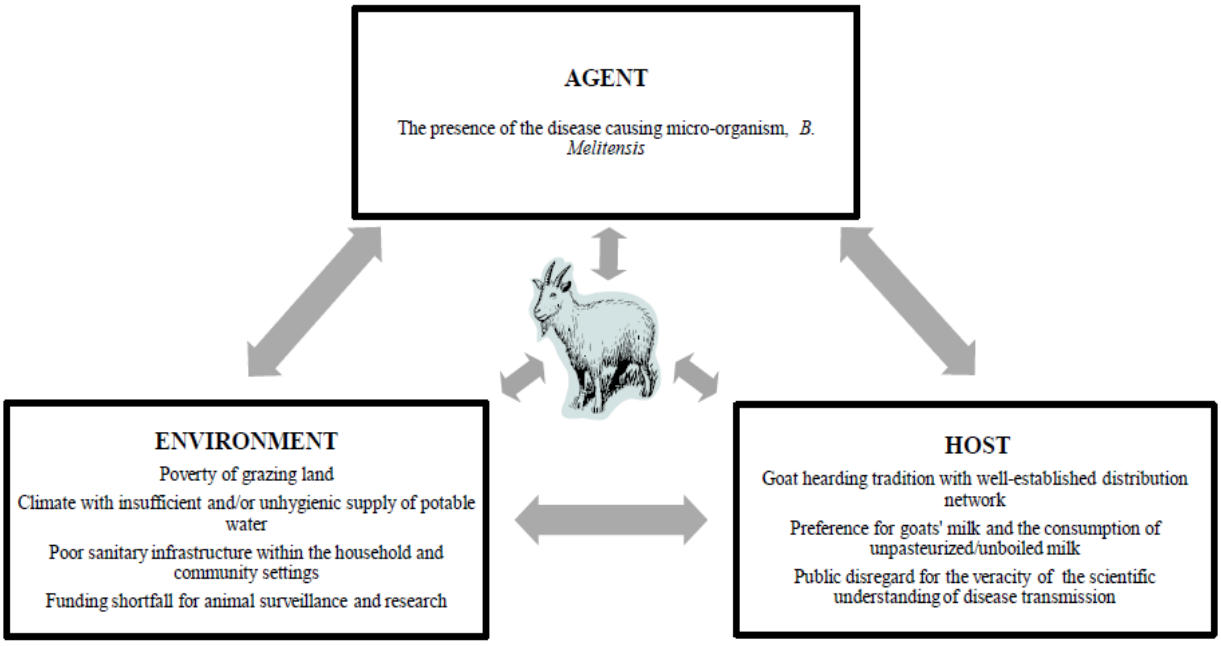
[45] National Archives Malta, *Annual Report on the Health of the Maltese Islands during 1931-32*, 1932, T6.
[46] M Monir Madkour, "Epidemiological Aspects," in *Madkour's Brucellosis 2nd Edition*, ed. M. M. Madkour (Springer, Berlin), 2001, 24.

Figure 2-1. Epidemiological Triad for Undulant Fever



Before we consider any chronicles of the history of undulant fever at the population level, it is important to address complications that arise from misdiagnosis, classification issues and under-reporting. Throughout most of the 19th century, undulant fever remained poorly documented.[47] After the discovery of the micrococcus by Bruce in 1887, our understanding of the disease and its prevalence was much improved. The low prevalence of undulant fever in Gibraltar in the latter part of the 19th century stemmed, in all likelihood, from the diversity of terms used to name undulant fever. For example, Hughes identified 46 terms used to refer to what he aptly coined as

[47] In Gibraltar the Medical Health Authorities used 'Mediterranean Fever' and by at least 1927, they had adopted the name undulant fever. It was later changed to Brucellosis in the late 1960s. The term Brucellosis was adopted beginning in the 1920s in Malta (Cassar, 247).

'undulant fever' in 1896.[48] Similarly, various synonyms were used in the Malta Health Reports: Remittent fever (1897 and 1902-1903), Continued Fever (1897, 1906-1908), Febricula (1898, 1906-1907) and Undulant fever (appearing for the first time in 1912-1913).[49] 'Remittent fever,' at one point was used in the Official Returns of the Royal Navy and Civil Government of Malta, but 'was not used much except in connection with cases of fever developing

in regiments which had recently arrived from stations where malaria was prevalent.'[50] Some terms were used so loosely that they could refer to any one of many fevers. The most notable of these was 'Simple Continued fever,' an umbrella term that covered 'febrile attacks of short character as well as cases of prolonged fever attended by marked anemia and complicated by rheumatism. 'Malta Fever,' 'Rock Fever' and 'Gibraltar Fever' were the three most commonly used terms just before the turn of the century.[51]

Compounding the problem of prevalence estimation were the issues of misdiagnosis, confusion over the etiology, and intentional failure by civilian doctors to report cases. In 1909, Fowler noted that underreporting may have been an issue of confusion with other diseases such as influenza or even Phlebotomus fever.[52] Even in 1910, the Medical Surgeon of Health, Dr. Parsons was not convinced that the only mode of infection for undulant fever was from drinking goats' milk, but felt that '*the virus*' could be acquired from the sand fly.[53] Doctors also found it difficult to collect blood samples for testing and confirmation of diagnosis, since many patients, especially the 'uneducated,' were not compliant.[54] A significant complication was that civilian doctors, who faced strong competition for patients in a location with a limited clientele, needed

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[48] Matthew Louis Hughes, "Undulant (Malta) Fever," *The Lancet*, Summer 1896, vol. No., 238-239.
[49] John William Watson Stephens, "Undulant Fever in the Naval, Military and Civilian Populations of Malta," *Annals of Tropical Medicine and Parasitology*, Winter 1922, vol. 16, 11-17.
[50] William Heaton Horrocks, "Mediterranean Fever in Gibraltar," Commission for the Investigation of Mediterranean Fever, part 5, Winter 1907, 54; Horrocks was the Medical Officer of Health in Gibraltar from 1904 until 1908.
[51] Sir Weldon Dalrymple-Champneys, Man. in *Brucella infection and undulant fever in man* (Oxford University Press, London), 1960, 11.
[52] C. E. P. Fowler, Mediterranean Fever in Gibraltar in 1909, *Journal of the Royal Army Medical Corps.*, vol.15, 1910, 55-58.
[53] L. E. Parsons, "Surgeons Report for the Colonial Hospital for the year 1910," *GGA*, 1911, 16-17.
[54] Similarly; Major McCulloch, Major Weir and, Staff-surgeon Clayton, *The Reports for the Investigation into Mediterranean Fever Commission Report*, 1907, part VII, 257, reported that less than 25% of suspected cases of undulant fever were confirmed with blood tests.

to maintain a good rapport with their patients. They were keenly aware of the stigma under which those of a lower class would suffer if they were diagnosed with a notifiable and infectious disease. Consider the fact that 'the patient and house are marked, and liable to visitations by the servant of the sanitary authorities, of whom people of this class are always in some dread.'[55] As stated by Fowler, it was no wonder that doctors' 'conscience became dull' and that they turned a blind eye to cases of undulant fever.

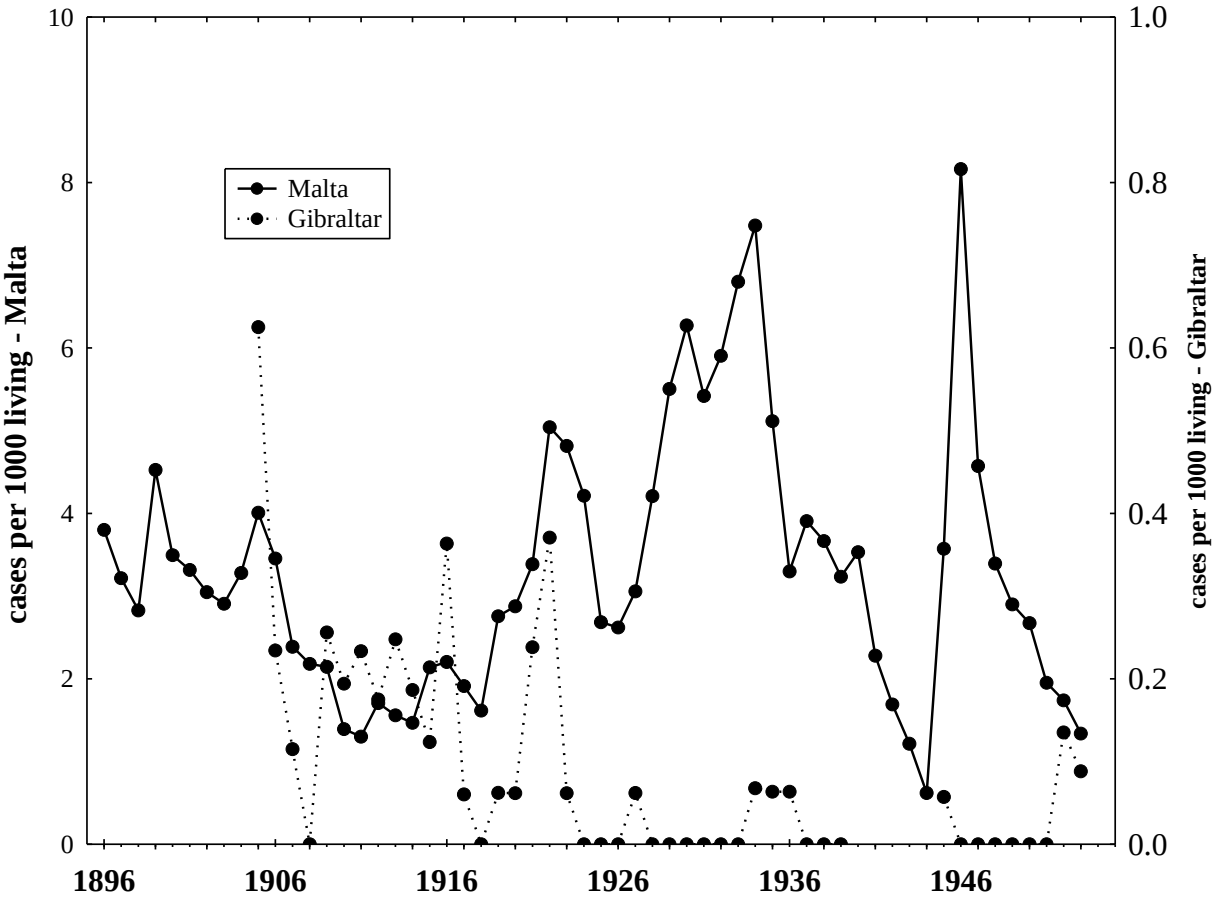
Historically, the epidemic experience of Gibraltar and Malta represents two distinct patterns that underlie the inherent complexity of undulant fever etiology. In Gibraltar, undulant fever was typically mild and sporadic in nature, found predominantly among the troops, whereas in the sister colony of Malta, undulant fever was endemic, interspersed with mild to severe epidemics until milk pasteurizations became compulsory in 1957 (see

[55] Fowler,1910, 57.

Figure 2-2).[56]

Figure 2-2. Cases of Undulant Fever in Gibraltar and Malta from 1896-1952

[56]Cases were counts of illness taken from the annual health reports. From 1904 to at least 1906, doctors made an effort to confirm cases by testing blood samples of cases, however less than a quarter of cases were tested. Thus, cases as reported in the health reports were primarily identified/confirmed by medical doctors based on the presence of symptoms."



*Note that the Y2 (Gibraltar) scale is 1/10 that of Y1 (Malta) scale

2.5.1 Gibraltar: the Civilian Community

The first description of what might be plausibly considered undulant fever in the civilian population dates back to 1879 from the Public Health Report.[57] It draws attention to the nature and scope of the disease, and possible causes, as pointed out by the Medical Officer, Stokes:

> in every month of the year and in every part of the central and southern districts there were cases of remittant catarrhal fever. ... Some public alarm was caused by the knowledge of the presence of so many cases of fever, and it was generally rumoured that there had never been so much fever in the city. .... The disease was not of a severe

[57] The first formal accounts of undulant fever date back to 1878 in the Army Medical report.[57]

> character and therefore not reported to the sanitary commissioners by the medical attendants. It lasted from seven to ten days, left patients very weak, but they soon recovered under the use of tonics, or change of air, they were subject to relapses.' ... The number of deaths from fever was large (25) exceeding the average of the last few years. Every case of the fever that was reported was visited and placed under sanitary inspection.

As to causation, Stokes remarked:

> The disease appeared to be quite independent of atmospheric changes, prevailing in all winds, and in different degrees of temperature. An ailment which was so general and so constant must have had its origin in some malarious source. In the majority of cases a nuisance or cause was found in the dwelling, or near it, which probably had given rise to the disease; viz: an untrapped or defective drain which permitted a free influx of sewage gas into the dwelling, day and night. This subtle poison does not effect all alike. The weak and depressed or those exhausted by bodily fatigue are most liable to be affected by it. The poison enters the system slowly, accumulates and multiplies itself, or ferments, till the patient is at last thrown on his back to undergo a long and dangerous illness. Patents who could be removed from this impure atmosphere in which they were living quickly recovered.'

Specific reference to undulant fever was made in 1883 in a report by Dr. Turner, the surgeon of the Colonial Hospital. Reflecting on Turner's report, Horrocks noted that, in 1883, civilians suffered from outbreaks of a fever which were not enteric fever and had a very low death rate. We quote Dr. Turner in reporting that during 1882 to 1883, many of the approximately 785 cases of fever, 'Rheumatism is undoubtedly present in varying degrees of intensity in a large proportion of the cases.'[58] It was not until the micrococcus was discovered by Bruce in 1887 and with the advent of serum diagnosis in 1897 that cases of Mediterranean fever were confirmed and recorded in the Annual Health Reports.

The first unambiguous reference to 'Mediterranean fever' was made in 1904. The Medical Officer of Health reports that there were two deaths[59] from Mediterranean fever, but he regretfully acknowledges that 'we have no idea how many cases occurred in the town.' At this

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[58] Horrocks, 1907, 54.

[59] one male 35-44 years old and one male between 45-54 years of age.

time, there was considerable disagreement as to the source of the disease: some suggested that the mosquito might be a vector and others, referring to the research conducted in Malta, implied that 'dry infected dust is the probable cause of this disease.'[60] By 1910, Medical Health Authorities knew full well that goats' milk was the main source of infection. Horrocks, reported that it was probable that each year would return a few cases of this particular fever as the goats continued to show 10 to 15% of their number yielding a reaction with the Malta Fever organism. 'Unless milk is pasteurized or boiled there may therefore be danger of imbibing a dose of the offending germs.'[61]

Over the 50 year study period, the morbidity pattern of brucellosis in Gibraltar is remarkably stable, typically presenting less than a handful of cases. Most of these originated from drinking milk in Spain or from milk sold to Gibraltarians by Spanish milk vendors. Lesser numbers were caused by milk from imported Maltese goats, and fewer cases still were contracted among travelers abroad (e.g. to Malta and South America).[62]The only exceptions to this pattern occurred in 1916, 1922, 1923 and 1962. In 1916 and 1922, six cases of undulant fever occurred. The origins of the infections in 1916 were traced back to Spain; in 1922, the source of the infection was unknown since sampled milk entering Gibraltar tested negative for the micrococcus. In 1923, there were twelve cases, for none of which was it possible to trace the source of infection. The year 1962, when 15 cases of undulant were reported, was atypical. No mention is made about the origin of the infections; however, taking into account the evidence of the years preceding and following 1962, we suspect that the disease probably originated in Spain from consumption of fresh cheese.

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[60] William Heaton Horrocks, *Annual Report on the Public Health of Gibraltar for the year 1904,* 1905, 6.

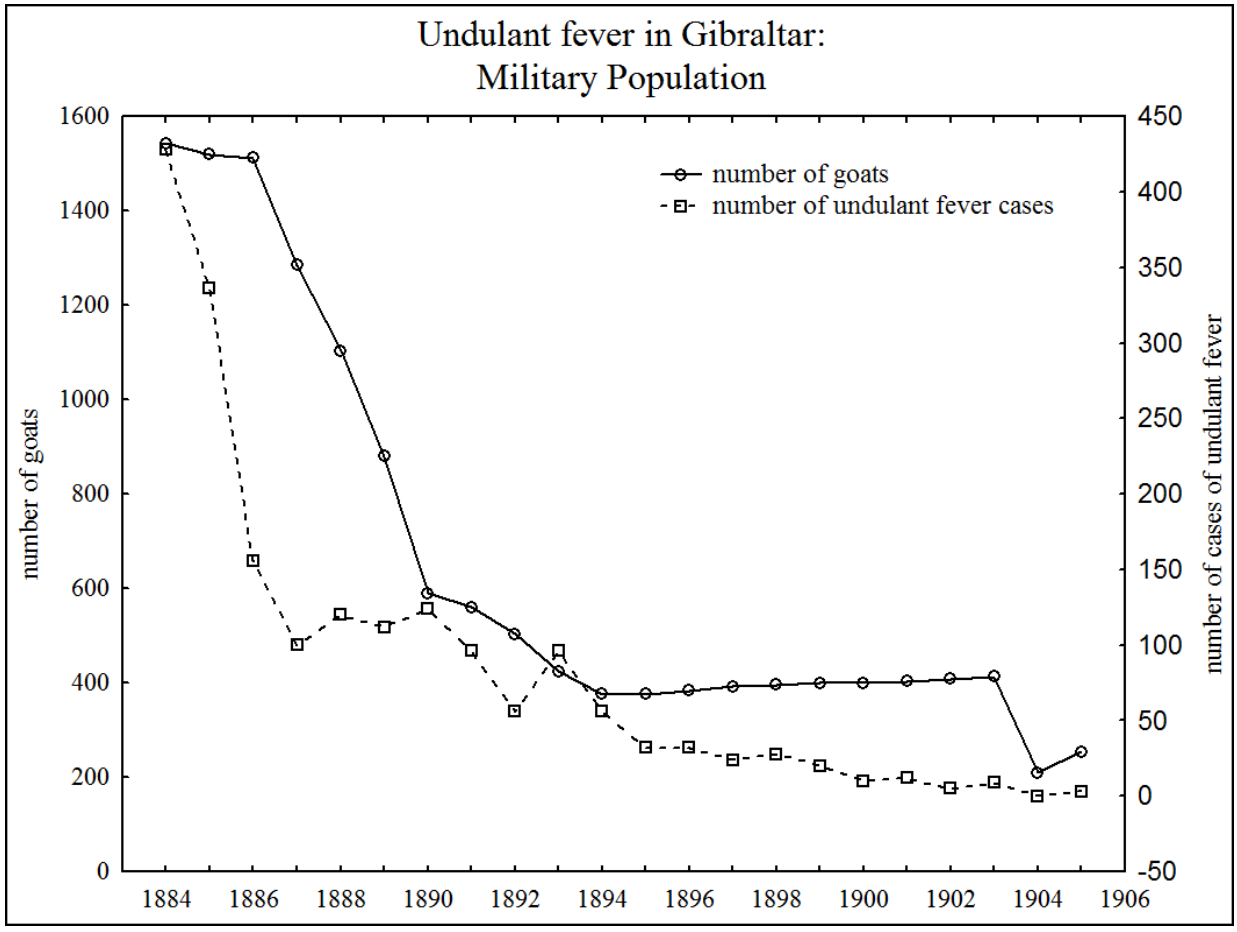
[61] C. E. P. Fowler, *Annual Report on the Public Health of Gibraltar for the year 1909*, 1910 8.

[62] Because of War World II, the government of Gibraltar did not publish annual health reports from 1940-1944. 1967 is the last year for which we could access the public Health Reports

2.5.2 Undulant Fever among the Military

The first mention of Mediterranean fever among the troops comes from the 1878 Medical Department Report, and by 1880, 194 cases of undulant fever were reported. The first systematic empirical accounts begin in 1884 when Admission and Discharge books became available. As we can see from Figure 2-3, undulant fever appears to have peaked in 1884 with approximately 428 cases and continued to fall until no cases were reported in 1908. There was, however, a resurgence of the disease, a cluster of 14 cases in 1909.

Figure 2-3. The number of goats and cases of Undulant Fever in the Military Population of Gibraltar



Our final observation notes the discovery made by Horrocks[63] on June 23rd 1906 which linked the number of goats to the number of cases of Mediterranean fever.[64] In Gibraltar, undulant fever among the military was (1) never as severe as that in Malta and (2) fell to insignificant numbers after the 1909 epidemic.

2.5.3 Malta

As

[63] It should be noted that Dr. T. Zammit had already discovered that goats were the reservoir for *B. melitensis* as early as 1904, and, as a fellow member of the Mediterranean Fever Commission (MFC), Horrocks was well aware of this discovery. He was Zammit's supervisor at the time and tried to take credit for Zammit's discovery; see Wyatt, 453.

[64] As important as this observation was, it must be recognized that the actual number of goats as the predictor for undulant cases may not be the significant factor, as the cases of undulant fever began to decline before the number of goats. In addition, in 1909 when goat numbers were much lower than in the previous years, an outbreak of undulant fever occurred because of four infected goats imported from Malta.

Figure 2-2 illustrates, the experience of undulant fever in Malta stands in sharp contrast to that of Gibraltar. The rates were at least ten times higher than those experienced in Gibraltar, and significantly, undulant fever in Malta was endemic to the islands. The history of undulant fever in Maltese Islands is well documented, and the reader here is advised to consult numerous authorities that address such issues as the history of discovery, epidemiology, prevalence figures, health policies and initiatives. Our examination is focused on using the Maltese experience as a foil against which undulant fever in Gibraltar can be more clearly understood.

Three points of interest, nonetheless, warrant repeating here. First is the fact that among the civilian population, the occurrence of undulant fever remained high as opposed to the experience of the military community in 1906. As a case in point, the average number of cases from 1899 to 1905 among the Navy was 240. Still, there were temporary periods of respite; in 1906, there were only 105 cases of undulant fever in the Navy.[65] The reduction was the direct result of the 1906 Mediterranean Commission measure that forbade Navy and Military officers to consume goats' milk but supplied them with condensed or tinned milk. A similar reduction in the number of cases was observed among the troops in 1906. The intervention by military authorities represents a classic illustration of how removing the source of infectious disease can break the chain of infection. The second feature, unusual for Malta, was a noticeable decline in undulant fever cases after the opening of the pasteurization centre in 1938 and in the period from the beginning of World War II until 1946. This first significant decline observed in Malta was due to the simple fact that food sources for goats were difficult to find, and many goats were sacrificed to feed a population also in dire need of sustenance.[66] A third remarkable feature to note when

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[65] Major D. J. Vassallo, "The Corps Disease: Brucellosis and Its Historical Association with the Royal Army Medical Corps," *Journal of the Royal Army Medical Corps*, vol.138, no.3, Fall 1992, 143; J. W. H. Eyre and M. S. Durh, "The Incidence of Mediterranean Fever in Malta and its relationship to the size of the goat population," The Lancet, vol. 179, no. 4611, Winter, 1912, 88.

[66] Cassar, 246; S. Busuttil, "Agriculture in Malta: A historical note," in *Options Méditerranéennes: Série B. Etudes et Recherches no. 7, Malta: Food, agriculture, fisheries and the environment,* ed. S. Busuttil, F. Lerin, and L. Mizzi, (CIHEAM- IAMM, Montpellier), 1993, 21.

tracking the case prevalence of undulant fever in Malta is the dramatic, but short-lived, increase in 1946, 1947 and 1948. After this spike, the number of cases continued to decline well into the 21st century.[67]

2.6 Goat-herding in Gibraltar and the Malta Nexus

The presence of domestic goats on the Rock dates back to at least 1827. Andrew Bigelow, traveler[68] to the Mediterranean region, noted that there was a limited, but nonetheless important, local supply of milk derived from goats grazing on the upper portions of the mountain. While the goats were owned by separate families, they milled together in one herd. At sunrise, 'two of three goatherds set forth to collect them, beginning at one end of the town and proceeding through the principal streets, to issue at the opposite gates…They seem to have instinctively come under the military discipline that reigns throughout the garrison.' Much like the civilians of Gibraltar, the lives of the goats appeared to be regulated according to the demands of the fortress. After milking, the seemingly intelligent and docile creatures were left to their own devices, and just before gun-fire, 'they form themselves again in battalion' and, ostensibly unaware of their surroundings, they would march back home. Bigelow remarks on the comical scene 'of a motley herd' entering through the grand gates, 'whimsical enough especially in contrast with the objects around.'

Gibraltar's Officer of Health, John Hennen,[69] adds to Bigelow's account affirming the practical need of goats' milk as local source of food to the garrison particularly during periods of hostility between Spain and Gibraltar when the free exchange of food stuffs between the two locals would be interrupted. A similar conviction was expressed fifty years later when E. B. Ewart of Royal

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[67] For more information on the Maltese civilian experience: H. Vivian Wyatt, "Brucellosis and Maltese goats in the Mediterranean", *Journal of Maltese History,* vol. 1, no. 2, Fall 2009, 10-13.

[68] Andrew Bigelow, "Chapter III: Gibraltar -Animal Sagacity," in *Travels in Malta and Sicily with Sketches of Gibraltar in 1827* (Carter Hendee and Babcock, Boston), 1831, 76-77.

[69] John Hennen, "A Sketch of a Plan for Memoirs on medical topography," in *Sketches on the medical topography of the Mediterranean comprising an account of Gibraltar, the Ionian Islands and Malta,* (Thomas and George Underwood, Fleet Street, London), 1830, 56.

Engineers wrote to the Inspector General of Fortification, stating that goats were a welcome commodity in Gibraltar '...in order that the inhabitants both military and civilians may reap the benefit of a cheap and abundant supply of milk.'[70] He also reiterated the need for 'proper regulation' of the whereabouts and number of goats on the Rock; goats were allowed to graze on the upper portions of the western side of the Rock only if passes were granted to the goat keepers by the royal engineers.

The Maltese goat-herder emerged as a milk supplier around 1834 when the census of that year shows that the population of Maltese on the Rock was less than 1% of the approximate 15000 civilians. While the Maltese had opportunistically filled the labour void[71] as coal heavers, they came to dominate the milk trade in Gibraltar. The tradition of goat-herding, the Maltese goat's reputation as a high yielding[72] producer of good quality milk, the fact that the Maltese were part of the British Empire, and 'the poverty of grazing' on the Rock reinforced the status of the Maltese goat as a reliable and convenient food supply as opposed to milk from Spanish goats or pasture-hungry cows. From a mere handful of individuals, the Maltese presence on the Rock grew to 171 strong by 1868. Like many migrant groups, the Maltese community was predominantly male,[73] the majority of them being aged 15 to 44 (see **Figure 2-4**).

For example, in 1868, there is evidence that there was an increasing number of goat-herders (n=26) in Gibraltar, and the majority were of Maltese origin. As the Maltese population grew in numbers, [74] so did their dominance in the milk industry.[75]

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[70] E. B. Ewart, *Royal Engineers to the Inspector General of Fortification Report*. May 1st, 1882.

[71] Lawrence A. Sawchuk and Stacie D. A. Burke, "The Barefooted Foreigner: A Case Study of the Scapegoat in Nineteenth- Century Gibraltar," *Current Anthropology*, vol. 49, no. 3, Summer 2008, 512.

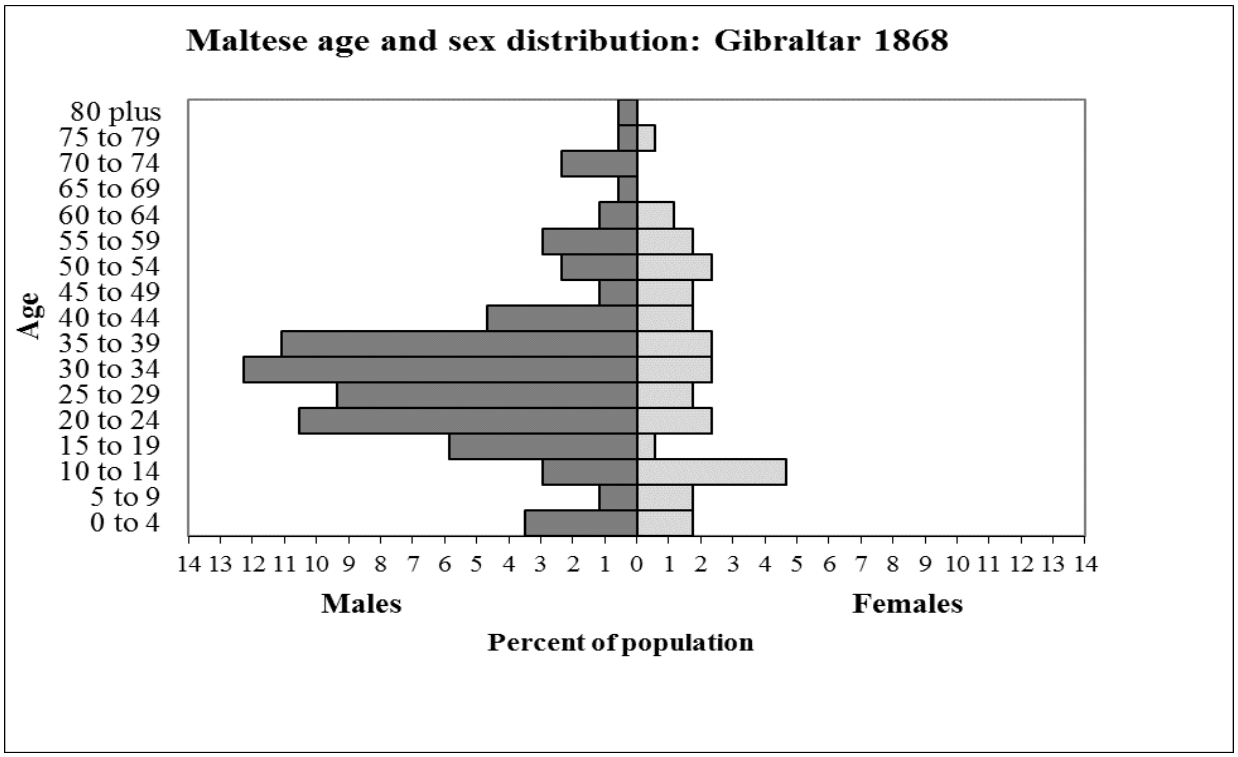
[72] Maltese goats are known to have the highest milk yield, of 357 kg per lactation, days in milk (DIM); J. M. Serradilla, "Use of high yielding goat breeds for milk breeding." *Livestock Production Sciences,* vol. 71 no., 2001, 63.

[73] Sex Ratio was 271.74, or approximately 272 males for every 100 females.

[74] Between the censuses of 1871 and 1881, the number of immigrants grew from 650 to 702 (a growth rate of 12% per annum). The Maltese community reached its maximum size in the 1890s with roughly 1000 inhabitants.

[75] By 1881 for example, there were thirteen milk sellers: three from Spain, three local and seven from Malta.

Figure 2-4. Age and sex profile for the Maltese population resident in Gibraltar



In Gibraltar, the tradition of goat-herding and using raw goats' milk continued well into the 20th century, although their laws regarding goat's milk consumption (i.e. boiling milk prior to consumption) had come into full force. As Gibraltarian Benady notes, goats were kept by Simon (El Cabrero) on the Upper Rock, and he would herd them into town and milk them for each household.[76] Even though the goats' movements were strictly regulated by the military, there was a social and communal aspect to the presence and function of goats on the Rock because they were part of the everyday life of the Gibraltarian. One Gibraltarian, R. Garcia recounts a personal recollection of the daily interaction of a goat and his mother in the late 1920s:

'A goat would be brought to the doorstep of [my mother's] flat and milked on the doorstep. She would feed the goat a slice of bread, which the goat thoroughly enjoyed. One day, the milkman brought a different goat instead of the regular one, and this new goat got the slice of bread. A while later, that same morning, there was a noise as if someone were pushing against the front

[76] Samuel M. Benady, *Memoirs of a Gibraltarian*, (Gibraltar Books Ltd, Grendon and Northants), 1993, 8.

door of the apartment. When they went to see what it was, my mother found that the regular goat had managed to evade its owner and had made its own way to the flat in search of its slice of bread! It was duly rewarded.'[77]

Figure 2-5. Woman milking goats in Gibraltar. ca. 1906

Source: (Robert J. Urie`s, A Trip to the Orient: A story of a Mediterranean Cruise, 1907)

Despite the amicable relationship between Gibraltarians and the goat-herding tradition, the number of goats permitted in Gibraltar after 1885 progressively declined as did the number of goat-herders.[78] In the period from 1891 until 1900, twenty-nine goat herders remained; by 1911, there were four; then in 1921, seven goat and cow herders remained.[79] The question arises: why was there a reduction in the number of grazing passes and in turn the goats on the Rock? There are a number of possible reasons. First, there was the issue of nuisance and degradation to the

[77] Personal communication from Richard Garcia to author, L. Sawchuk, 2013.

[78] This stands in strong contrast to the Malta experience. These goats were sent to Malaga, La Linea Oran, Algiers, and Tangier; Horrocks, 1907, 64.

[79] Gibraltar Government, *Gibraltar census, 1921*.

environment. In a limited area such as Gibraltar, the predominantly woody topography of the top of the Rock offered a delectable buffet for the goats' voracious feeding habits. Unlike Bigelow's 'docile' and obedient goat, these animals caused major environmental damage and degradation by consuming virtually all organic material on site such as leaves on bushes and trees. Furthermore, inexperienced herdsmen can find it difficult to control goats because they can easily jump over fences and barriers, climb trees, cliffs, rocks, and other areas that are not accessible by other ruminants.[80] Medical Officer of Health, Major Fowler in 1909 noted, 'the damage caused by goats to trees and to vegetation, as I have on many occasion seen them trespassing on parts of the Rock, where they should not have been...'[81] It appeared that complaints of nuisance were common. As goat-herders openly defied, 'any restrictions on the wandering of their flocks, although grazing passes were suppose to limit such areas.'[82]

Second, there was the issue of hygiene, since goats created unsanitary conditions as they were herded through the streets.[83]And, 'the accumulation of manure in the vicinity of every cow or goat-shed…form the breeding ground of myriads of these flies of various sorts, but more especially the ordinary house-fly.'[84] The presence of the goats on the upper portions of the Rock, posed a significant threat to the contamination of the water supply catchments that were newly erected at the beginning the twentieth century for both the military and civilian populations.

Finally, by the 1870s, attitudes regarding the Maltese presence on the Rock began to worsen with calls for halting Maltese immigration. Perhaps the most noteworthy of these came from Gibraltar's Bishop Scandella who, depicting the Maltese in uncharitable terms, recommended cutting off their immigration to the Rock. His reasons were:[85]

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[80] P. Morand-Fehr, A. Bourbouze, H. N. Le Houerou, C. Gall, and J. G. Boyazoglu, "The role of Goats in the Mediterranean Area," *Livestock Production Science*, vol. 10, no.6, Winter 1983, 569, 579, 573 and 579.
[81] C. E. P. Fowler, *PMO Rem., No. 128 688,* 1909, 1; Fowler went so far as to proclaim that the restriction on grazing passes were actually ineffective at regulating the number of goats on the rock, as '[a]ny resident can buy and breed goats so long as overcrowding does not take place and nuisance is not caused by their presence.' The restriction on passes, 'would however on the other hand, tend to interfere with the well being of the animals in so much that many of the others would be entirely stall-fed.'
[82] Fowler, 1909, 18.
[83] Benady, 8.
[84] Fowler, 1909, 18.

[85] Gibraltar Government Archives, *Bishop Scandella to Governor Napier, 7th October*, 1876.

1. With some honourable exceptions, only the scum of that people betakes itself hither: the worthless, and particularly those who, on the expiration of their imprisonment, have to look elsewhere for that subsistence which they cannot honestly earn in their own country.

2. Employers have no means of satisfying themselves as to the honesty, ability and activity of those immigrants.

3. Once they have landed here, it is not easy to send them back to their island home or to get rid of them, particularly as they are excessively hardy and inured to want, so that they need but little to live on, and that little is readily found among their own. Were a Maltese unable to eke out a livelihood here, it is not probable that he could maintain himself on his own barren island.

4. As is the case with every British subject habituated to vice, the Maltese becomes, in general, a lasting calamity for this place...

5. As in virtue of their nationality, they cannot be compelled to leave the Garrison, they prove a source of a very serious evil in time of war of epidemic.

The year 1885 was the breaking point in relations with the Maltese immigrants because they now served as a convenient scapegoat for being the source of the dreaded cholera.[86] Shortly after the cessation of the epidemic, *The Times* out of London ran a series of three columns describing conditions in Gibraltar and their link to cholera. In the column titled, 'Cholera in Spain: The Housing of the Poor at Gibraltar,' we see the local perceptions of the Maltese reaffirmed in most unflattering terms:

During the last few years Gibraltar has been *invaded* by more than 1000 Maltese British subjects. There are inhabitants who can remember the time when there were only two Maltese in the entire colony: but in an evil hour, a firm sought to defeat a strike of Spanish coalheavers by the importation of Maltese labour. This gave an impulse in a new direction to the flow of emigration from the island of Malta, and the new comers proved to be the *most troublesome* section of the population…These *unwelcome* British subjects, who speak a *bastard* Arabic, are a *bloodthirsty set*. They never wear shoes, but *creep* about silently on bare feet. The criminals among them, of whom, unfortunately, there is a goodly proportion, can scarcely be qualified as the bold burglar type. They are better described as what are technically called 'area sneaks.' [*emphasis added*]

[86] Sawchuk and Burke, 511.

From the colonial perspective, the Maltese represented a real problem of overcrowding. They were British subjects, and, once in Gibraltar, they could not be compelled to leave. By the 1890s, it was clear that colonial officials were no longer tolerant of continued Maltese immigration to Gibraltar. In a letter to the Colonial Secretary dated May 25th 1894,[87] Gibraltar's Governor wrote:

> It is most necessary that this addition to the resident population should be prevented and I request that I will have the authority to prohibit their entry and the governor of Malta may be moved to issue a notice warning inhabitants of Malta from coming here for, as they will not be allowed to work here. There will be no difficulty obtaining Spanish labour which will not be more costly and will have the great advantage of not increasing the resident population[88]

Ironically, curtailing Maltese immigration along with their goat-herding tradition had little connection with undulant fever at this time. During this period, the etiology of undulant fever was poorly understood with little thought given to the goat as a source of the disease.[89]

2.6.1 Milk Consumption Traditions

By the 1890s, when the milk supply began to come under scrutiny from the health authorities, we gain a clearer understanding of the milk drinking customs in Gibraltar. Four aspects of the situation in particular became apparent. First, although there was a longstanding tradition of goat-herding in Gibraltar, there was no distinct preference for consuming either goats' milk or unpasteurized milk. Although many Gibraltarians drank goats' milk, it was not uncommon to

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[87] The stimulus for this statement came from concern over employing the Maltese for work on the dockyard that was to begin in October 1894.

[88] Gibraltar Government Archives, *CO 91/403, Gibraltar Governor Robert Biddulph to the Colonial Secretary May 25th*, 1894.

[89] In fact even in Malta; Gibraltar Government Archives, *The Report of the Public Health of the Civil population of Malta for 1899,* 4, states numerous possibilities regarding the cause of undulant fever, including air-borne or water-borne modes of transmission through drainage systems. Interestingly, in 1907 when the goat was known to be the carrier of undulant fever, in Horrocks' seminal piece, he holds the Maltese goat responsible for undulant fever in Gibraltar: "whereas in 1883 all the goats on the Rock were Maltese and Malta Fever was then very common, the disease had disappeared in 1904 with cessation of importation of Maltese goats due to the withdrawal of grazing passes and the increase in the cost of shipment, and their replacement by Spanish goats;" In the years to follow, examination of cases would indicate that the majority of cases were coming from goats in Spain. Horrocks,1904, 143; Horrocks, 1907, 56- 58.

drink a mixture of milk from both cows and goats imported from Spain. The upper class, on the other hand, disdained goats' milk, and consumed cows' milk instead. It has also been noted that goats' milk was used only for baking purposes in the hospital, and cows' milk was reserved for drinking. Second, only a small proportion of the milk consumed in Gibraltar was locally derived, since many of the goat farms on the Rock were abolished by 1893.[90] Most of it, 5/7[91] came from Spain. Third, until the 1890s, Gibraltar authorities had little control over the quality or purity of the milk supply from Spain. Fourth and last, milk from Spain came in two forms: *leche pura* and *leche con agua*. *Leche pura* cost more at 3d or 4d and was most likely purchased by the affluent. *Con agua* cost 2d and 2 1/2 a pint, but 60% of it was water drawn in all probability from a surface well in La Linea. Those of lower socio-economic status probably did not know that they were purchasing a diluted commodity.[92]

Unlike Gibraltar, the preferred drink in Malta was goats' milk of local origin, with 'sheep and cow's milk being used only exceptionally.'[93] Furthermore, the only form of goat milk was fresh milk.[94] The important point here was the culturally entrenched preference for unpasteurized goats' milk. The goat was considered to be 'a household feature of Maltese culture and daily life.'[95] The reasons for this were: environmental factors, a belief system and not least, poverty. Like much of the Mediterranean, Malta lacked refrigeration. The high concentration of the population and short distances between villages and towns, and 'the poverty of grazing land,' such that the wasteland served as natural grazing land,[96] made the goat an ideal candidate for distributing milk to customers' doorsteps.[97] The belief system was based on conviction that boiling milk:

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[90] New New goat sheds are constructed in 1893, however; W. G. Macpherson, *Annual Public Health Report on the Health of Gibraltar for the year 1892*, 1893, 12-14.
[91] W. G. Macpherson, *Annual Public Health Report on the Health of Gibraltar for the year 1891*, 1892, 21.
[92] Lawrence A. Sawchuk, Stacie D. A. Burke and Janet Padiak, "A Matter of Privilege: Infant Mortality in the Garrison Town of Gibraltar, 1870-1899."*Journal of Family History*, vol. 27, no. 399, Fall 2002, 422.
[93] Themistocles Zammit, "Milk Poisoning In Malta," *The British Medical Journal*, vol. 1, no. 2054, Spring 1900, 1151.

[94] One traditional delicacy is the goats' milk that is still consumed today: cheeselets, "gbejniet"; Vassallo, 144.

[95] Azopardi, 22.
[96] Busuttil, 21.
[97] Azopardi, 22.

1. Ruined the quality and flavour of milk;[98]

2. Was considered superfluous by the people because they knew that the Maltese goat did not suffer naturally from tuberculosis for which the precautions of boiling had been advocated abroad by members of the Mediterranean Fever Commission; [99]

3. Was unnecessary because having the goat milked at the door meant that contamination or adulteration of the milk was not possible.[100] This had proven true in other locations. In Gibraltar, it was found that milk brought in from Spain was adulterated. In some cases 60% of that 'milk' was water;

4. Was irrelevant. They believed any problem associated with goat milk occurred because the goat had eaten a poisonous plant (Euphorbiaceous plants or in the vernacular – as Tenhout); [101]

5. Was an unproven technique. With their distrust of scientific findings, 'the general public has yet to be convinced that an apparently normal beverage drawn straight from the familiar goat can be productive of a deadly fever';[102]
6. Was impractical because the poor simply did not have the means to boil milk;[103]

2.7 The Introduction of Dairy Legislation

After the last appearance of cholera in 1885, as there was no longer a 'single, great corrupter of death,'[104] the Medical Officers of Health continued to press for sanitary reform. Their attention,

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[98] Zammit, 1900, 1151; H. Vivian Wyatt, "Brucellosis and Maltese goats in the Mediterranean," *Journal of Maltese History*, vol. 1, no. 2, Fall 2009, 10.
[99] Cassar, 245; Zammit points out that even if the milk in the goat is uncontaminated, during milking, the skin of the animal, the hands of the milker and the tin measure that collects milk afford ample opportunity for pathogenic microbes to enter into the goat; Zammit, 1900, 1152.
[100] Zammit, 1900, 1152; J. E. H. Gatt, "Undulant Fever in Malta," *The British Medical Journal,* vol. 1, no. 4025, Winter 1938, 454.
[101] This theory was proven false by the researchers appointed by the Commission; Zammit, 1900, 1151.
[102] Themistocles Zammit, "Undulant Fever in the goat in Malta," *Annals of Tropical and Medical Parasitology*, vol. 16, no. 6, 1922, 5.
[103] Wyatt, 2009, 12.
[104] Sawchuk, 277; Staples, *The Chronicle*, 1886.

however, was now focused on the excessive number of deaths in infants and children. Amounting to almost a third of all deaths, the mortality rate for infants and children was considered, 'one great blot on the sanitation of Gibraltar.'[105] Armed with the growing knowledge of germ theory, public health officials set in motion new, effective measures, such as ensuring a good supply of milk.[106] The milk byelaws of 1893, focused on milk adulterated by the addition of impure water to cows' and goats' milk from Spain, would prove to be forward thinking and most likely contributed to keeping undulant fever at bay.

In 1894, new byelaws were introduced, imposing fines on vendors for adulterating milk and requiring milk shops to be licensed. Other efforts to ensure that Gibraltarians were consuming pure milk included the purchase of a milk sterilizer for use by the station hospital and the establishment of a bacteriology laboratory in 1897.[107]

In April of 1907, a new law was passed requiring that all milk introduced into Gibraltar, from Spain in particular, had to be boiled.[108] By 1913, an extensive series of byelaws was introduced under the heading, *Control of the Milk Supply of Gibraltar and with respect to Dairies, Cowsheds, Goat sheds, and diseased Cows and Goats in Gibraltar.* This piece of legislation was the first to state explicitly that milk from a diseased cow or goat was not to be mixed with any other milk. It also stipulated that milk from diseased ruminants should not be sold or used for humans, or sold or used for food of other animals unless it had been boiled. The law specified two diseases in animals: tuberculosis and Malta Fever.[109]

Steps taken by the Health Authorities' efforts to minimize attacks of undulant fever began in 1905, when major advances in understanding Mediterranean Fever began to unfold. First, the

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[105] Gibraltar Government Archives, *Sir Lothian Nicholson to the Marques of Ripon, May 18th,* 1893.
[106] Sawchuk, 277.
[107] Sawchuk, Burke and Padiak, 422.
[108] In 1910, about two-thirds of goats' milk came from Spain and a similar quantity of cows' milk that was produced locally was imported from Spain. The Sanitary Inspectors continually sampled imported milk to ensure milk was indeed boiled before reaching the consumer. However, locally produced milk was not required to be boiled; Fowler, 1910, 58.
[109] The point of labeling Mediterranean fever as "Malta fever" should not be lost on the reader. In 1909, Fowler suggested that in order to enforce registration of goat keepers and purveyors of milk on the Rock, and in turn gradually reduce the number of goats, clauses from sections 6 and 34 of the "Dairies, Cowsheds and Milkshops Order" should be introduced into the Public Health Ordinance of Gibraltar. This would give the Sanitary Commission freedom to limit the number of goats owned by an individual.

disease was made notifiable. 1905 was also the year that saw a small resurgence of eleven cases as opposed to the usual morbidity rate of zero to four cases. Consequently, the Health Authority in Gibraltar issued warnings to the civilian population regarding the dangers of drinking unboiled goats' milk. Pamphlets were issued by the public health department.[110] Third, in 1906, the Sanitary Commissioners sanctioned the performance of the 'blood test' in the laboratory free of charge. In 1909, the troops in garrison were not allowed to consume any fresh milk whatsoever. Gibraltarians again were warned against drinking raw fresh milk, as 'they incur the grave risk of contracting this most obstinate disease.'[111] Finally in 1916, the Medical Officer of Health announced that no goats would be imported unless found free of infection.

In Malta, prior to the Mediterranean Fever Commission Report, there was health legislation regarding goat keeping and dairying. The Malta Sanitary Ordinances (No. III of 1904, Chapter II, Section V, Articles 79-100) was not intended to minimize undulant fever per se, but rather to ensure healthy goats and good quality milk. Pertinent to the transmission of undulant fever were the measures regarding the cleanliness of cow and goat sheds:

1. *All purveyors of milk be licensed and the license shall only be granted on condition that the dairy is well built, fitted with impervious floors, well ventilated, and otherwise sanitary and;*
2. *Dairies are to be kept clean and periodically lime washed; and*
3. *Vessels and utensils used for preservation and sale of milk are to be kept clean*

Such measures would have effectively curtailed disease among goats because undulant fever is passed in excrement and urine. Two years after implementation of the Malta Sanitary Ordinance however, the Mediterranean Fever Commission noted that most of these recommendations were not being carried out. When the Commission tried to enforce washing dairies with lime and laying down impervious floors, they were met with resistance and non-compliance. The goat herders felt they were being blamed for undulant fever in Malta. They believed that the government wanted to ruin them and went on strike from May to June1906.[112]

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[110] Sir William Heaton Horrocks, *Annual Report on the Public Health of Gibraltar for the year 1905,* 1906, 16.
[111] C. E. P. Fowler, *Annual Report on the Public Health of Gibraltar for the year 1909,* 1910, 9.
[112] Major McCulloch, Major Weir and, Staff-surgeon Clayton, 1907, 259.

2.7.1 Changes to Milk Health Policy Emerge in Malta

Despite opposition by the goat herders and the public, the government was successful in implementing a number of progressive steps to combat undulant fever in Malta in the decades following the Mediterranean Fever Commission. Beginning in 1905, as in Gibraltar, Health authorities issued pamphlets on the dangers of drinking unpasteurized goats' milk, and disseminated this information through the clergy as well. In 1909, the health authorities gained increased control over 'purification of the milk supplies', and by 1910, the number of goats found to be infected and then slaughtered was no less than 461.[113]

More than a decade later than in Gibraltar and beginning in 1923, regulations for boiling milk were put into place. The focus was outside the home setting, and the legislation stipulated that unboiled milk could not be kept, sold or supplied in any hotel, coffee or other shop.[114] The second step, in 1931, came about because the government recognized that the best method of eradicating undulant fever in the population would be to find the sources of the disease and destroy the goat. Nevertheless, the government also realized that '[t]he goat-herds are an uneducated class, and much prejudiced against what they consider unnecessary innovations. It will probably take a long time before these prejudices are overcome, and the only alternative appears to be dairies or depots under government control.'[115] Accordingly, in 1932, a special committee was set up to facilitate the process of pasteurization. In 1933, the committee published a recommendation for the pasteurization of milk and, by 1938, the Milk Pasteurization Center was opened to improve milk consumption and nutrition. As the Medical Officer of Health noted there was '...no other single measure which would do more to improve heath, development and resistance to disease of the rising generation than a large consumption of milk.'[116] In an effort to increase milk consumption in Malta, the government intended to make pasteurized milk available at a lower price than the current charge for raw goats' milk. Health authorities were primarily concerned that neither children nor adults were consuming adequate amounts of milk

[113] Eyre and Durh, 89.
[114] Cassar, 245.
[115] Major McCulloch, Major Weir and, Staff-surgeon Clayton, 1907, 259.

[116] Dr. G Apap, *GMR, Notes on the Milk Supply of the Islands of Malta, and Measures being taken by the Government to Increase and Improve the supply and Consumption of Milk*, 1937, IX Appendix C.

or dairy products.[117] In addition to the pasteurization scheme, an educational program was launched with the aim of changing Maltese perceptions about milk consumption. It involved 'healthy propaganda' about the value of clean and safe milk, and the free distribution of the pasteurized milk in government schools.[118] In 1939, goats were prohibited from entering Valletta. During this year, the sale of goats' milk was banned in Malta. Not until 1957, would raw milk be prohibited in Malta.[119]

2.7.2 Quarantine Measures and surveillance of goats

When Zammit discovered, in 1905, that the goat was the reservoir of *B. melitensis*, the Sanitary Commission in Gibraltar took immediate steps to ensure that undulant fever would not prove to be a nuisance among the troops. In 1907, the Medical Officer of Health adopted the following measures:[120] Part of this step in combating the disease was taken in 1907 with the passing of a milk byelaw requiring Gibraltarians to boil imported milk, described above.

> (1) Regular and systematic examination of all goats now living in Gibraltar. Blood and milk from each goat have been examined twice during the year…..Meanwhile the public have been warned that all goats' milk obtained from herds in Gibraltar should be boiled before consumption.
>
> (2) Quarantine [121]all goats which are brought to Gibraltar until examination of the blood and milk have shown that they are free from infection. This will be done in the future and the Commissioners are now preparing a goat shed at the North Front, where owners

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[117] S. F. Barnes, *GMR, Notes on the Milk Supply of the Islands of Malta, and Measures being taken by the Government to Increase and Improve the supply and Consumption of Milk,* 1937, Appendix I.
[118] Gatt, 1938, 454; J.E.H Gatt, "Health and Milk Supply of Malta (Correspondence)," *The British Medical Journal,* vol.1, no. 3989, Summer 1937,1282.
[119] Cassar, 246.
[120] These measures were also published in the Department of the Army Medical Department Report in the following year

[121] In 1909 quarantine was limited to 14 days. Unfortunately, this proved to be ineffective, as the bacteria can last in a goat for 2 years and post birth secretions are higher in bacteria.

> desiring to bring goats into Gibraltar will have to keep them until they have been declared free from disease.

The Health Authorities in Gibraltar seem to have been proactive in their efforts to eradicate undulant fever from the Rock given the fact that, at this time in 1907, no such regulation of the sale of milk existed in Malta.[122] A year later, Medical Officer of Health Fowler gave a resounding accolade to his predecessor and fellow Health officials for their management of the disease in Gibraltar:

> No case was reported during the year, which speaks well for the late medical officer of health, Major Horrocks, and shows the *enlightened views* [*emphasis added*] taken by the authorities of this Colony as compared with Malta, where the incidence of the disease amongst the civil population has diminished but little, though practically extinct amongst the Navy and Army.[123] Fowler also claims to have personally inspected most goats on the Rock.[124]

2.7.3 The Effectiveness of legislation

From the standpoint of the Health Authorities, the legislation implemented successfully reduced contact with undulant fever in Gibraltar. Time and again, the Medical Officer of Health in Gibraltar referred to evidence of declining rates of undulant fever in the population and declining rates of micrococcus in goats. By 1912, Fowler credited the legislation implemented in 1907 with the positive result due to the fact 'that the infection amongst the goats is dying out,' as only 5% of goats yielded a reaction *B. melitensis*, compared to 10% a few years before. By 1913, no case of *B. melitensis* was detected in the milk of goats in Gibraltar, and Fowler was pleased to speculate that undulant fever 'will soon be a thing of the past.'[125] There was a slight resurgence of 7% of goats yielding a positive reaction to the micrococcus in 1915, but, significantly, no case

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[122] J. F. Anderson, "The relation of Goat's milk to the spread of Malta Fever," *Hygienic Laboratory---Bulletin No. 41: Milk and its relation to the Public Health,* 1908, 199.
[123] William Heaton Horrocks, *Annual Report on the Public Health of Gibraltar for the year 1908*, 1909, 7
[124] C. E. P. Fowler, 1909.
[125] G. Dansey-Browning, *Annual Report on the Public Health of Gibraltar for the year 1913,* 1914, 7.

of undulant fever was contracted from locally produced milk over the previous six years and there never would be another case that originated from goats in Gibraltar.[126] Reaffirmation of the need to uphold the legislation on restricting the importation of goats and the sale of unboiled milk was based on the fact that, immediately across the border in Spain, goats were still 'badly infected'[127] and that all cases were of Spanish origin. Even though Health Authorities in Gibraltar had no jurisdiction to monitor the health of goats and the quality of milk, their hands were not completely tied as they required milk vendors to provide up-to-date lists giving the names and localities of the farms in Spain from which milk was obtained.[128]

Arising from the observation that rates of undulant fever was declining in Gibraltar, we pose the question: why were legislations successful in minimizing outbreaks of undulant fever in Gibraltar, but not in Malta? The primary cause of failure to control undulant fever in the goat in Malta was structural scale effect issues relating to (1) legislation and (2) enforcement of recommendations. In Gibraltar, the careful and regular inspection of goats for *B. melitensis* and milk supplied from Spain, a seemingly easy task, required adequate staffing and a concerted, vigilant attitude. Second, the compliant nature of the civilians of Gibraltar, who trusted and respected the Health Authorities, was strongly reinforced by the fact that members of their own community were members of the Sanitary Commission.

A case from 1914 highlights how diligently the byelaws were upheld and enforced. The Sanitary Commission imposed a fine on two vendors, Mr. Vega and Mr. Balloqui, for selling adulterated milk to Gibraltarians.[129] This particular incident illustrates the first and second of four factors that Heckathorn[130] has identified as important in intra-group compliancy: the strength of the sanctions, monitoring capacities, and the efficacy and cost of intra-group control.

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[126] G. Dansey-Browning, *Annual Report on the Public Health of Gibraltar for the year 1915*, 1916, 25.
[127] G. Dansey-Browning, *Annual Report on the Public Health of Gibraltar for the year 1917*, 1918, 20.
[128] G. Dansey-Browning, *Annual Report on the Public Health of Gibraltar for the year 1922*, 1923, 35.
[129] It should be noted however, that many of the milk vendors were boys 12 to 15 years of age and were not likely to be convicted if caught selling impure or previously unboiled milk.

[130] Douglas D. Heckathorn, 1990, "Collective Sanctions and Compliance Norms: A Formal Theory of Group-Mediated Social Control," *American Sociological Review*, vol. 55, no. 3, Summer 1990, 366.

Ironically, the quarantine measures actually had little impact on lowering the rates of undulant fever among the goats, because, although goats can appear free from infection, they can, at a later time, pass the micrococcus in their milk or to their offspring,[131] 'This points out what little value there is in quarantine regulations with regard to these animals, and also the emphasis on the care that should be exercised in allowing the importation of goats to the Rock.'[132] Quarantine was, however, an effective deterrent for further importation to Gibraltar. In 1907, a few Maltese goat herders wanting to take up the trade in Gibraltar, upon hearing of the quarantine measures that their goats would be subjected to upon arrival on the Rock, decided against pursuing migration to the Rock.[133]

Unlike Gibraltar, Malta lacked inspectors for routine inspections of livestock. The shortage of qualified staff perpetuated the cycle of infection when healthy and unhealthy goats were allowed to mingle. By comparison, Gibraltar's quarantine methods and legislation were superior to the haphazard and periodic inspections that were commonplace in Malta.[134] Here again, the scale effect exacerbated the problem in Malta where goats numbered in the 10,000s as opposed to the very small number on the Rock. So even with high rates of inspection in Malta, the scope of the problem was daunting. Matters were further complicated by the lack of coordination on the government's part in regulating both the dairy and agriculture industries.[135] Inspection and monitoring were easier in fortress Gibraltar where ingress and egress were carefully guarded when the gates opened and closed at sunrise and sunset. Consider the court testimony by one of Gibraltar's sanitary inspectors:

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[131] Quarantine was limited to 14 days as the bacteria can last in a goat for 2 years and post birth secretions are higher in bacteria.

[132] Fowler, 1910, 8; once infected, a goat can secrete this germ at irregular intervals, and that when it is apparently cured the germ can be recovered from its secreta or its internal organs after post mortem examination.

[133] Williams Heaton Horrocks, *Annual Report on the Public Health of Gibraltar for the year 1907*, 1908, 10.

[134]The examination and destruction of infected animals was "haphazard" given the fact that there was no complete registration and no complete marking of goats; National Archives Malta, *Report on the Health of Malta during 1936-37*, 1937, 14.

[135] Up until 1955, there was no coordinated Government policy on aid to agriculture. A Department for the sector existed, but it cannot be claimed that farming and dairying problems were treated with any efficiency. No sustained efforts to help farms to increase their output were made. This was due in part to a virtually complete absence of personnel with any specialized knowledge; Busuttil, 1993, 25.

> At about 3pm on the 9th instant I meet the defendant in Town Range carrying a can of milk, … I stopped him and asked him to come with me to the Sanitary Commissioners Office to sell a pint of milk. He agreed but said he must fetch another can which he had in a yard opposite the place I met him and he said he made a mistake that the can was in another yard further up, I again went with him in another yard … where he pretended to slip and upset the can of milk in the yard, I picked up the can and found an ounce or so remaining in it, I showed it to the sanitary assistant who in the presence of the defendant and the medical officer of health divided it into three portions … only to find it adulterated, deficient of milk fat. [136]

The zeal shown by the inspector in tracking a 'suspicious milk vendor' coupled with the ability to take immediate action by the Health authorities speaks directly to the efficiency and ease by which disease prevention could occur in the confines of a small-scale society. This particular example reinforces Heckathorn's second measure of intra-group compliancy in terms of monitoring the population to ensure compliance with health byelaws, which was also demonstrated in the scenario below.

2.7.4 A Most Telling Outbreak

The case study of an outbreak in 1909 is yet further testimony to the ease of tracking the disease source in a small-scale setting.[137] In October of 1909, there was a recrudescence of undulant fever among the troops of fourteen cases. At this time, most of the regiments stationed in Gibraltar used only tinned or condensed milk occasionally supplemented by milk from the market or that brought by a few married families. But headquarter companies for Norfolk and Bedford Regiment used milk that was supposed to be boiled before consumption as required and recommended by the health Authorities. The milk supplier for these regiments and the Hospital was Mr. Debono, a Maltese immigrant.

Dr. Fowler compiled statistics of the outbreak, and from that, he drew a number of conclusions. Eight of the subjects drank infected milk while in hospital, and three others drank Debono's milk supplied in their rations. The officer's daughter is most definitive example of the association

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[136] Sanitary Commissioner's Report, *Letter to the Colonial Secretary by W. Cerutti, Sanitary Inspector, Oct 12th,* 1914.

[137] We should note, as well, that in order for an outbreak to occur, the minimum requirement is for only one infective goat to supply multiple patrons.

between contaminated milk and cases of undulant fever. Milk supplied to her came solely from Debono, and, above all else, she openly admitted that she did not boil the milk before drinking it. The evidence showing that the outbreak was confined to a defined group and did not spread to the surrounding civilian population adds weight to contaminated milk as the sole source of the disease.

Further inquiry into the origin of the goats proved equally telling. After the outbreak, investigation revealed that a few months earlier Debono had purchased fifteen goats and two kids from Malta. All animals had been given a clean bill of health from the veterinary surgeon to the Public Health Department of Malta. Upon arrival in Gibraltar, the goats were placed in quarantine at the North Front for fourteen days, and the blood of each was examined on three separate occasions for *B. melitensis*. Two goats yielded a positive reaction and were ordered to be disposed of outside Gibraltar. The other fifteen goats were passed over to Debono. At a subsequent examination on October 4th, four were found positive. One of these goats bore a suspicious resemblance to a condemned goat from the quarantine period in April.

Armed with this information, Fowler took immediate action and ordered that Debono's goats be removed from the food chain. Debono promptly sold the animals to a buyer in Tangier. After the unfortunate episode, Debono, like many of his fellow goat-herders, returned to Malta. Fowler vowed never again to import goats from Malta. It is possible that, as of 1909, no more goats were ever exported to Gibraltar, as records indicate no more goats were imported from Spain.[138] By 1911, the Medical Officer of Health reported that no 'strange goats' from Spain or Malta had been introduced in Gibraltar.[139]

The second cause we must consider when comparing the undulant fever in Gibraltar and Malta, in concert with the scale effect operating on enforcement of legislation, is the largely non-compliant population in Malta. Their intransigence was driven by the goat-herders and milk vendors who refused to abide by the Mediterranean Fever Commission recommendations and other health authorities warnings. Their beliefs stemmed mainly from mistrust of government authorities and they feared losing their livelihoods.

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[138]G. Dansey-Browning, *Annual Report on the Health of Gibraltar for the year 1916*, 1917, 25.
[139] C. E. P. Fowler, *Annual Report on the Health of Gibraltar for the year 1911*, 1912, 8.

2.7.5 Mistrust and non-compliancy: The uneducated goat-herder, the milk vendor and the disobedient civilian

Although there was opposition to milk legislation by goat herders and milk vendors in Gibraltar, there did not exist the widespread intra-group non-compliance as was observed in Malta. In Malta, the larger community of goat-herders could rally together and make their voices heard. Goat herding was not only an economic enterprise, but also a sophisticated, complex network that the civilian population depended on, and 'the government could not sacrifice the goat herder to minimize its own losses.'[140] The goat-herders in Gibraltar, however, had very little political or economic clout since they were few in number and largely of Maltese and Spanish origin. Both nationalities stood on the bottom rung of Gibraltar's social ladder.

Initially, after the creation of the Commission, five reasons account for the report's failure to alter the skepticism about the transmission of undulant fever among the Maltese public. First, they believed that the fever had no connection with goats' milk, but was due to inhalation of infected dust and dirt during the rebuilding of Malta's new water supply and drainage system. Second, they believed that the association between the goat milk and undulant fever was 'post hoc and the evidence was adduced by the Mediterranean Fever Commission as to the infectivity of the goats' milk…'[141] Others still believed that improvement of sanitary conditions, such as the removal of the military garrison to modern barracks was the actual impetus for the decline in the incidence of undulant fever.[142] Fourth, the Royal Commission of 1912 was told that the sanitary authorities blamed spread of undulant fever on the goat as an excuse for destroying them and, ultimately, ruining the goatmen.[143] Adding to their mistrust of the health authorities was the fact that goat-herders and milk vendors, being of the lowest class, were uneducated and largely illiterate and consequently unable to understand warnings published in pamphlets. However, even after warnings from the clergy, they did not take heed. The milk vendors were afraid of losing their livelihood because the public demanded fresh goats' milk, and they devised crafty

[140] Busuttil,1993, 22.
[141] Eyre and Durh, 88.
[142]Eyre and Durh, 88.
[143] Cassar, 245.

ways to circumvent the 1923 byelaw. For example, the vendors would tether a goat to the door outside their shops so that they could serve their customers fresh milk and avoid keeping a supply of milk on the premises.[144]Furthermore, after the opening of the pasteurization centre in 1938, many milk vendors did not want to stop supplying raw milk to hospitals and orphanages because it would mean breaking existing contracts, and destroying the multi-generational family tradition of supplying milk to these institutions. The deeply entrenched tradition of goat-herding partly explains why there was an illegal trade of raw milk in Malta.

Finally and most significantly, public confidence over the danger of consumption of raw milk was further weakened when both foreigner and local experts, expressed doubt on the veracity of the Mediterranean Fever Commission's findings. In particular, Agositino Levanzin, a pharmacist and local medical practitioner, Dr. Peter Aguis, who both owned and edited local newspapers, directly challenged the findings of the Commission. One eminent British Doctor, Hadwen, made personal attacks on the department of Medical Health and the Chief Medical Officer, adding great weight to the argument that the goat was not the only factor in spreading undulant fever. [145] A further illustration of the undermining of the department of public health was the scandal of 1911, when one of the Public Health employees was convicted of failing to destroy an infected goat, and in fact resold the goat for profit.[146]

The non-compliant attitude extended to the civilian population who were equally complicit in refusing to abide by the recommendations set out by the Health Authorities. As recounted by Zammit, [147] there was resistance by the local community who remained 'obdurate, or careless.' Gatt also reported in 1937 the Maltese were 'apathic and prejudicial even to passive resistance on the part of a considerable section of the community and the vested interests of the goat owner and milk vendor have proved insurmountable...'[148] Warnings spread by school teachers and

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[144] "Pasteurisation of Milk," *Report of the Commission appointed to Investigate and Report upon the Feasibility of introducing a supply of Pasteurised Goats Milk in the Islands,* 1932.
[145] John Rizzo Naudi, *Brucellosis: The Malta Experience, A Celebration 1905*-2005, (Publishers Enterprises Group Ltd, Malta), 2005, 107.
[146] The employee was 'sentenced to 7 years hard labour and perpetual interdiction by the presiding judge.' It is noteworthy that the public was well aware of this case, as it was reported in the Malta Herald 13th March 1912 and this individual was known to have been in a habit of repeatedly committing the aforementioned offence. Rizzo,113.
[147] Zammit, 1922, 10.
[148] Gatt, 1937, 1282.

publicized through educational health films, the clergy, and musical bands were all unable to change the opinion of the Maltese civilian.[149] Even as late as 1948, the Medical Officer of Health remarked that people continued to drink unboiled goats' milk, 'in spite of the fact that this year we made it a point to hammer this 'warning' into the peoples' heads.'[150] In 1954, in areas where the sale of raw goats' milk was forbidden, it was noted that goat-pens were found in the outskirts of all the villages and milk could be obtained cheaper when bought directly from the goatherd.[151] This example shows that consumers willfully flouted the law by purchasing raw goat milk. It also shows the vendors placed the milk in convenient locations to dodge the problem of entering villages and towns to sell milk. Here both the actor (the goat-herder/vendor) and group (the milk consumers) worked defiantly in concert to circumvent the health policy set out by Maltese authorities.

The year 1908 saw small improvements in milk consumption habits in parts of the Maltese population. Many affluent individuals had taken heed of the public health department's admonitions and were either drinking condensed milk or boiling the fresh variety.[152] Substantial changes in perception among the general population probably began with educating children on the dangers of consuming raw milk as there may have been a psychological impact from lessons on the benefits of pasteurization. This, coupled with free pasteurized cows' milk for students brought about the result: children lost their preference for goats' milk and, in particular, fresh milk.[153] However, this change in attitude would take many generations before adopted by the population at large and, in turn result in a substantial decline in undulant fever cases.

One final point on the subject of undulant fever in Malta that deserves mention is how life in that time of high background mortality[154] shaped the world view of the civilian population. While we draw heavily on official public health reports, 'the voice of the insider' is conspicuously absent

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[149] Azopardi, 23; Cassar, 245

[150] National Archives Malta, *Report on the Health of the Maltese Islands during 1948-49*, 1949.

[151] J Galea, *Report on the Health Conditions of the Maltese Islands and on the Work of the Medical and Health Department for the year 1954*, 1955, 26.

[152] Eyre and Durh, 89.

[153] Busuttil, 1993, 21.

[154] For example during the period, 1919 to 1950, the average infant mortality rate for hot late summer months August and September stood at 314 and 343 per 1000 livebirths respectively.

from this paper as well as the Maltese attitude toward policies set by perceived 'outsiders.' How could 'the outsider' understand or empathize with those who experienced a life filled with hardship, misery, and fatalism when nearly one third of children born died before their first birthday? It is clear that various health policies regarding undulant fever were well intentioned, but it was often lost on a suspicious public whose world view on health matters was deeply rooted in the culture of generations past.

2.8 Conclusion

Undulant fever lives on as a disease that wreaks misery, sickness, economic hardship, and death at both the individual and community level. Our understanding of this disease emerged in the latter part of the nineteenth century when colonialism and imperialism flourished on the global stage.

Despite the commonality of control under British colonial administration and a region distinguished by a combination of the temperate Mediterranean climate with a scarcity of grazing land, Malta and Gibraltar showed marked differences in experience, management and acceptance of knowledge transfer with undulant fever. The preceding discourse argues that a complex interplay of colonialism acting on cultural milk practices together with the scale effect's impact on the creation, implementation, and enforcement of health policy, can explain differences in the disease experience between the two colonies. Specifically, we can account for the lower rates of undulant fever in the Rock because Gibraltar had: (1) a non-exclusive tradition of consuming raw goats' milk; and (2) effective health-directed policies that dealt with herding and milk consumption; (3) and not least in importance, greater enforcement of policies, and higher levels of intra-group compliancy.

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Chapter 3

3 Host Immunity, Children and Gender differences during the 1918/19 Influenza Epidemic in an Island Population

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Author Contributions: The idea and conceptual framework was mainly developed by myself. Data collection, analysis and the writing of the manuscript was performed by myself with the assistance of L.A. Sawchuk. I was the sole contributor to the development of the nurturant hypothesis, the key factors explaining the influenza heterogeneity in the pandemic experience of island populations, and to the overall presentation of the manuscript. M. Saliba facilitated with the acquisition of the notification records, and assisted with revisions to drafts of the manuscript.

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3.1 Abstract

Using the small island population of Gozo, and a case study perspective, our investigation examines the sources of variability in shaping the morbidity and mortality experience of 1918/19 influenza pandemic. We used the larger sister island of Malta as a point of reference to examine inter-island differences in the signature features of the pandemic. In Gozo, there was a complete absence of a herald wave. In addition, Gozo experienced higher morbidity (90.11 per 1000 versus 53.15 per 1000) and mortality (4.03 per 1000 versus 1.85 per 1000) than Malta during the fall from September to November 1918, but higher rates in the winter wave were observed in Malta. Limited exposure history as a consequence of isolation and rurality, lie at the core of the heterogeneity in the influenza island experience, because Gozo had a long history of martial endogamy. The preference for local mates arose from a limited choice that was constrained by the paucity of immigrants and resulted in biological isolation from the larger island of Malta. Gozo's disease experience was also shaped by community interconnectedness because of the small-scale society, and limited social distancing measures.

We used rare nominative information from notification records in Gozo to uncover intra-population variation in the influenza experience. While current studies show the importance of children as introducers of sickness to the household, this is the first study that demonstrates the presence of this phenomenon during the 1918/19 influenza pandemic. Because of their role as primary caregivers, females were infected at disproportionately higher rates. One of the unexpected findings is that pregnancy is not a factor that measurably increases morbidity in females.

3.2 Introduction

Within the last two decades, the influenza pandemic of 1918/19 has advanced from the status of a forgotten epidemic to one of the most heavily investigated mortality events of modern times. Today, there is a general consensus that there were three distinguishing attributes of the 1918 pandemic: (1) rapidly recurring waves over a 9 month period with the latter two waves exhibiting substantially higher morbidity and mortality; (2) higher mortality rates than the preceding influenza epidemics for all ages except for the elderly; and (3) unexplained mortality in healthy young adults commonly referred to as the w-shaped mortality distribution (Miller, Viboud, Balinska & Simonsen, 2013).

Despite the apparent homogeneity in the manifestation of these features, there is sufficient evidence of substantial inter-population variability in this signature complex to warrant research into the source and scope of the diversity. In particular, island populations were known to vary greatly in morbidity and mortality rates (Shanks & Brundage, 2012) and in wave patterns. Previous studies on the 1918/19 influenza pandemic in island populations have postulated that the variation in rates can be attributed to factors such as overcrowding, malnutrition, poverty and host immunity (Shanks & Brundage, 2012) as consequence of isolation (Mathews, McBryde, McVernon & McCaw, 2010). A growing number of researchers have linked previous exposure to earlier pandemics, as well as to seasonal influenza in order to explain variations in intensity, tempo and vulnerable age groups during the 1918/19 pandemic (Gagnon, Acosta, Madrenas & Miller, 2015; Mathews, McBryde, McVernon, Pallaghy & McCaw, 2010; Worobey, Han, & Rambaut, 2014). We use the case study of Gozo, contrasted with the larger sister island of Malta, to gain a deeper appreciation of the nature of the heterogeneity between two islands that share intrinsic commonalities and yet present sufficient differences that contributed to variability in the epidemic experience.

In addition, we explore intra-population variation in pandemic influenza in Gozo. A re-examination of the reports taken at the time on influenza epidemics across numerous major cities points to a neglected feature of the 1918/19 pandemic: the fact that female influenza morbidity

was significantly higher than male morbidity (Frost, 1920; Low, 1920). To date, there has been no contemporary study that explains this phenomenon. While there are numerous possible reasons for this oversight, the most obvious one is the absence of notification records that are extant and readily accessible. We take advantage of the disease notification registry for Gozo to gain insight into this forgotten distinctive feature.

Factors that might explain the sex disparity include: biological differences as a result of immune response and/or pregnancy (Klein, Hodgson, & Robinson, 2012; Rasmussen, Jamieson, & Bresee, 2008); nutritional differences; and social gendered roles such as the nurturant role (Gove & Hughes, 1979). It is widely accepted that women who take on the traditional role of primary caregivers are at higher risk of morbidity from influenza, especially if they are tending children who themselves are effective transmitters of influenza virus (Whitely & Monto, 2006). We pay particular attention to whether the differential could be, in part, attributed to elevated risks associated with pregnancy and/or the nurturant role, as well as the role of children in the spread of influenza.

The spatially delineated and isolated nature of island populations such as Gozo's provide a valuable resource in the study of evolutionary, ecological and epidemiological processes. From the perspective of population studies, we were afforded the opportunity to observe intrinsic community factors that facilitate the spread of disease without the interference of external factors that arise from interaction with peripheral communities (Rhodes & Anderson, 1996).

3.2.1 The Study Population and Background

Situated in the central Mediterranean, the Maltese archipelago consists of three inhabited islands: Malta, Gozo, and Comino. During our study period, the early 20th century, prevailing conditions on the islands were detrimental to good health: high population density and household overcrowding; high birthrate; inclement weather; and a low standard of living (Ganado, 1937). Under British rule, Malta moved from primarily agriculture based society to marine orientated matters in order to serve the interests of the Colonial Empire (Cassar, 1997). Colonial officials emphasized Malta's strategic position in the Mediterranean for servicing naval vessels,

bunkering steam ships and acting as an *entrepôt* rather than developing its limited agricultural potential. (Atkins & Gastoni, 1997). In contrast, Gozo remained undisturbed by British interests and maintained normal daily operations.

Our knowledge of influenza epidemics in Malta (1730, 1754, 1836, 1847, 1862, and 1873; Cassar, 1964) remains unclear until the 1890s. With the onset of influenza disease notification, we begin to gain a numerical appreciation of the impact of the disease by month and by location as early as the Russian flu in 1889/90 (Government of Malta, 1896; Savona-Ventura, 2005).

Our understanding of the 1918 epidemic begins with early reports of sickness and deaths in early June and lasted until August 8th, 1918. This first, or herald wave, was confined to Malta, with ninety-three cases and two deaths among the civilian population. The second (fall) epidemic wave, lasting from September to the end of November, rapidly spread throughout Malta taking its toll of sickness and death in unprecedented numbers. The first recorded case in Gozo was on September 19th in the capital city of Victoria. The Maltese health authorities identified the third (winter) wave as occurring between December 1918 and June 1919. This last wave occurred over a much more protracted period with the emergence of a clear peak wave in March with 4,412 cases in Malta and 95 in Gozo.

3.3 Materials and Methods

By the close of the 19th century, health officials appointed under British rule followed a rigorous and comprehensive registration system for monitoring vital statistics. Tracking of influenza cases in the Maltese islands became possible as early as the 20th of January 1890 when cases were made notifiable. From that point on, authorities had an information base potentially allowing them to estimate the magnitude, tempo and spatial distribution of the disease (Sydenstricker, 1931).

We used two separate sources of disease reporting. The first was annual cases (for the years 1891to 1938) and monthly cases (for the years 1912 to 1929) from the Annual Health Reports.

Cases were identified as "influenza," in all years, except in 1918 where information on bronchitis and bronchopneumonia was available and included as a case. The second source was the Register of Prevailing Zymotic Diseases that was available solely for Gozo. The Gozo registry provides the following information: nature of disease, street and number of house infected, name of patient, age of patient, date of report, result and date of that result, disposal of case, reporter. The sex of individual can be inferred from the patient's forename. There are not any ambiguities with using forenames to identify sex, as there are a limited number of names are in Malta and they are dichotomous as strictly male or female. If there was any uncertainty over the sex based on name, it was cross referenced with marriage records. For example, Andrea is always the husband when listed in the marriage records Doctors identified these cases by conducting door-to-door queries of infected individuals. Because of issues associated with stigma and misdiagnosis, under-reporting of influenza was inevitable, it was nevertheless minimized since the sick were required to report their illness to health authorities or face summary conviction and a fine under Malta's Prevention of Disease Ordinance (Cap.36, August 10th 1908). Additionally, there were regulations in place encouraging physicians to report notifiable diseases not only through small financial incentives but penalties as well if specific diseases were not reported to the District Health Officer (Saliba, 2012).

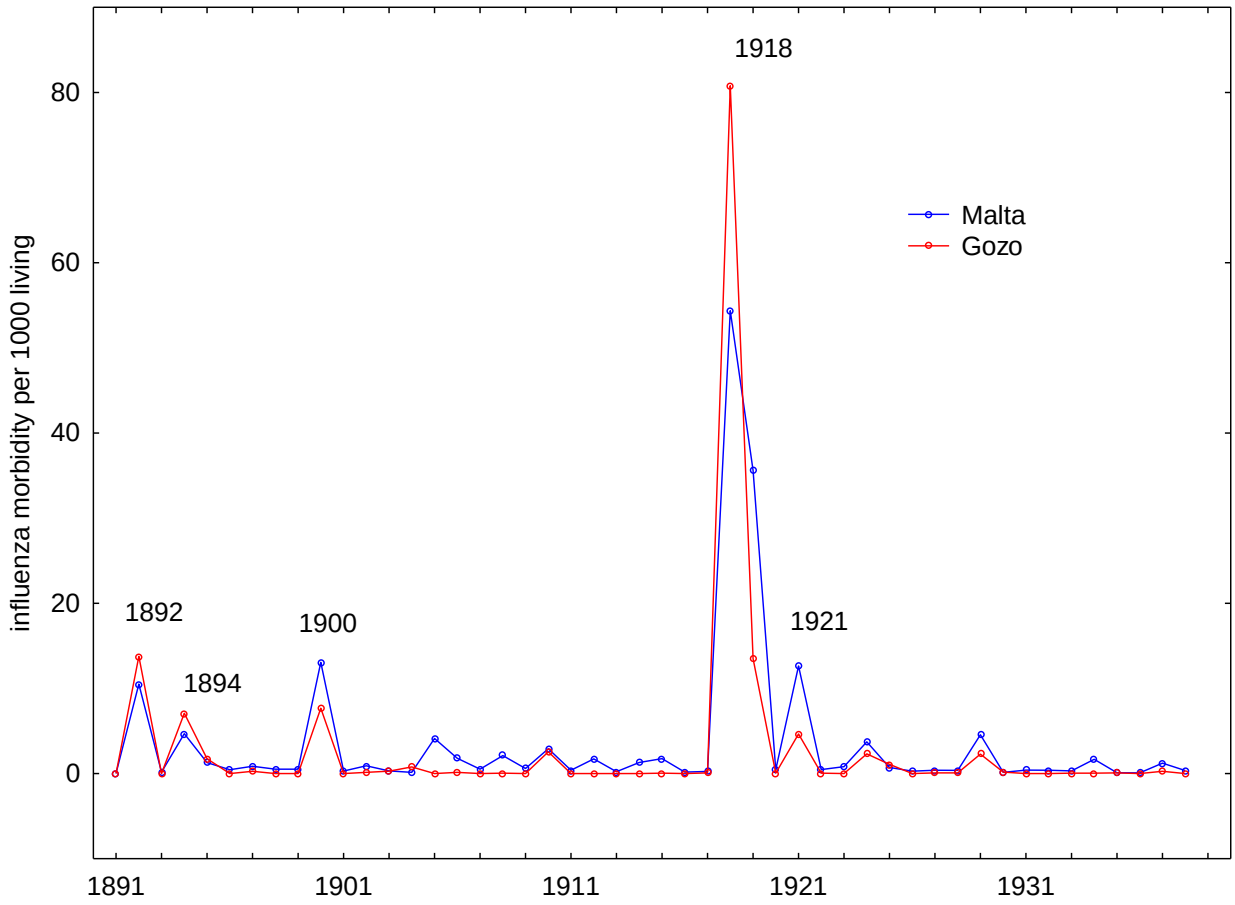
Data from the birth and death registers provided nominative information to complement the disease registry. The birth register allowed us to link influenza cases of mothers to births within nine months of those births, and to facilitate the process of matching name, surname, place of birth and age of the mother who gave birth. The death registry provided information on name, age at death, cause of death, place of birth, place of residence, name and surname of parents whether living or dead, cause of death and date of death. We used published aggregate censuses from the Island of Gozo for 1911 and 1921 as the basis to reconstruct the population at risk. Sprague's multipliers were used to remove the issue of age heaping in the respective censuses (Judson & Popoff, 2004). Population at risk by sex was refined using the Malta Health reports, which listed population size for Gozo and the number of births. Observations regarding the state of health and sanitary affairs we collected from the Annual Health Report by the Chief Medical Officer and other government officials.

3.4 Results

3.4.1 General Morbidity and Mortality considerations: Comparison of Gozo to Malta

Annual seasonal and epidemic influenza morbidity rates for Malta and Gozo are shown in **Figure 3-1**. With the exception of the epidemic years 1892, 1894 and 1918 when Gozo experienced higher rates of influenza, Gozo's overall experience with influenza was muted compared to the larger island of Malta. While Malta experienced outbreaks of influenza each year over the twenty-eight year period preceding the 1918 pandemic, there were thirteen instances when Gozo did not record a single influenza case. Consequently, prior to the 1918/19 pandemic, Gozitans had limited contact with influenza viruses.

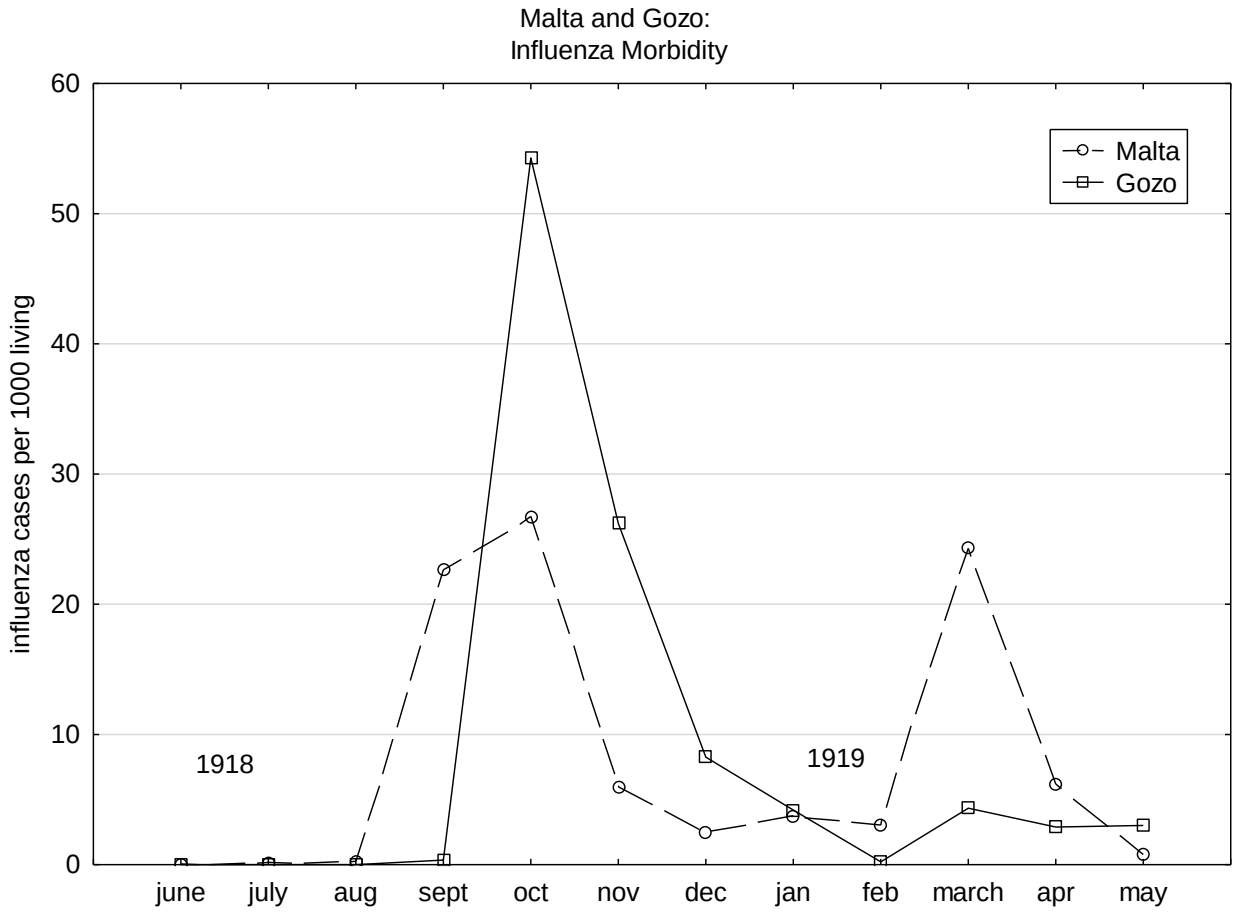
Figure 3-1. Annual morbidity rates for Malta and Gozo: 1891 to 1938



Unlike Gozo, Malta experienced a small first or herald wave, followed by two pronounced waves. Gozo went through the latter two: wave 2 from September to November 1918 (fall wave), and wave 3 from December 1918 to May 1919 (winter wave). Overall, Gozo experienced higher morbidity rates than Malta. These were driven primarily by the surge of cases in Gozo during the second wave of 90.11 per 1000 versus 53.15 per 1000 in Malta.

During the winter wave, there was a substantial drop in rates in both locations. In Gozo, there was a gradual decline in cases and then a slight increase in March. Malta's rates were nearly double that of Gozo: 43.70 per 1000 and 22.53 per 1000 respectively.

Figure 3-2. Monthly morbidity rates in Malta and Gozo during the 1918 pandemic



To capture the psychological and physical stress placed on a population by an epidemic, which in part follows from the work of Hollingsworth (Sawchuk, Tripp, Damouras & Debono, 2013), we constructed the Morbidity Burden Index (MBI) defined by:

$$MBIt = \{[s/(v - s)] * (1/\sqrt{(t)})\} * 100$$

Where, s= number of individual sick with influenza and associated complications; v = size of vulnerable population to contract s; and v is reduced relative to those exposed in an earlier wave and those who died during preceding interval; and, t = time measured in weeks for duration of

epidemic. The duration of epidemic in the fall wave was eleven weeks and twenty-eight weeks in the winter wave.

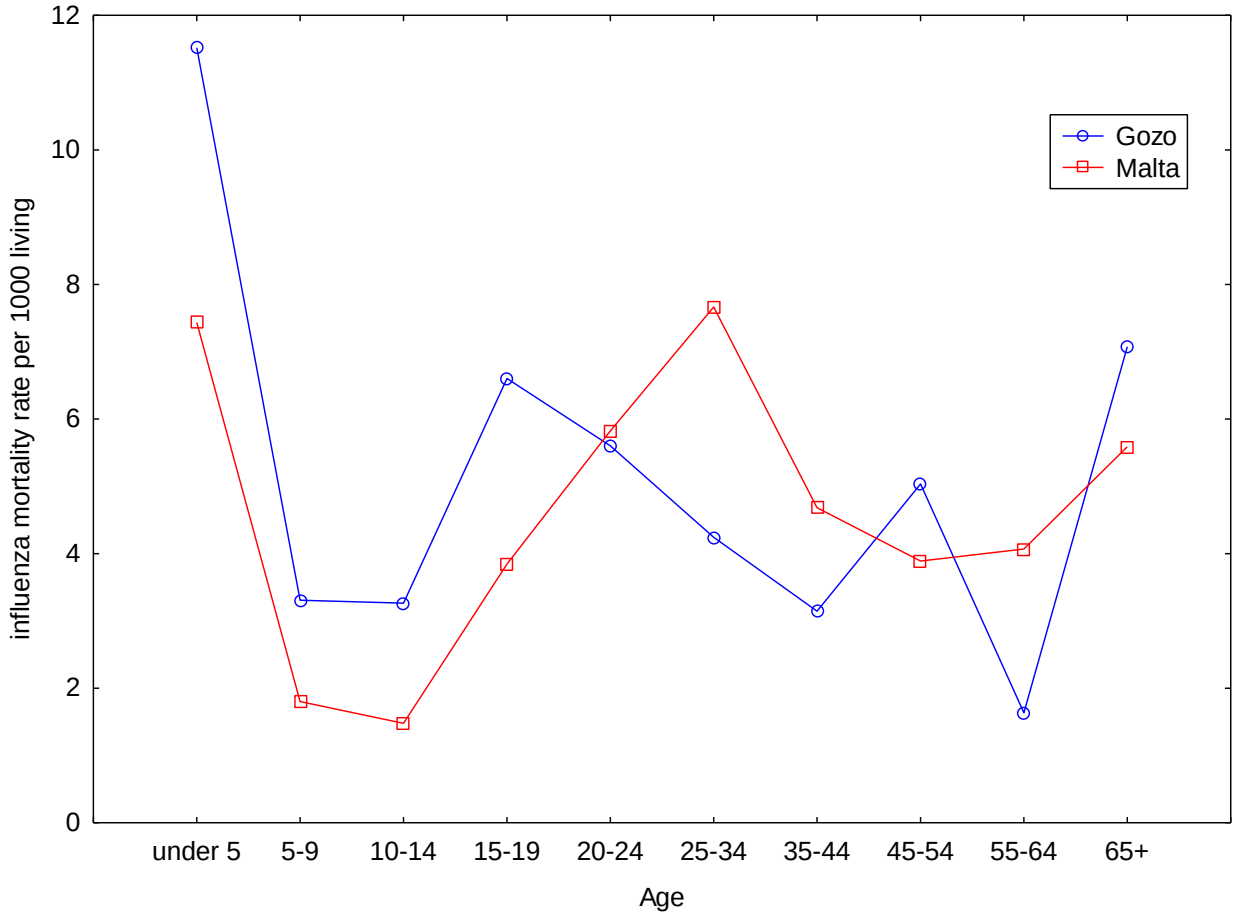
The morbidity burden was considerably higher in Gozo than in Malta during wave 2, but the location pattern was reversed in wave 3. In both locations, the stress of the epidemic was more perceptible in wave 2 (See **Table 3-1**).

Table 3-1. Morbidity Index by location and wave

	MBI	**MBI Ratio of Gozo to Malta**	**MBI Ratio of winter to fall wave**
Wave 2			
Gozo	2.99	1.91	
Malta	1.56		
Wave 3			
Gozo	0.452	0.50	0.15
Malta	0.896		0.57

As shown by the w-shaped graph in **Figure 3-3**, the age-distribution of influenza deaths in Malta and Gozo highlights Gozo's unique age at death experience. Unlike most populations, including Malta, where the peak age interval at death is twenty-five to thirty-four years, the ages of the peak of the young adults in Gozo is much lower at fifteen to nineteen years. The w-shape for age distribution in Gozo is skewed to younger aged individuals because Gozo's childhood mortality (birth to fourteen) exceeds that of Malta.

Figure 3-3. Mortality rates by age for the 1918/19 Pandemic for Gozo and Malta



An examination of mortality by waves reveals a corresponding pattern of morbidity rates in Malta and Gozo: during the fall wave, Gozo experienced significantly higher death rates than Malta, but lower rates during the winter wave (see).

Table 3-2).

In Gozo, there was a significant decrease in total, male and female mortality influenza rates from fall to winter waves ($p<0.0001$). In Malta, there was a significant increase in total and male mortality rates from the fall to the winter wave, but no significant change in female rates ($p=0.328$). Our results show that there was no significant sex differential in mortality in both locations and during both waves (see).

Table 3-2).

Table 3-2. Comparisons of influenza mortality rates per 1000 for Gozo and Malta by wave, and by sex for all ages

	Wave 2	**Wave 3**	**Z-score**
Gozo			
Total	4.027	1.022	6.272; p <.0001
Males	4.397	0.897	4.957; p <.0001
Females	3.632	1.135	6.197; p <.0001
Z-score (for sex)	0.760; p=0.447	0.352; p=0.725	
Malta			
Total	1.853	2.195	2.317; p= 0.021
Males	1.809	2.275	2.191; p= 0.028
Females	1.895	2.109	0.978; p= 0.328
Z-score (for sex)	0.383; p=0.702	0.729; p=0.466	
Z-score (for Total Gozo vs. Malta)	4.968; p <.0001	4.844; p <.0001	

There was a significant difference in median age at death between Gozo and Malta: during the fall wave, Gozo's median age at death was significantly lower. There was no significant difference in median age between the two locations during the last wave. Malta's age at death remained stable across the waves and was comparable to the universal mode age of approximately twenty-eight years (27 years) observed in many other populations during the pandemic (Gagnon et al., 2013; Hallman & Gagnon. 2014; Hallman & Gagnon, 2015). In the case of Gozo, using the mode age at death due influenza in a relatively small population to produce meaningful results is problematic given that the age range could be 1 to 100. Nonetheless, both the mean and median indicate that the age of death in Gozo is lower than that of Malta. Comparing the age distribution of deaths with the age bands in the life table indicates that Gozo is not comparable in structure nor in magnitude to that of Malta.

Table 3-3.Comparison of influenza median age at death by location and by wave

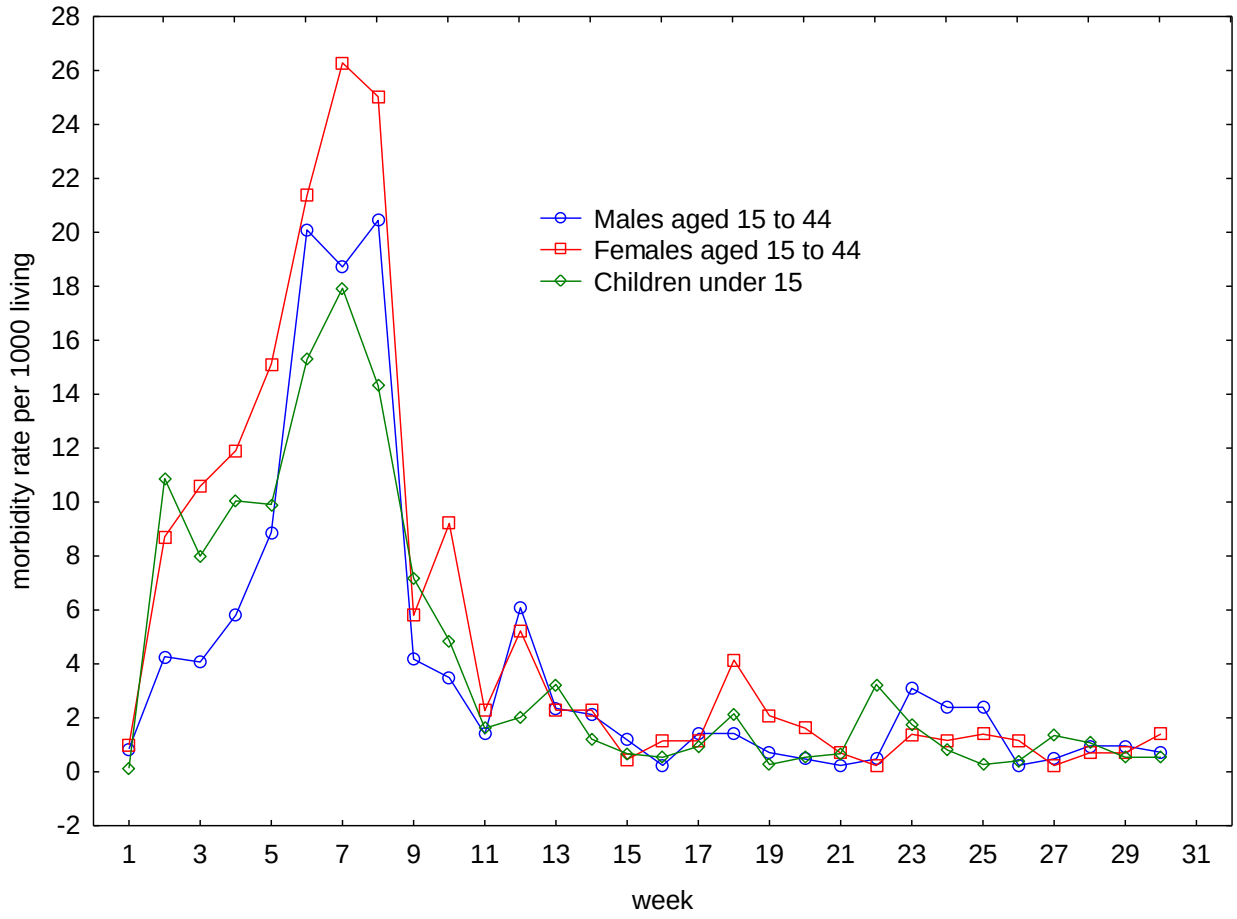
	Median Age at Death	**Man-Whitney U test**
Wave 2		
Malta	27.00	p=0.004
Gozo	19.00	
Wave 3		
Malta	27.00	p=0.088
Gozo	40.00	

3.4.2 Gozo: Sex and age differences in morbidity

Although information on age and sex of influenza morbidity was limited to Gozo alone, it still warranted closer examination given the exceptionally high sickness rates especially during the fall. Morbidity rates for the reproductively aged (15 years to 44 years) and for children are shown here because these age categories were the largest contributors to the influenza epidemic (see **Figure 3-3**).

Figure 3-4 shows morbidity rates by age and sex for Gozo starting on September 19th and ending in the last week of April. Reproductively aged females displayed the highest morbidity rates and, like those of the children, peaked during the fourth week of October. During the weeks directly after the fall wave, there were small spikes in morbidity, but, as noted above, these rates were minimal especially when compared to Malta. Consequently, further examination of sex and age differences in Gozo will focus only on the fall wave.

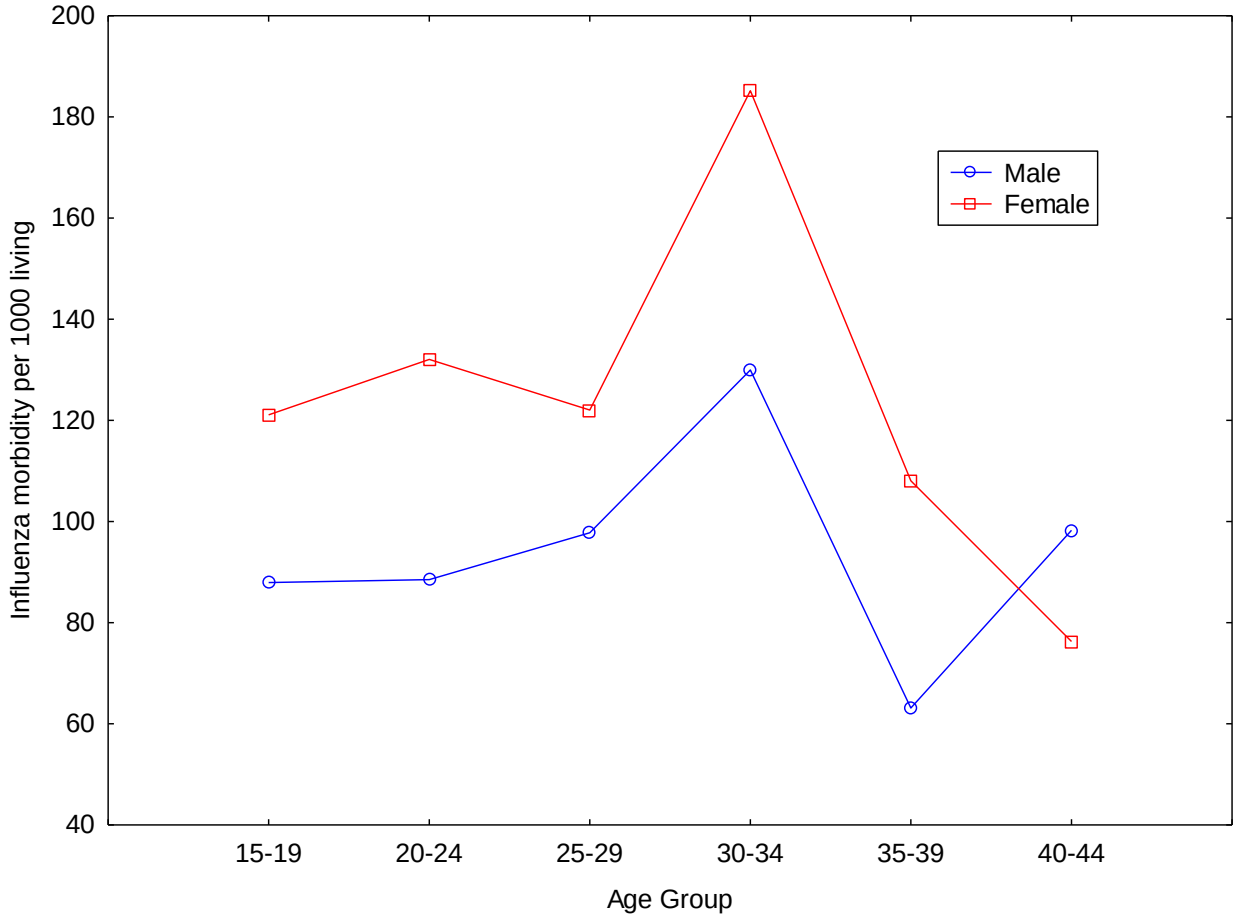
Figure 3-4. Weekly Influenza cases by age group (reproductively aged men, reproductively aged women, and children), and sex in Gozo during the 1918/19 pandemic



A total of 2036 cases were reported in the fall wave: the number of families affected totaled 1284, with an average number of 1.58 cases per household. There were 492 cases in the winter wave. These cases were matched (by surname, given name, age, town and street) against those infected in the fall wave. No individual case of reinfection was discovered, and this finding suggests that there was cross-protective immunity of influenza during the winter after the fall wave.

A distinguishing feature was a significant age at infection by sex (t=3.939, p=0.000) where the average age of infection was 23.93 for males and 26.00 for females. A visual inspection indicates that women aged 30-34 experienced the highest morbidity rates resulting in a w-shape age pattern of rates (see **Figure 3-5**).

Figure 3-5. Morbidity by age and sex, during wave 2 in 1918 Gozo



Despite the lack of sex differences in mortality during the fall wave, there was a highly significant sex differential in morbidity rates for the reproductive and post-reproductive age groups with an excess of female cases (see **Table 3-4. Comparison of morbidity rates per 1000 by sex and age for Gozo during wave 2**).

Table 3-4. Comparison of morbidity rates per 1000 by sex and age for Gozo during wave 2

Age group	Male	Female	Z-score
Pre-reproductive	92.70	83.10	1.53; p= 0.125
Reproductive*	97.28	138.29	5.28; p <0.0001
Post-reproductive	25.12	43.74	3.56; p= 0.001

*Reproductive age is 15-45 years

3.4.3 Children as Introducers

Weekly morbidity rates by sex and age show that children played an important role in the dynamics of the epidemic, not only as cases, but also as introducers of influenza into the household since the tempo of the weekly distribution of cases was similar for women and children (see **Figure 3-4. Weekly Influenza cases by age group (reproductively aged men, reproductively aged women, and children), and sex in Gozo during the 1918/19 pandemic**). Stepwise regression indicates that childhood influenza sickness (subjects under fifteen years) was a significant predictor of influenza morbidity among reproductive women (adjusted R^2 = 0.906), which increased (R^2= 0.958) with the inclusion of reproductive aged men. Interestingly, the inclusion of children as predictor of the influenza morbidity pattern of males aged fifteen to forty-four was not significant, but was a significant predictor of morbidity in reproductive women (adjusted R^2=0.910).

3.4.4 Pregnancy and Influenza

Given the sex difference in morbidity, we investigated the possibility of an association between influenza and pregnancy. Women in their reproductive period (fifteen to forty-four years) who reported influenza were linked to the births that took place nine months after the start of and the end of the fall wave (September to November). Information derived from the notification files was linked to births and yielded the following numbers: (a) women who were sick and pregnant (n=97); (b) women who were not sick but pregnant (n=698); (c) women who were sick but not

pregnant (n=517). The number of women aged fifteen to forty-four in the 1911 census was adjusted for the population as reported in 1917 (before the appearance of the epidemic) and was used as the grand total of potentially susceptible women. After subtracting quantities a through c, the total number of women estimated as not having the disease and not being pregnant, (d) were estimated at (n=3,477). The results indicate that pregnancy and influenza were not associated during the fall (x^2= 0.003, 1df, p= 0.957). An odd ratio test confirms that pregnancy does not increase the risk of contracting influenza (OR=0.935, Mantel-Haenszel x^2=0.264).

3.5 Discussion

Given the huge variation in 1918 influenza mortality rates across island populations (Shanks & Brundage, 2012), the finding of variation in influenza trends between the two islands of Gozo and Malta is not surprising. We discovered a distinct influenza pattern in Gozo with the following characteristics: (1) a complete absence of the herald wave; (2) a heightened second wave and significantly lower third wave relative to Malta; (3) influenza deaths in Gozo at a significantly younger age; and (4) an elevation in female morbidity rates compared to males among the reproductively and post-reproductively aged. With the exception of host immunity, the traditional factors for explaining inter-island variation in rates, overcrowding, poverty or unemployment and malnutrition, (Mathews, McBryde, McVernon, Pallaghy & McCaw, 2010; Murray, Lopez, Chin, Feehan, & Hill, 2006; Shanks & Brundage, 2012) did not apply to the Maltese islands. Overcrowding could not explain the elevated rates in Gozo because, at the household level, Malta was considered to be more crowded. During the early 20th century, the average number of persons per dwelling (exclusive of institutions) for Malta was 4.93 and 4.21 for Gozo (Government of Malta, 1912a). The average number of persons per room in each dwelling for Malta was 3.2 and 3.1 for Gozo (Government of Malta, 1922). With respect to poverty and the related factor of malnutrition during the 1918/19 influenza pandemic, which coincided with World War I, Malta was at an economic disadvantage and experienced higher unemployment rates. Because large-scale manufacturing opportunities were limited (Government of Malta, 1922), Malta was dependent on employment in the Royal Naval

dockyard. With the increase in unemployment at the close of the World War I, there was an accompanying increase in food rationing, a decrease in quality of food products and an increase in the cost of living. Conversely, Gozo's limited participation in the First World War and its primarily rural setting allowed for reliance on their own agricultural produce as well as minimal dependency on imported goods. Gozitans were better equipped to provide for their own employment needs and nourishment during periods of crises.

The only intrinsic factor operating in the Maltese islands was variation in host immunity as a result of prior exposure, isolation and rurality. Related factors that contributed to the disparity in disease experience included the following: variation in community interaction as a consequence of the scale effect and along with social distancing measures.

3.5.1 Isolation, Previous exposure and Rurality

We attribute the lack of any detectable herald wave, together with the occurrence of a heightened fall wave, in Gozo to the isolation of its residents to the outside world. Relative to Malta, Gozo is unique in its extreme degree of biological and social isolation where less than 1 percent of both males (0.6%) and females (0.09%) immigrated from abroad (Government of Malta, 1912a; 1922). Gozo was marginalized by the Maltese authorities because of neglect and perceived inferiority to its sister residents. Not surprisingly, over the centuries Gozitans have developed a unique and separate identity from that of Malta (Mamo, 2012). Because martial endogamy was commonly practiced, it further shaped self-identity along with limited biological contribution to the Gozitan gene pool from the Maltese. Notwithstanding the permanent biological separation from Malta, Gozo was in contact with Malta because the two islands were only separated by a mere five kilometers. Disease entry between the two locales was inevitable. As seen in **Figure 3-1**, from 1819 to 1917, rates of influenza in Gozo were dependent on rates in Malta (Rho=0.45; p=0.01). The relationship, however, is tenuous at best since during the same time period, the average influenza infection rate in Malta was significant higher at 2.06 per 1000 living as compared to 1.38 per 1000 in Gozo (z-score= 9.297, p = <0.0001). Gozo's prior exposure to influenza was extremely limited. Even in years with cases of influenza, it was sometimes only restricted to institutions and not the general population. For example, the influenza epidemic of

1910, which resulted in 58 cases, mainly infected the inmates of the Poor House in Victoria. Rurality figured prominently in the spread of influenza in Gozo as documented in other isolated agrarian locations. Because they were less densely populated with limited exposure to the influenza virus during the summer of 1918, they experienced a heightened fall wave compared to urban locales (Mamelund, 2011; Mamelund, Haneberg & Mjaaland 2016; Nishiura & Chowell, 2008).

3.5.2 The Scale effect: interconnectedness

Another important factor operating in the two islands was that of scale differences in territorial scope, and that played a role in structuring the ethos of Gozo where the population occupied an area of less than 67 square kilometers compared to 246 square kilometers in Malta. As a small-scale society where face-to-face contact was a daily experience, Gozo represented a web of highly interconnected settlements that increased the degree of solidarity and the strength of its traditions more so than its Maltese counterparts. This interconnectedness played a role in heightened morbidity during the fall wave because it facilitated the rapid transmission of the disease across the island. Within two weeks of the first case, seven of Gozo's twelve settlements, which held 78 percent of its population, had reported cases of influenza.

3.5.3 Social distancing measures

Evidence for community based prophylactic measures for limiting the spread of influenza in Malta is lacking in terms of the specificity in the timing of events. For example, during the early outbreak of influenza (mid-September), the military initially set out measures to prevent the spread of influenza. Later, local health authorities followed suit and encouraged those responsible for schools and other places of gathering to ensure that such places were clean, well ventilated and disinfected. In 1919, Malta's Chief Medical Officer of Health, Dr. Critien, stated that schools were closed during the epidemic (Government of Malta, 1919). There is no definite date, however, indicating when such places were closed or when they were re-opened.

It is noteworthy that much of Maltese life carried on as usual during the epidemic especially where religious activities such as marriages, baptisms and burials were concerned. As noted in a

local newspaper, the religious carnival, *il-Karnival ta' Malta* held in February and festivals in March went forward despite the continued presence of influenza cases in the islands. There is little doubt that these large crowded gatherings contributed to the resurgence of influenza cases as was reported in Malta's newspapers. Ultimately, these events resulted in a pronounced winter influenza wave in Malta and, to a lesser extent, in Gozo. The increased number of influenza cases in Gozo during the month of March, although somewhat muted, was largely attributed to an increase in the village of Nadur, the festival's centre. The influenza morbidity rate for Nadur was 18.79 per 1000 whereas the other Gozitans communities averaged 1.73 per 1000. The link between religious festivals and the resurgence of influenza at this time has not been fully explored and warrants the further examination of other Catholic communities.

3.5.4 Nurturant Women and Children Introducers

We argue that the most parsimonious explanation for the heightened morbidity among reproductive and post-reproductive women in wave the fall is grounded in their traditional gendered role as care givers, homemakers and other domestic duties and that it is irrevocably linked to children as influenza introducers. We borrow the concept of the nurturant role (Goves & Hughes, 1979), which has been traditionally applied to explain higher rates morbidity of mild cases of diseases in women, and we apply it to an epidemic setting where a highly infectious novel strain is easily and rapidly transmitted among family members of large households. We contend that, during such singular events, women underwent markedly higher stress levels as they tried to maintain essential daily elements of household security. In such moments of crisis, women are deprived of rest and sleep; they become physically run down; and they forgo much of their privacy (Goves & Hughes, 1979). Lack of sleep and being in a state of perpetual exhaustion is known to increase the risk of viruses due to alterations to the immune system (Irwin, McClintick, Costlow, Fortner, White, & Gillin, 1996; Prather, Janicki-Dewerts, Hall & Cohen, 2013). Furthermore, a mother would have been at increased risk of influenza. As the primary caregiver for children, she spent the majority of their time indoors in close quarters and was regularly in contact with her children. The nurturant role extends beyond the nuclear family: after marriage, the daughter is responsible for maintaining a close relationship with her parents,

and that includes providing for them during times of illness (McLeod, & Herndon, 1975). In the case of the first-born female, she was expected to remain single and reside with her parents to fulfill her duties as the primary caregiver (Father J. Bezzina, personal communication, February 17th 2015) and, presumably, a co-caretaker of younger siblings.

Adhering as they did to strict Catholic teachings, Maltese women were actively discouraged from practicing birth control. The result was a high birth rate and compressed age-specific fertility with closely spaced offspring. Crowded into unsanitary and poor ventilated living quarters, large families provided ideal conditions for spread of infectious diseases spread through continuous contact and close proximity to one another. Although the role of children as introducers of influenza has been accounted for during modern seasonal epidemics, the fact that children may have been key players in the spread of the disease during the 1918/19 influenza pandemic has not been demonstrated. Recent evidence of children as important carriers in the transmission of disease is based on the fact that children carry the virus for a longer period of time, they shed larger amounts of the virus than other individuals of the population and experience higher attack rates (Lau, Cowling, Cook & Riley, 2015; Munoz, 2002; Whitley & Monto, 2006). They may have been more susceptible to infection because of lower immunity (Monto & Sullivan, 1993) and, women and children spent more time in an overcrowded indoor environment, thereby increasing contact rates and altering the dynamics of transmission rates (Dushoff, Plotkin, Levin & Earn, 2004). Other local risk factors in Gozo warrant attention: for example, the closure of schools at the onset of the epidemic that placed women and children in continuous physical contact. The unseasonably cold and inclement weather during October encouraged indoor living and intensified the already overcrowded living conditions (Government of Malta, 1912b).

Heightened risk associated with gender was evaluated by examining influenza illness among married individuals. This was accomplished by examining a reconstitution of married couples from 1913 to 1918 and was linked to the notification information. The results yielded a significant difference in higher female influence morbidity (z-score=2.17 p =0.030). The morbidity rate stood at 5.40 for females and 2.78 per 1000 living for males. This supports the nurturant hypothesis because married females were two times more likely to be infected with influenza than married males. Additional support for the nurturant hypothesis is observed by the

fact that post-reproductively aged females also had significantly elevated morbidity rates compared to their male counterparts. It is very likely that these women provided care for children as mothers or grandmothers.

3.5.5 Pregnancy

Because of its characteristically large families averaged 6.51 children (Bland, 1994), Gozo provided an ideal setting to assess the possible relationship of pregnancy and influenza. Our study did not show a significant association between pregnant women and influenza cases in 1918. Studies on seasonal and pandemic influenza have brought to light the complexity of pregnancy as a risk factor for influenza viruses. Most recent studies conclude that pregnancy increases the risk of acute and complicated morbidity (WHO, 2015). Pregnancy does not affect risk of acquiring influenza, but rather the risk of becoming severely ill *if* the women should contract the virus. The cases from the 1918 pandemic in Gozo recorded in the notifications registry would have represented moderate to severe cases because individuals with mild symptoms would have been reluctant to report their illness to the visiting doctor.

Furthermore, during the second and third trimesters, the risk factors for increased severity/complications of the disease emerge (WHO, 2015). We could not examine the relationship between late stage pregnancies and increased risk of severe influenza because there was no information on the stage of pregnancy in Gozitan women from the birth registry nor on the level of severity of disease from the notification registry.

Our inability to ascertain the number of afflicted pregnant women who did not reach full term as a result of spontaneous abortions or miscarriages, could have contributed to incomplete records. It has been reported elsewhere that most hospitalized cases of influenza, especially those complicated with pneumonia, resulted in the termination of pregnancy and the death of the mother shortly thereafter (Harris, 1918; Woolston & Conley, 1918). It has also been reported that miscarriages during the first trimester may have been common, but gone unnoticed (Bloom-Feshbach et al., 2011; Harris, 1918). Potentially, there may have been missing cases of women

who were pregnant and who had contracted the virus. This number, however, is likely to have been too small to have any statistical impact on our results.

3.6 Conclusion

Our investigation represents the use of the case study approach, and the merits of using an island population of singularity to gain a better understanding of the sources of variability in shaping the morbidity and mortality experience of 1918/19 influenza pandemic. Using Malta as a point of reference, we found a number of significant differences with Gozo in the manifestation of signature features of the pandemic, despite the commonalities shared by the two islands. Limited exposure history as a consequence of isolation and rurality, lie at the core of the heterogeneity in the influenza pandemic experience, as Gozo had a long history of martial endogamy. The preference for local mates arose from a limited choice that was constrained by the paucity of immigrants and resulted in biological isolation from the larger island of Malta. Unlike previous studies on island populations, where overcrowding, poverty and malnutrition were contributors to the differential, we found that community scale and interconnectedness and social distancing measures were also key factors.

While current studies show the importance of children as introducers of sickness to the household, this is the first study that demonstrates the antiquity of this phenomenon, and how it played out during the largest influenza pandemic of the 20th century. Gendered roles proved to overload the coping capacity of women and it also explains why reproductively aged women suffered from higher influenza rates. While the universality of our findings cannot be verified by this study alone, future studies should be directed toward examining the variation in the expression of signature features of the influenza pandemic, and the importance of women and children as the nexus of past and future influenza epidemics.

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Chapter 4

4 Insights into Secular Trends of Respiratory Tuberculosis: The early 20th century Maltese Experience

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Author contributions: I was the main contributor to the conceptual framework of this paper. L.A. Sawchuk helped me with the data collection and the writing of the manuscript. I conducted the analyses of the paper. I was the sole contributor to the research into factors responsible for secular trends in tuberculosis and to the overall presentation of the paper.

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4.1 Abstract

Over half a century ago, McKeown and colleagues proposed that economics was a major contributor to the decline of infectious diseases, including respiratory tuberculosis, during the 20th century. Since then, there is no consensus among researchers as to the factors responsible for the mortality decline. Using the case study of the islands of Malta and Gozo, we examine the relationship of economics, in particular, the cost of living (Fisher index) and its relationship to the secular trends of tuberculosis mortality.

Notwithstanding the criticism that has been directed at McKeown, we present undisputable results that economics is the most parsimonious explanation for the decline of tuberculosis mortality. We reaffirmed that the reproductively aged individuals were most at risk of dying of tuberculosis, seeing that 70 to 90% of all deaths due to tuberculosis occurred between the ages of 15 and 45. There was a clear sex differential in deaths in that, prior to 1930, rates in females were higher than males. During times of extreme hardship, the sex differential is exacerbated. Over the course of World War I, the sex gap in tuberculosis rates increased until peaking in 1918 when there was also the influenza pandemic. The heightened differential was most likely a result of gendered roles as opposed to biological differences since female tuberculosis rates again surpassed male rates in 1945 during World War II.

Respiratory tuberculosis in both urban and rural settlements (in Malta proper) was significantly influenced by the Fisher index, which explains approximately 61% of the variation in TB death rates ($R=0.78$; $R2=0.61$; $p<0.0001$). In Gozo, there was no significant impact on respiratory tuberculosis ($R=0.23$; $p=0.25$), most likely a consequence of the island's isolation and a self-sufficient economy.

4.2 Introduction

As a re-emerging infectious disease of considerable importance, respiratory tuberculosis is the single main cause of death worldwide in young adults (Holmes, Hausler & Nunn, 1998; Ravigilone, Dixie, Snider & Kochi, 1995; The World Bank, 1993). Beginning in the sixteenth century, tuberculosis decimated populations in Europe (Murray, 2015), killing, for the most part, those in their reproductive prime. Since at least eighteen hundred, however, a considerable body of evidence shows a gradual and progressive decline in respiratory tuberculosis death rates (McKeown & Record, 1962; Murray, 2015; Vynnycky & Fine, 1999). As the secular trend in decreasing rates preceded knowledge of the etiology of tuberculosis and use of effective anti-tuberculosis drugs, reasons for the decline are the subject of considerable debate and remain elusive. Leading explanations include a number of factors. Better living conditions resulted in an improved diet and, possibly, a favourable trend in the relationship between the bacilli and the human host (McKeown & Record, 1962; McKeown, Record & Turner, 1975). Government initiatives aimed at public health measures were able to reduce "urban congestion" (Szreter, 1988). The average number of "effectively contacted" by an infectious case decreased for the following reasons: the decline in household crowding; improved ventilation in buildings; reduction in the proportion of the elderly, who are sources of tuberculous infection, residing at home; and the segregation of the infected to workhouses or sanatoria (Vnnycky & Fine, 1999) and possibly, due in part of the action of natural selection (Davies, Tocque, Bellis, Rimmington & Davies, 1999; Lipsitch & Sousa 2002).

The global decline in tuberculosis deaths was interrupted twice - during World War I and to a lesser extent during World War II - and then resumed in post-war years. Undoubtedly, wartime conditions played a huge role in spurring infections of tuberculosis by hastening the conversion of latent tuberculosis to active tuberculosis cases (Murray, 2015). During World War I, rates of respiratory tuberculosis reached unprecedented levels when even nonbelligerent countries experienced strikingly high tuberculosis death rates. In some of the countries at war (the entire British Empire, for example), more people died of tuberculosis in the single year of 1917 than soldiers on the battlefield (or after) during the course of the four plus years of war (Drolet, 1945).

Nevertheless, war conditions alone could not have accounted for the sheer magnitude of tuberculosis death rates. After all, the rates during World War II did not reach excessively high rates relative to the surrounding background mortality. According to one theory, a novel strain of M. tuberculosis, the Beijing lineage, resurfaced during World War I - a strain with a quicker transition from infection to disease, increased virulence, and transmissibility (Merker et al., 2015) - and would have been responsible for the increased mortality. Following the war, however, there was a sudden return to the declining trend of pre-war tuberculosis rates proving the strain could not have been the main contributor to the elevated rates: the bacilli would need to have disappeared abruptly from the population after the end of the war. These are the main theories about contributing factors to the increase of rates during the First World War: overcrowding, which would have been more noticeable in war countries where women, children, and refugees were displaced from war torn areas; increase in malnutrition, although there is evidence allied countries did not experience food shortages to the same extent as German occupied nations; shortage of medical care (Murray, 2015); and the selective effect of influenza on the tuberculous during the 1918 pandemic (Noymer 2010). Nonetheless, this relationship can account only for the increase in 1918/19 and not in the preceding war years. Together, the events of World War I and pandemic influenza constitute a singular conjunction that triggered population shock and, in turn, its effect on tuberculosis mortality was unprecedented. We contend that such rare and fortuitous events can be a useful tool to gain insight into the relative importance of specific factors that normally lie hidden in diseases of complex etiology.

In this paper, we explore reasons for the decline of tuberculosis death rates in the civilian population of Malta during the early 20th century. We also address the question of why there were deviations from the normative trend in 1917 and 1918 when rates exceeded background mortality. We examine trends in tuberculosis by sex, age, and sex-age specific rates as well as changes over time and during the crisis period of World War I.

4.2.1 The study Population: Background on Malta

The Malta archipelago consists of three major islands: Malta, Gozo, and Comino. Because Comino is sparsely populated, our study does not include this island. Historically, on the larger

island of Malta, there existed significant regional differences in terms of landscape: an urban and rural dichotomy. With an area of approximately sixty-seven square kilometres and lying five kilometres away from the main island, Gozo is about one quarter the size of Malta. Gozo's distinct cultural ethos and biological heritage is grounded in geographical isolation. Gozitans see themselves 'apart' from the Maltese for several reasons: they feel they have been marginalized by bureaucratic neglect, overlooked in regard to fundamental economic opportunities and denied adequate health and social infrastructure (Apolostolides, 2008). Because the island was so small and its people showed a long-standing preference for spatial endogamy, it comes as no surprise that, prior to World War II, there were scarcely any differences to be found between the life and customs in the town and in the villages (Bezzina, 1985).

Malta represents an ideal location to study secular trends in tuberculosis as it minimizes a number of confounding factors responsible for elevated rates of air-borne infections or obscuring real trends in tuberculosis mortality. First, prior to World War II, Malta was a geographically isolated population with little immigration. Consequently, the effects of immigration from high prevalence countries which could have altered the rates of tuberculosis over time can be viewed as minimal (Mason & Smith, 1989). Second, there was little large scale industry (Government of Malta, 1912; Government of Malta, 1922) to expose major segments of the population to airborne pollutions. Industrial emissions could have compromised the overall health of the population and exacerbated infections such as respiratory tuberculosis. Finally, the potential impact of exposure to *M. bovis* prior to the pasteurization of milk in 1950 and its subsequent impact on tuberculosis and reactivation (Tocque et al., 1998), can be considered negligible because Malta was completely reliant on goat's milk rather than cow's milk prior to World War II (see Tripp & Sawchuk, 2015).

Aside from the features of cultural and religious homogeneity, there is an important element of diversity in occupation and economics that allows for a better understanding of changes in tuberculosis mortality. The island of Malta's topography, with its marginal Xaghri (karstik land) and overall scarcity of productive land, meant that the Maltese were largely dependent on food imports for their nutritional needs (Boissevain, 1969). There were, however, marked differences within the Maltese landscape for food self-sufficiency. Inhabitants of Gozo and rural Malta farmed their land, thus these locales were less reliant on imported food products. By examining

the relationship at the three regional settings (Gozo, Malta suburban/urban, and Malta rural), we may gain a deeper understanding of nutrition and its role in tuberculosis deaths. In other words, the Maltese setting can be viewed as a continuum of populations residing in areas of high dependency to low dependency on food imports.

Accordingly, we shall take advantage of conditions equivalent to a "natural experiment" where the impact of a moment of crisis associated with World War II and the 1918 influenza pandemic combined with an unusual population setting can be studied for its effect on respiratory tuberculosis mortality. These conditions include the following: a high impact stressor that targeted a significant portion of the population and very likely had a negative and discernible impact on health because of its known biological and environmental etiology; a stressor that occurred over a clearly defined period of time and one of sufficient temporal scope to yield measurable results. The second factor, the population, was biologically and culturally homogenous and yet was diverse enough to let us evaluate the importance of potential risk factors on vulnerable segments of the community.

4.3 Data & Methods

To assess the overall health status of males and females in the Maltese islands, we used the life table analysis. We employed life expectancy estimates at birth and at age twenty-five for the years 1911 to 1924. The average of the life expectancy from 20 to 45 years supplies us with a proxy measure of health of the reproductively aged individuals, the age category most at risk of pulmonary tuberculosis, and they provide a more accurate indicator of adult health. Traditionally, the results from life tables have been used to assess the health of large populations. Recent studies, however, have based their studies of smaller populations on the life table methodology (see Manuel, Goel & Williams 1998; Sawchuk, Tripp & Melynchenko, 2013).

Using the Smith Survival Program (Version 9.2), we applied the Chiang (1984) period approach for estimating the various life table parameters. The benefits of employing the Chiang method are these: (1) it produces the most conservative estimates for comparison between local areas; (2)

it is easy to calculate (including statistical variance); (3) it allows for sensitivity analysis to perform on the major assumptions; and (4) it is widely used in research allowing for comparability of results to other populations (Manuel, Goel & Williams, 1998).

To capture the nature of the change in tuberculosis mortality by age and sex, we constructed four discrete time periods: (a) 1911 to 1916; (b) 1917; (c) 1918; and (d) 1919 to 1924. Results from our life table analysis framed the probability of dying from respiratory tuberculosis under the prevailing mortality pattern.

Annual deaths numbers by sex and age for all causes, tuberculosis and influenza were drawn from the Health Reports for the Maltese islands (1911-1938) and from the Maltese Gazette for monthly causes of death by sex and age (1939-1952). Published under the auspices of the Medical Officer of Health, the reports also yielded information on health related matters about infants, maternity sanitation, housing, food quality, water as well as detailed accounts and observations of morbidity of notifiable diseases over the course of a year.

To reconstruct the population at risk for the population and its respective regions, we took advantage of published census reports from 1911, 1921, 1931, and 1948. Annual sex and age specific population at risk taken at four-year intervals beginning with one year olds was interpolated by using age-specific multipliers applied to the age and sex specific population sizes from the census of the closest year. The total population, we estimated, fell within a margin of 100 individuals of the total population as cited in the Health Reports (e.g. the population size in 1918 was 242 323). Annual birth rates, retrieved and compiled from the monthly Malta Gazette death records where live birth information was recorded, gave us the approximate number of infants under one year of age. This approach assumed that stability in the proportions of individuals at risk for each age band over the decennial period. Using the aforementioned data sources, we compiled the overall as well as the sex and age specific (15 to 44 years) annual tuberculosis mortality rates for Malta from 1911 to 1952.

Using census returns and their protocol for defining the residential settlement type, we divided Malta's settlements into dichotomous distinct settings: (1) urban and suburban setting and, (2) rural setting. We extracted regional information from the Annual Health Reports based on Malta's administrative definition of the respective regions as specified in the Census returns of

1911 and 1921. We gathered the collective and individual settlement structure of Gozo from both the census and annual Health Reports. Tuberculosis mortality rates were produced for each of the three regions.

Because of the varying degrees of dependency on the importation of foodstuff across the Maltese islands, we used food imports as a proxy measure of the cost of living, which can be examined for its effectiveness as an explanatory variable for the rates of respiratory tuberculosis mortality over time and within the three regions. Data on economic parameters used to construct the price and quantity index, the chained linked Fisher index, for 1910 to 1938 (years 1916 and 1920 were excluded from the study), was sourced from the importation of goods information found in the Malta Blue books. J. Falzon generously supplied the values for the Fisher index as presented in Falzon and Lanzon, 2011. We chose it for its superiority as a price and quantity index because it satisfies most of the desirable properties of an index (see the 10 properties as outlined in Falzon and Lanzon, 2011 and as originally presented by Diewert, 1987). The Fisher index is a measure of inflation based on house consumption and unit price values, and is the square root of the Laspeyres index multiplied by the Paasche index. We analyzed the relationship of economics to tuberculosis death rates (overall and regional) using least square regression and Pearson's correlation analysis.

We recognize the potential limitations in our study. Since tuberculosis was often incorrectly identified as the cause of death (McKeown, 2004), it is inherently possible that we overestimated our rates of tuberculosis mortality. At the same time, there was no sure method of confirming cases and causes of death even by World War when portable x-rays were used, but not readily available, so that many were diagnosed without the confirmation of x-rays (Murray, 2005). For this latter reason, some have argued that the improvement in diagnosis over time has been partly responsible for the decline in tuberculosis deaths (McKeown, 2004).

4.4 Results

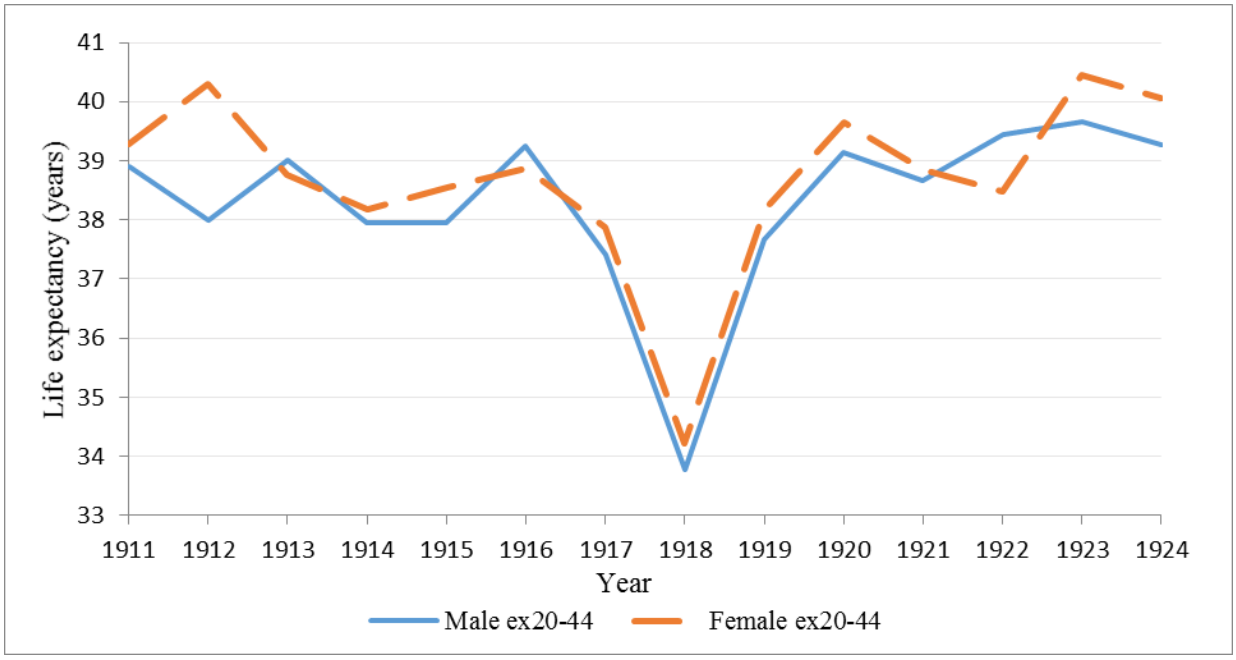
4.4.1 Background Health

Figure 4-1 shows that during the thirteen year study period life expectancy at birth did not exceed 44 years, however life expectancy at birth is highly variable for one year to another as life at birth in Malta was tenuous. Diarrheal deaths accounted for high infant mortality rates, and harsh climatic conditions such as an unseasonably dry hot summer would have exacerbated infant deaths (Sawchuk, 2008). However, life expectancy at birth concurs the general disadvantaged health of both males and females.

Figure 4-1. Male and Female Life expectancy at birth: Malta 1911 to 1924

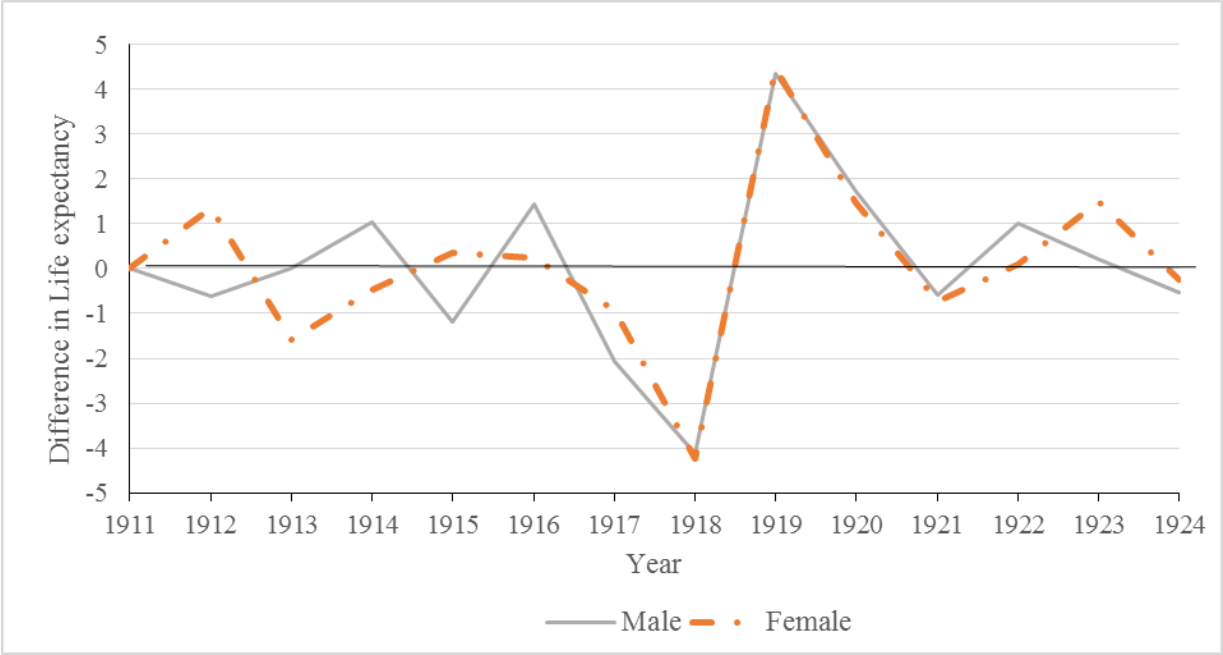
As shown in **Figure 4-2**, life expectancy from 20-44 years of age for both males and females remains relatively stable over the study period, with the exception of 1918. With a maximum life expectancy of 34 years, the total average lifespan would be approximately 66 years.

Figure 4-2. Male and Female Life expectancy at 20-44 years of age: Malta 1911 to 1924



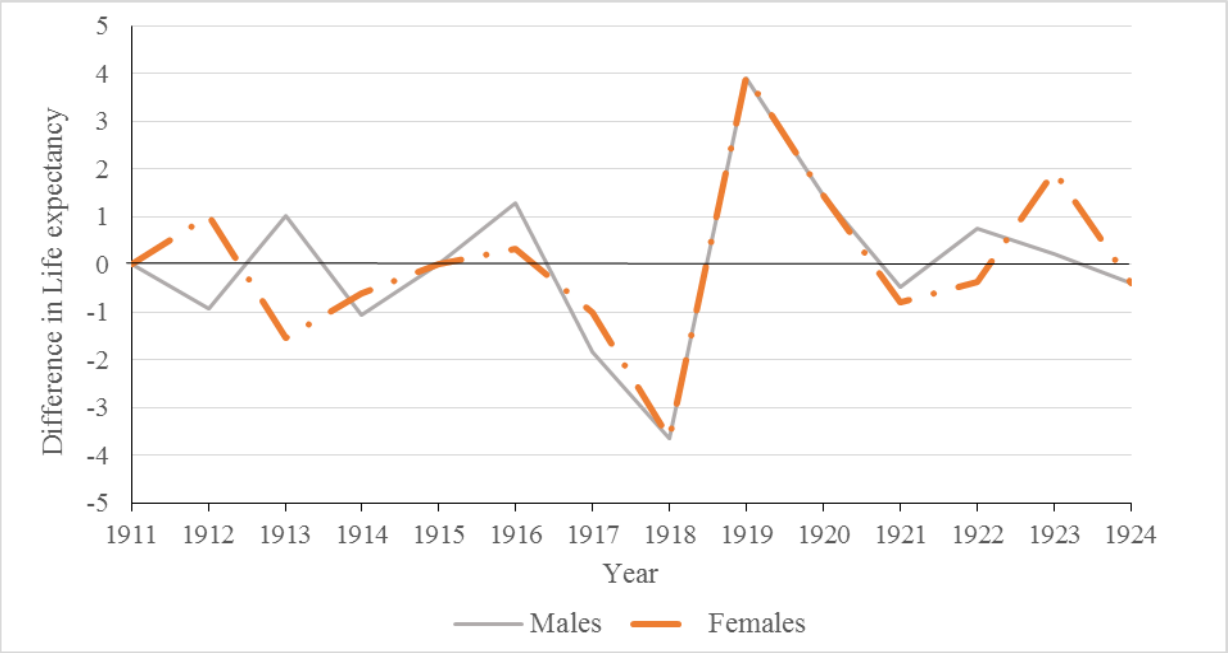
Annual changes in life expectancies for 25 years were assessed in **Figure 4-3** (25 years was used as we can report the statistical changes in life expectancy from the lifetable). Significant decreases in male life expectancies occurred in 1915, 1917, and 1918 (p-values <0.05). In females, the only significant drop in life expectancy at 25 years occurred in 1918; the impact of the 1918 influenza epidemic on the overall health of the population cannot be overlooked. During this year alone, life expectancy plummeted to an all-time low of 35.58 years for males and 35.04 years for females, a four year decrease from 1917. Following the war in 1919 and 1920, there were significant increases in life expectancy, rebounding or, in some years, exceeding pre-war levels.

Figure 4-3. Male and Female changes in annual Life expectancies at 25 years of age: Malta 1911-1924



The pattern of the differences in the average of the life expectancies from 20 to 44 years of age is similar to that of the life expectancy of 25 years (see **Figure 4-4**).

Figure 4-4. Male and Female changes in annual Life expectancies for 20-44 years of age: Malta 1911-1924



4.4.2 Probability of Dying from Respiratory Tuberculosis

Figures **Figure 4-5** and

Figure 4-6 show the distinctive pattern of the rise in tuberculosis mortality for both 1917 and 1918 relative to the period before and after the dramatic rise in tuberculosis mortality. For males, the increase was concentrated in the age bands 25 to 34 years and 35 to 44 years. It is also noteworthy that probability of dying from respiratory tuberculosis after 1918 was very similar to the pattern before 1917. The female pattern of tuberculosis mortality was different in 1917 and 1918 from that of males in terms of a broader base of heightened mortality, as well as a larger peak mortality. Following 1918, respiratory tuberculosis mortality retained its distinctive peak at age 25 to 34 and remained higher than the period preceding 1917.

Figure 4-5. Male Probability of dying from Tuberculosis for four time periods

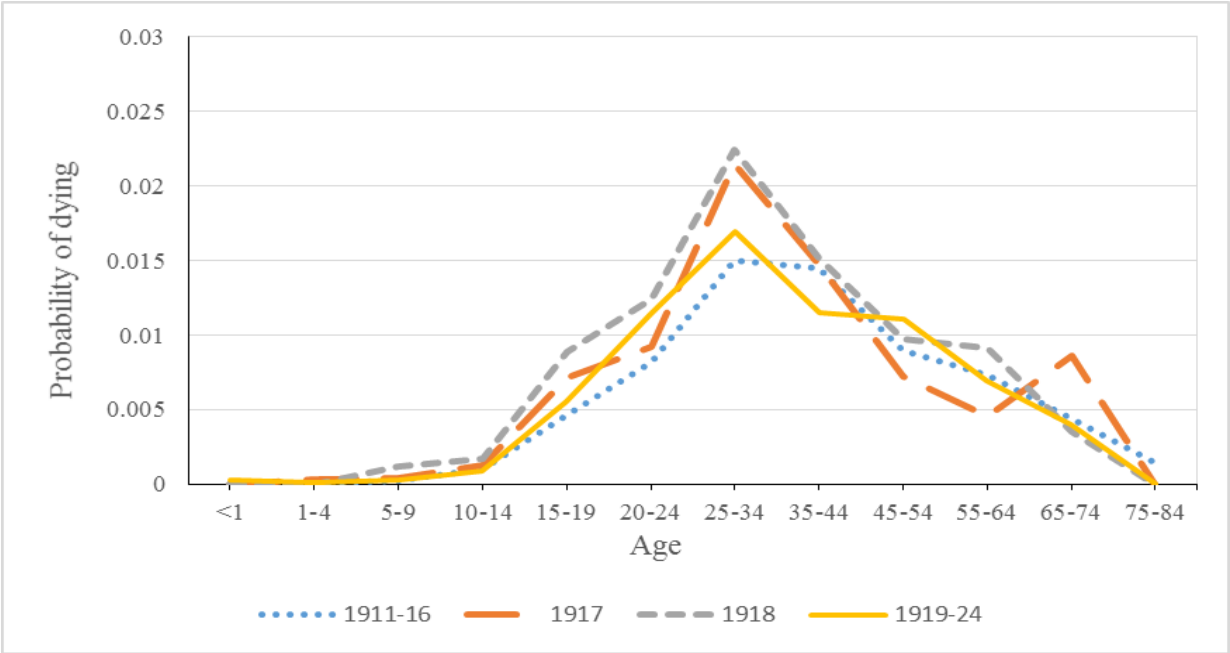
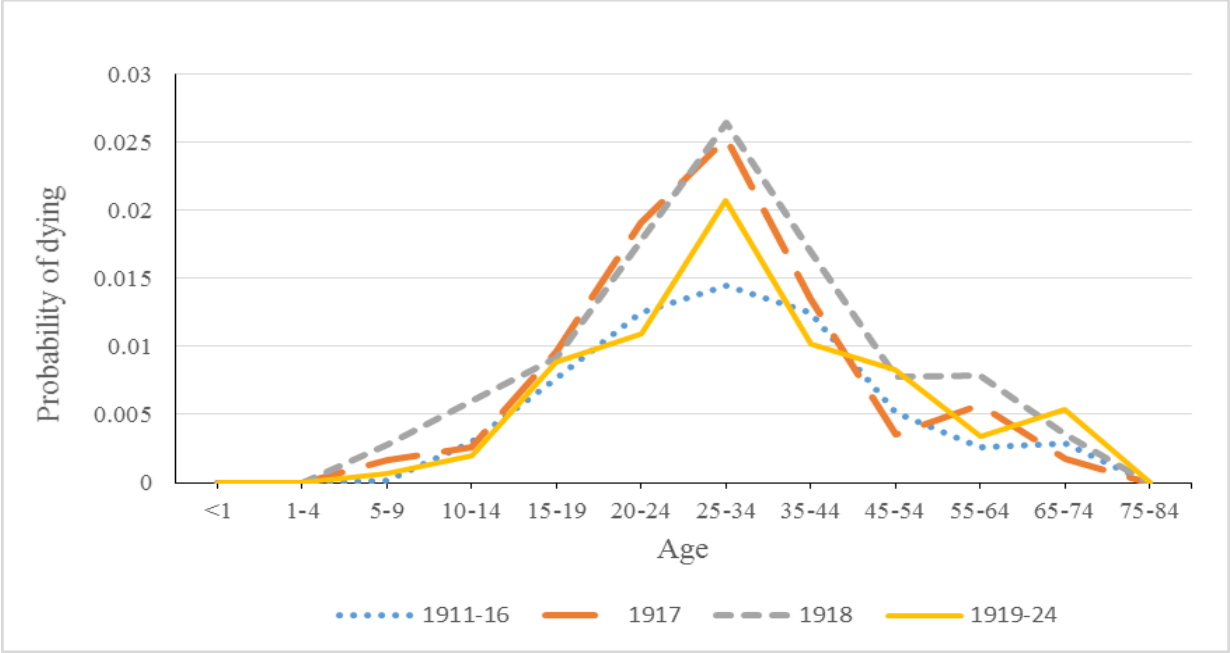


Figure 4-6. Female Probability of dying from Tuberculosis for four time periods

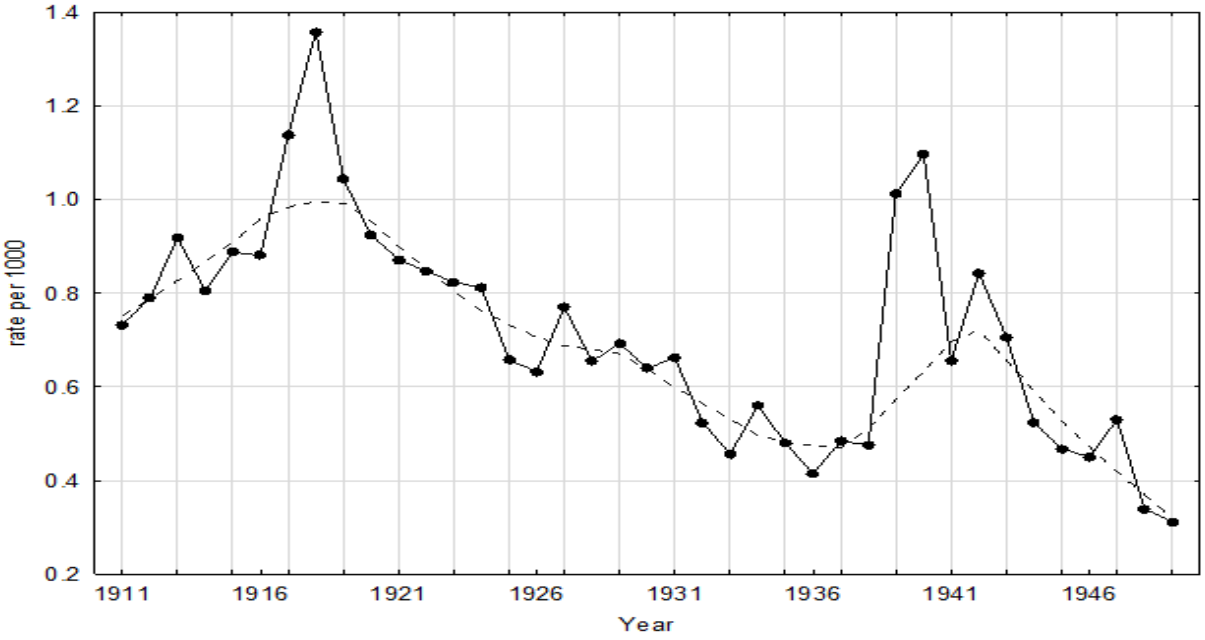


4.4.3 Respiratory Tuberculosis Rates over Time

As is shown in

Figure 4-7, the general trend for tuberculosis deaths rates from the early to mid-1900s in the Maltese islands was a gradual decline. During World Wars I and II, the secular trend was interrupted, and rates rose to exceptional levels, 1.36 deaths per 1000 individuals in 1918, and to a lesser magnitude of 0.84 deaths per 1000 individuals in 1942. After accounting for annual variation, the lowess curve for mortality rates show that spikes in rates during the wars still persist, and there were increases in rates around 1929 to 1931. Similar findings of exceptionally high mortality rates during the world wars have been observed elsewhere (see Cobbet, 1930; Drolet, 1945; Murray, 2015). The markedly high tuberculosis rates during 1917 and 1918 are attributed by most scholars to the confluence of the war and the influenza epidemic.

Figure 4-7. Overall Tuberculosis mortality rate and Lowess curve: Malta 1910-1952



The mortality rates of reproductive age adults provide a more refined exploration of the chronological trend in tuberculosis mortality rates since, in any given year, 70 to 90% of all deaths due to tuberculosis occurred between the ages of 15 and 45 years of age. **Figure 4-8** shows that the general trend of a reduction in tuberculosis rate remains the same, but the absolute rates during the war were more pronounced: 2.32 deaths per 1000 individuals and 1.36 per 1000 individuals in 1918 and 1942 respectively. There was a decline in rates beginning in 1920, reaching the nadir in 1922 and rebounding to almost pre-war levels in 1923.

Figure 4-8. Tuberculosis mortality rate and Lowess curve for reproductively aged individuals: Malta 1915-1949

Figures**Figure** 4-9 and **Figure 4-10** shows the tuberculosis death rates for males and females and the lowess curve. With the exception of 1922, prior to 1928, rates in females were higher than males. We observed a trend in reproductively aged females similar to the overall tuberculosis death rates: there was spike of tuberculosis during the war that peaked in 1918, followed by a

rapid decline thereafter, with an increase close to pre-war levels (rates not shown here). On the other hand, the trend in male tuberculosis rates during the war and post-war period differed from that of the females. Male tuberculosis rates dipped only slightly in 1919 when the third wave of the epidemic was occurring, and then returned to near pre-war levels in 1920. It follows that reproductively aged females rates are driving overall rates regardless of age. During World War I, the sex difference in tuberculosis death rates peaked (see

Figure 4-11). The heightened differential is most likely a result of gendered roles as opposed to biological differences since female tuberculosis rates again surpassed male rates from 1924 to 1928, and in 1943 during World War II.

Figure 4-9. Male and Female Tuberculosis Mortality rates: Malta 1911-1949

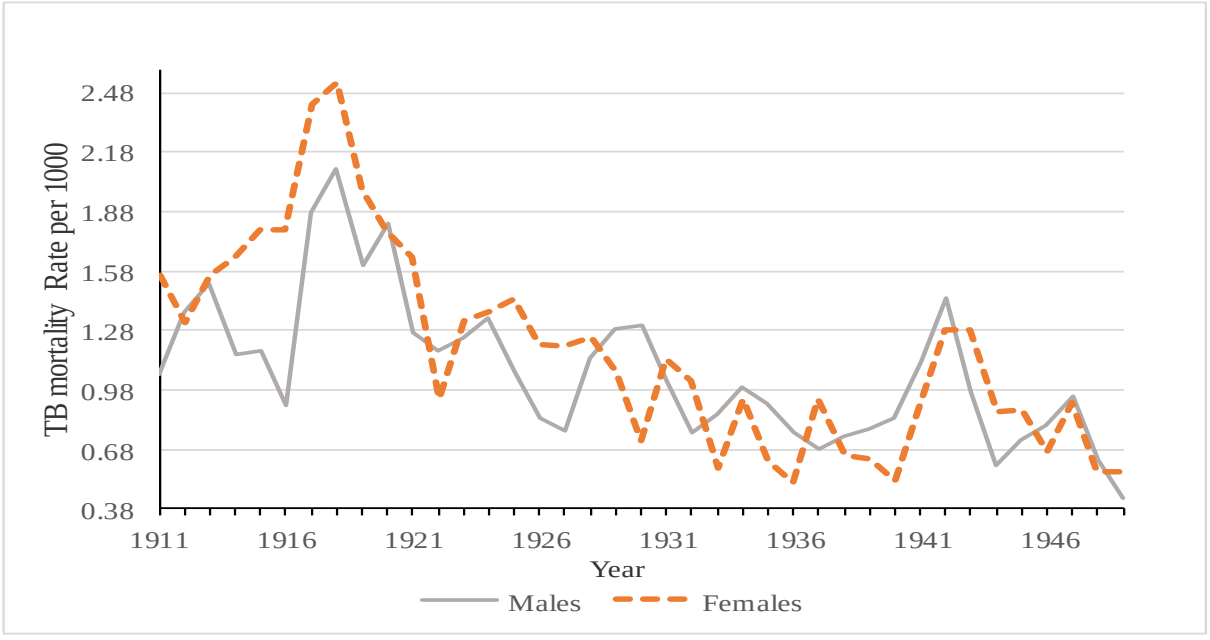


Figure 4-10. Male and Female Lowess curves for Tuberculosis Mortality rates: Malta 1911-1949

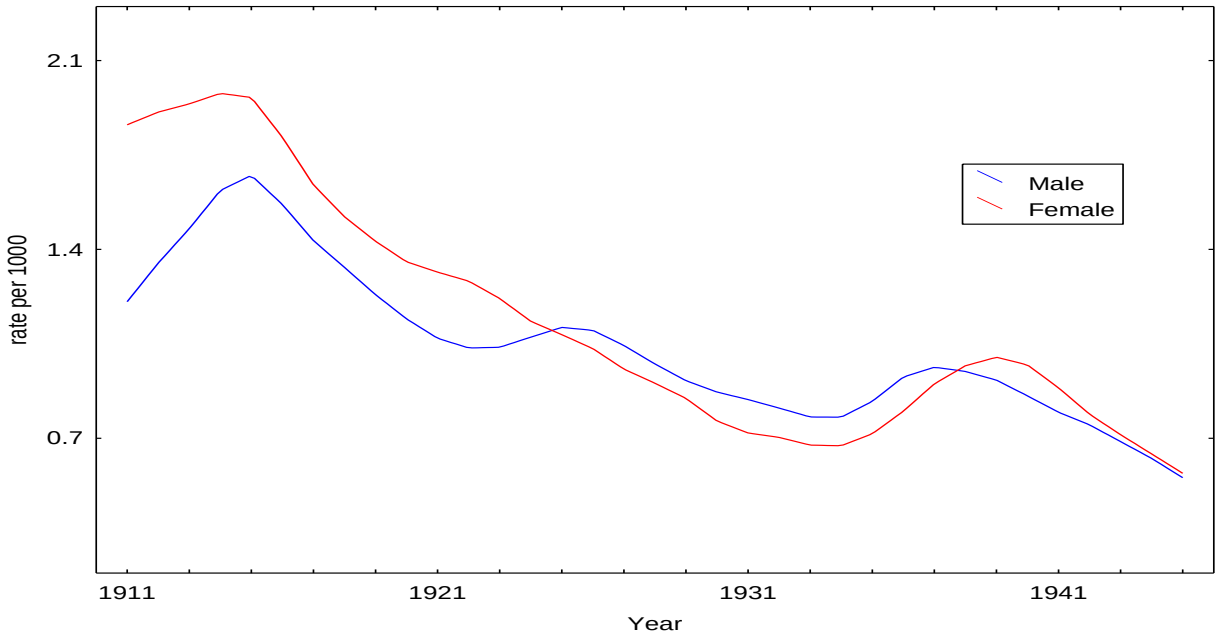
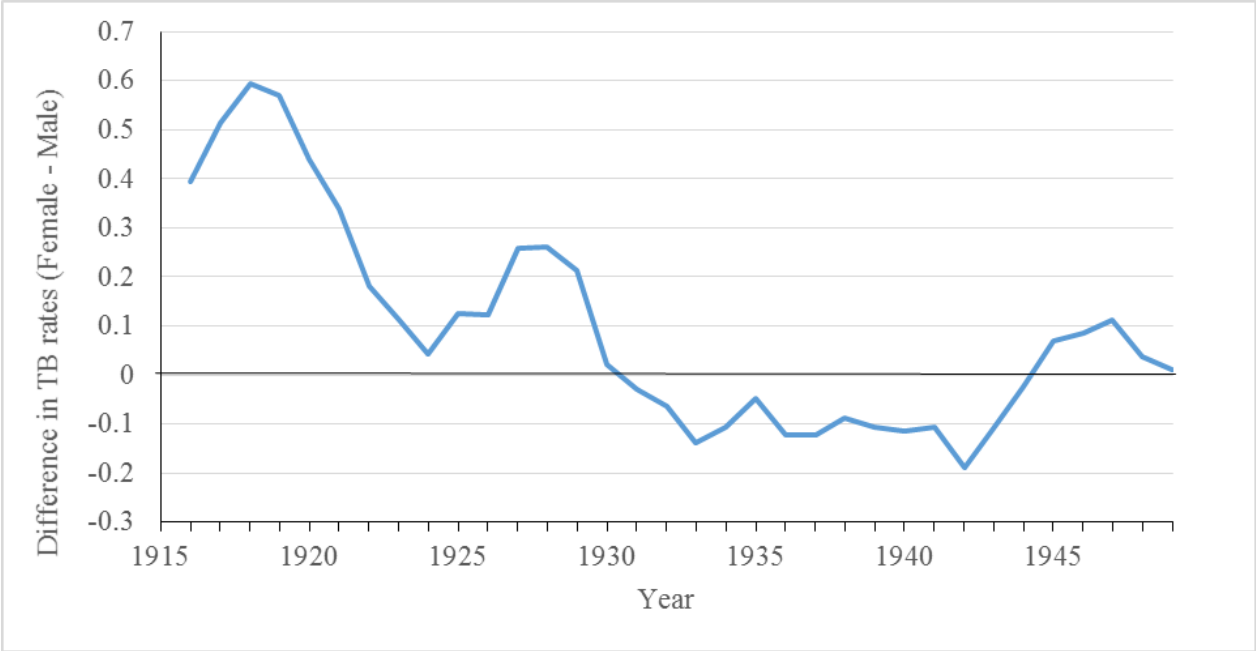


Figure 4-11. Absolute sex differences in tuberculosis mortality rates: 1911-1949*

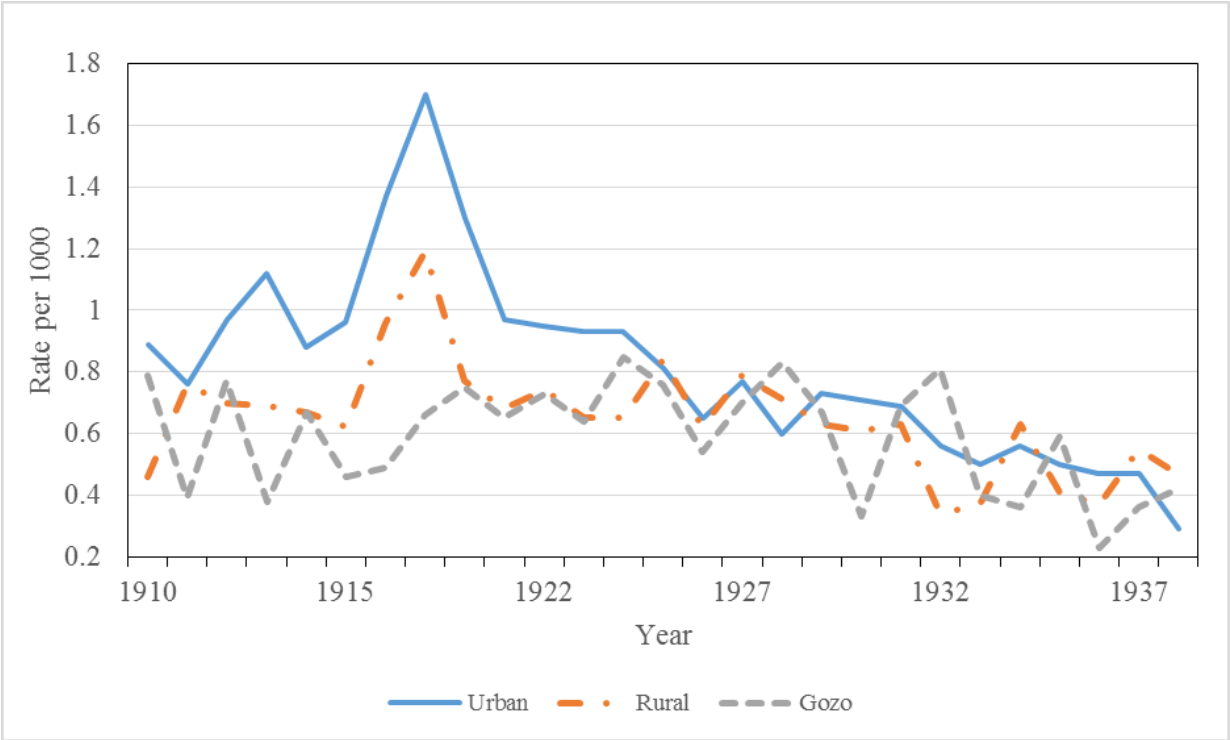


*difference is=Female TB mortality rate- Male TB mortality rate

4.4.4 Respiratory Tuberculosis and Settlement Type

Figure 4-12 depicts the secular trend of respiratory tuberculosis mortality rates by settlement type (Urban, Rural, and Gozo) from 1910 to 1938. The vast regional variations in death rates reveal the importance of hidden heterogeneity of tuberculosis. Urban and rural tuberculosis death rates follow similar trajectories inasmuch as these settlements showed a sharp rise in rates beginning in 1917, peaking in 1918 and returning to pre-1917 rates after the 1920s. Unlike the other two settlements, Gozo's tuberculosis death rates did not peak during World War I and had markedly lower tuberculosis rates relative to Malta until the mid-1920s.

Figure 4-12. Tuberculosis Mortality rates by settlement type: Malta 1910-1938



4.4.5 Respiratory Tuberculosis and Economics

The regression and correlation results shown in

Table 4-1 indicate that respiratory tuberculosis in both urban and rural settlements (in Malta proper) were significantly influenced by the price and inflation of imported food ($p<0.0001$). For both urban and rural settlements, just over 60% of the variation in tuberculosis death rates can be explained by the cost of living. In Gozo, there was no significant impact on respiratory tuberculosis even as the cost of living rose during the years 1917 to 1919. An examination of overall tuberculosis for reproductively aged individuals before and during the war shows a very strong relationship between high tuberculosis death rates and the poor economy. Obviously, the war was a driving force in lower economic levels, and economics explains the general downward trend in tuberculosis rates over the study period.

Table 4-1. Relationship between Regional tuberculosis rates and Fisher Index

	R	R^2	p-value
Region			
Urban/Suburban	0.782	0.613	<0.0001
Rural	0.778	0.606	<0.0001
Gozo	0.229	0.052	0.25
Time Period			
Total (1912-1918)	0.969	0.939	<0.001
Total (1919-1938)	0.889	0.791	<0.0001

4.5 Discussion

This paper examined the complexity within secular trend in respiratory tuberculosis in Malta, noting both the slow progressive decline since the early 20th century as well the sharp increase observed in 1917 and 1918. Undoubtedly, there is considerable complexity at the root of the "causes" of the observed pattern. Nevertheless, we argue that the most parsimonious explanation for the decline and temporary increase can be attributed to changes in the economy and its trickle-down effects. While this explanation was originally proposed by McKeown (1975) nearly half a decade ago, the Malta case study provides direct evidence of the undeniable relationship between a nation state's economy and tuberculosis rates. Malnutrition is a direct proximal cause for tuberculosis susceptibility and death resulting from the increase in cost of living (Cegielski & McMurray, 2004; McKeown, 1975). Most likely, the lack of meat consumption deprived individuals of dietary B3 and tryptophan and was responsible for increase of tuberculosis infections (Williams & Dunbar, 2013).

Further confirmation of the role of the standard of living and its impact on health can be seen in the results of our regional analysis. Our results fall in line with those of Spain where there is evidence that urban centers with a large concentration of the working poor and abysmal living conditions provided ideal conditions for a number of respiratory infections and, in particular, respiratory tuberculosis. The "urban penalty" suggests that urban locales such as towns and cities "concentrate poor people and expose them to unhealthy physical and social environments"

(Freudenberg, Galea & Vlahov, 2001, pg. 1). Similarly, there were lower rates of tuberculosis deaths in rural areas than urban rates (Harpham & Molyneux, 2001). It has been postulated that rurality protected individuals from mortality during the influenza pandemic in New Zealand because social distancing (lower person-person contact) and remoteness lowered transmission of infection from urban to rural areas (McSweeny, Colman, Fancourt, Parnell, Stantiall, Rice, Baker & Wilson, 2007). Our findings on Gozo's low tuberculosis mortality, even in the face of disruption related to World War I, point to the importance of lower exposure owing to a number of conditions: isolation and healthy outdoor agrarian life style; economic self-sufficiency (in addition to being farmers and fishermen, the other chief occupations for men were furniture craftsmen and masons); and relatively low reliance on imported food compared to Malta (Government of Malta, 1922).

As stated earlier, a number of reasons can account for the increase of tuberculosis rates during World War I, but our primary explanation lies in an economic upheaval. While the war effort initially brought economic prosperity to the Maltese because of the war effort, this prosperity was short lived. By 1917, the cost of food items rose; they were inferior in quality and difficult to purchase, even at inflated prices (Daily Malta Chronicle, 1918 [Aug]). For example, from 1914 to 1918, high protein food items (fish, meat, cheese, eggs) increased from 200% to 500% (Daily Malta Chronicle, 1918 [Dec]). As a British colony situated in the heart of the Mediterranean, the largest island of Malta was a strategic stronghold for the British military. During World War I, Malta, a supply station for the British military, was heavily involved in caring for the sick and injured and became known as "the Nurse of the Mediterranean." Not surprisingly then, the economy of island of Malta during the course of the war was dependent on providing services for the Royal Navy (Bland, 1994). As the war progressed, there was a downturn in the war related activities, which culminated in a large number of unemployed men and women. Other evidence of the dire state of the economy was the lack of available and new housing, a shortage that certainly would have contributed to overcrowding as large family size in Malta continued unabated. We argue that household security was compromised, not only because of growing rates of unemployment, but also because construction of new housing dwindled during the war years exacerbating the existing state of overcrowding. Stagnation of housing was evident in 1915 when the number of houses built declined from 152 in Malta and 25 in Gozo, to

17 and 5 by 1920-21. This was precisely the period when respiratory rates rose. Only in 1922 was there an improvement in living conditions when a total of 5311 houses in Malta and 370 in Gozo were built from 1922 to 1933 (Government of Malta, 1934). Not only did overcrowding, unemployment and high prices of food and other necessities fuel a compromise to general health, but the absence of public welfare for the needy further affected the well-being of the Maltese working poor (Bland, 1994).

4.5.1 Influenza and Tuberculosis

Our emphasis on the war and economy stands in opposition to the work of Noymer (2011) who singles out the influenza pandemic as a defining moment in the history of tuberculosis and precipitating its decline, especially in males (see also Noymer & Garenne, 2000). Furthermore, Noymer (2009) postulates that there was a selection effect, specifically passive selective, which resulted in increased tuberculosis mortality during the 1918 pandemic because of the "age-mortality overlap" with influenza (p. 1601). Because of the exceptionally high rates of tuberculosis during World War I, there was a rapid two year decline of tuberculosis death rates after 1918 in the USA (Noymer & Garenne, 2000). Undoubtedly, the influenza pandemic played a contributing role to the increase in tuberculosis deaths in our study period, but it cannot be the primary factor simply because the rise began a year before the start of the pandemic in September, 1918. Collectively, the augmented tuberculosis rates in 1917 and 1918/1919 in Malta resulted in a rapid decline of tuberculosis rates post-1919 and returned to almost pre-war levels in the overall rates and for females. The decrease in death rates following a stressor period is known as the "harvesting effect" or "short-term mortality displacement." This phenomenon occurs when there is a heightened, albeit temporary, mortality rate among those with health complications because of underlying health problems (especially cardio-respiratory diseases) and among the elderly (Dominici, McDermott, Zeger & Samet, 2003; Zanobetti, Ward, Schwartz & Ryan, 2000) or because of increased vulnerability associated with lower socio-economic status. Following the spike in deaths, there is a drop in the death rate, the aftermath of the harvesting of the frail segment of a population (Sawchuk, Tripp, Damouras & Debono, 2013). The war together with influenza cases accelerated deaths in the tuberculous, who might have otherwise

had many more years to live and, very probably, hastened the transition from latent state tuberculosis to full blown tuberculosis since almost all young adults were exposed to the bacillus during this time (Murray, 2015).

The lack of the harvesting effect in males is most likely a result of lower levels of tuberculosis rates. In addition, we must remember that identifying specific events associated with harvesting is fraught with many complications: there is no established method for assessing the harvesting effect. First, the stressor or event cannot be constant in the population, as in the occurrence of extremely hot weather, drought, or pollution (Hajat, Armstrong, Gouveia & Wilkinson, 2005). Second, there is no specific time frame defining when the "dip" or healthy period begins and how long it should last (Toulemon & Barbieri, 2008). Obviously, the scale of the stressor will determine the length of the healthy period, be it days, weeks, months or years. It is incumbent on the researcher to clarify the extent of the stressor or event and the expected limits of the health period. Fourth, we emphasize one additional requisite condition that determines whether the harvesting effect is operating: there must be an eventual return to background levels; that is, rates should return to pre-stressor levels. Otherwise, harvesting will persist indefinitely or fail to exist. One such example of the misuse of harvesting in this context is the study by Oei and Nishiura (2012) who stated that harvesting of tuberculosis occurred following the influenza epidemic in Japan and the Netherlands. However, because tuberculosis has been declining over time, it is not expected that the return to "normalcy" will necessarily obtain the same level as pre-war rates. Lastly, it is paramount to recognize that harvesting is population specific: it is contingent on the population at risk, age distribution, and causes of death (Schwartz, 2000).

4.5.2 Tuberculosis and Gender Differences

Hudelson (1996) suggests that there are a number of factors that have potential implications for gender differentials in tuberculosis morbidity and mortality. Of these, two factors merit consideration for our study. Both center around gendered vulnerabilities: (1) differential

exposure to the tuberculosis bacilli; and (2) general health/nutritional status of TB-infected persons.

Our research supports this earlier suggestion that gendered vulnerabilities lie at the root of heightened female respiratory mortality rates that began in 1917. We posit that, as the primary caregivers for the sick within the traditional patriarchal large extended family unit, Maltese women were uniquely placed to be exposed to the bacilli during periods of deprivation and instability. Owing to their gendered role as caregivers, homemakers and to the burden of domestic duties, women underwent markedly higher stress levels as they tried to maintain daily essential elements of household security (Government of Malta, 1919). Crowded into unsanitary and poor ventilated living quarters, large families provided ideal conditions for spread of infectious diseases spread through continuous contact and close physical and social proximity to one another. Furthermore, the selflessness of the women placed family and husband first, especially when there were food shortages and/or a lack of quality foodstuffs.

Our results on sex differences in tuberculosis rates agree with the findings of Cobbett (1930), who, nearly a century ago, reported that females, rather than males, were most affected during the war. From the vantage point of working shortly after World War I, Cobbett concluded that it was not an increase in new cases, but those who were already affected that succumbed to tuberculosis. The rise in mortality came about, he suggested, because nutrition was seriously impaired by the war. In Malta during World War I, the sex differential in adult (aged 15-44years) tuberculosis rates peaked; the heightened differential was a result of increased stressors placed on women to maintain a household when resources were scarce. Obviously, increased tuberculosis rates during the World War I placed a burden on the reproductive fitness of women. During World War II, women bore the brunt of many pressures, and the importance of gendered roles was again thrown into prominence. We cannot ignore that as of 1928 until 1931 male tuberculosis mortality rates surpassed those of females. Explanations for the change in the sex differential in tuberculosis, resulting from the increase in male rates and the continuation in the decline in female rates, will be explored in future studies.

4.6 Conclusion

Tuberculosis along with HIV is one of the leading causes of death (WHO, 2015), and it remains the single most common cause of death in the reproductively aged population. The drain of tuberculosis morbidity and mortality on public health is apparent in both developing and developed nations alike.

In developing nations, tuberculosis account for about 26% of avoidable deaths (Elo & Preston, 1992) and, in all parts of the world, it is a remerging opportunistic disease in those with HIV and other vulnerable groups. Understanding trends in tuberculosis mortality in past contexts during periods of stability and moments of heightened stress offers insight into disease management when future epidemics occur.

We have reaffirmed that economics, cost of living in particular, was a major factor in determining tuberculosis mortality rates in the 19th century. Furthermore, we observed the harvesting of deaths in the tuberculous was observed during times of economic strain. Neither can we disregard the heterogeneity of regional rates of tuberculosis because of variation in economic dependency within a nation state: Gozo's experience with tuberculosis was muted primarily because of isolation and a self-sufficient economy.

4.7 References

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Chapter 5

5 Final Thoughts

The objective of this research has been to explore the health of small-scale populations in the context of infectious disease using traditional statistical, anthropological, demographic and epidemiologic methods.

The obvious link among the study populations is their commonality in place and time. Foremost, the study covers British colonial period in the early 20th century. As small western nations located in the Mediterranean, both Gibraltar and Malta fell under the rule of authorities from abroad. As strategic locations for naval and garrison settings, the unusual geographical characteristics of the two locations placed civilians at risk of exposure to new pathogens from distant locations. The daily interactions and dependency between civilians and military personnel mutually affected the health of both populations.

Each investigation utilizes the case study approach, whereby "the focus is on understanding the dynamics present within single [or multiple] settings" (Eisenhardt, 1989). Consequently, the findings from each population can be generalized to other small size populations (approximately 300 0000 individuals or less). The two main study locations had comparable/much the same geopolitical status: a Mediterranean climate with protracted hot and dry summers acting as a powerful ecological stressor; an overcrowded population; a deficiency in even the most rudimentary sanitary infrastructure as well as in public and domestic hygiene, particularly in the urban centers; a marginal setting largely incapable of providing sufficient food and other necessities of life so that the Maltese and Gibraltarians were economically dependent on imports of food. In addition, with respect to research attributes, the populations satisfy the requirements of "living laboratories". Here are two examples. Citizens were under the care of health professionals who adhered to the same medical paradigm ensuring that death registrations were not subject to idiosyncratic classifications of death. There was also a long-standing tradition of reliable record keeping in both populations. Ostensibly, shared commonalities in geography and living conditions put Gibraltar and Malta on an even footing in terms of health.

Another feature common to all three papers is that the focal diseases were post-first epidemiologic transition (stages 2 and 3) that mainly affected the reproductively aged individuals. As a result, we can see that the study period coincides with the decline in rates of plague and cholera, the great pandemic diseases of the first epidemiological transition.

Because undulant fever, influenza and tuberculosis mainly affected individuals in their reproductive years, each played an important role in shaping the well-being of those who survived deadly childhood epidemics of whooping cough, measles and the diarrheal diseases that were ubiquitous throughout the study period. The diseases had profound implications that went beyond sickness or death because their effects could permeate the wellbeing of the family and that of the community. Each of the endemic diseases had potential repercussions. They could bring about evolutionary change by dampening reproductive fitness or success. Upon reaching epidemic proportions, they could disrupt the social, economic and political structure of the population.

Each discovery, however small, brings us closer to a deeper comprehension of how disease and humans interact. Three important themes emerge throughout my dissertation. First, I encounter the issue of economics and its importance in the progression of disease. It seems obvious but, in my research, the evidence presented here goes beyond speculation and is empirically grounded. Another recurring theme is the role of gender and disease. Gender is not monolithic in how it plays out in the three diseases. Variation in risk of disease rates are associated with traditional gender and occupational roles. There was great population heterogeneity in the expression of the infectious diseases at the international level between two countries or when examining regional variation between urban and rural settlements.

5.1 Summary of Findings

In Chapter 2, *Undulant Fever: Colonialism, Culture, and Compliancy*, I ask the question, why did the undulant fever experiences of Malta and Gibraltar differ drastically despite a known etiology? The chapter provides a compelling illustration of how culture, tradition and complicacy

shaped the progress of a disease in Malta and Gibraltar during the late 19th to 20th century. Despite the recognition that exposure to unpasteurized milk was responsible for heightened undulant fever rates, morbidity for this disease remained high in Malta partly because of the economic dependency on goat herding. Consequently, tradition, non-compliancy, along with the scale effect contributed to the persistence of undulant fever in Malta throughout the study period. I propose a new concept: the scale effect, a multifaceted construct that embodies the demographic properties of size, density and dispersion together with its impact on the social determinants of health. In addition, Gibraltar's effective health-directed policies that dealt with herding and milk consumption, its greater enforcement of policies and higher levels of intra-group compliancy can account for lower undulant fever rates compared to Malta. Finally, undulant fever morbidity was predominantly male because goat herding was primarily a male occupation.

Chapter 3, *Host Immunity, Children and Gender differences during the 1918/19 Influenza Epidemic in an Island Population***,** explores reasons for variation across island populations in the signature feature of the 1918 pandemic, and intra-population variation in sex influenza morbidity.

I uncover differences in the disease experience between Malta and Gozo, in that Gozo experienced higher morbidity (90.11 per 1000 versus 53.15 per 1000) and mortality (4.03 per 1000 versus 1.85 per 1000) than Malta during the fall from September to November 1918, but higher rates in the winter wave were observed in Malta. Furthermore, there was a complete absence of a herald wave in Gozo, The disease experience during the 1918/19 pandemic, in Gozo, appears to have been unique and was shaped by limited exposure to influenza as a consequence of isolation and rurality, along with a community interconnectedness because of the small-scale society, and limited social distancing measures.

Using rare nominative information from notification records in Gozo, I found that, on closer examination of sex differences in morbidity, there were significantly higher rates of influenza morbidity in reproductively aged women (15 to 44 years) compared to men (z-score=5.28; p <.0001) during the 1918/19 influenza pandemic. I also found significantly higher rates in post-reproductive women than males of the same age (z-score=3.56; p= .001). I propose that children

were significant agents of disease by introducing influenza into households and infecting their female caregivers at disproportionately higher rates. One of the unexpected findings is that pregnancy is not a factor that measurably increases morbidity in females (x^2= 0.003, 1df, p= 0.957).

Chapter 4, *Insights into Secular Trends of Respiratory Tuberculosis: The early 20th century Maltese Experience*, delves into the relationship of economics, in particular, the cost of living (Fisher index) and its relationship to the secular trends of tuberculosis mortality in the islands of Malta and Gozo. We present results that economics is the most parsimonious explanation for the decline of tuberculosis mortality.

We reaffirmed that the reproductively aged individuals were most at risk of dying of tuberculosis, seeing that 70 to 90% of all deaths due to tuberculosis occurred between the ages of 15 and 45. There was a clear sex differential in deaths in that, prior to 1930, rates in females were higher than males. During times of extreme hardship, the sex differential is exacerbated. Over the course of World War I, the sex gap in tuberculosis rates increased until peaking in 1918 when there was also the influenza pandemic. The heightened differential was most likely a result of gendered roles as opposed to biological differences since female tuberculosis rates again surpassed male rates in 1945 during World War II.

Respiratory tuberculosis in both urban and rural settlements (in Malta proper) was significantly influenced by the Fisher index, which explains approximately 61% of the variation in TB death rates ($R=0.78$; $R^2=0.61$; $p<0.0001$). In Gozo, there was no significant impact on respiratory tuberculosis ($R=0.23$; $p=0.25$), most likely a consequence of the island's isolation and a self-sufficient economy.

5.2 Current Impact and Future Implications

Brucellosis continues to be a health concern on the global stage. The rarely fatal disease often causes debilitating symptoms, most commonly "undulating fevers" and other symptoms such as: chills and weakness, insomnia, headaches, malaise, and weight loss, constipation, nervousness and depression and sexual impotence. Forty percent of cases experience bone and joint complications (WHO, 2006). Undulant fever continues to stay its course in Egypt (where it most likely originated) and is not only an emerging disease in central Asia, but re-emerging in the Middle East. Seleem and co-workers, 2010, suggest that *B. melitensis,* one of the most common zoonotic diseases worldwide, may be circulating in the ruminants of any country at any time. For example, as recently as 2013, a young British woman was infected with the disease after consuming unpasteurised cheese in Kos, Greece (Staufenberg, 2016). Because there is no single effective antibiotic treatment, the disease has afflicted her for three years now, and she is wheelchair bound as she suffers excruciating end of life type pain (Staufenberg, 2016). Her torment graphically illustrates, at the individual level, the historical experience of undulant fever in Malta and Gibraltar, which would have been much the same as hers. What further complicates the implementation of efficient treatment is that diagnosis of undulant fever may be delayed because the symptoms at the onset of brucellosis cases are similar to those of influenza (Chain, Comerci, Tolmasky et al., 2006).

Both seasonal and pandemic influenza like brucellosis continue to present major concern in the public health community. As demonstrated in Chapter 3, it is not unlikely for factors such as isolation and gender to be predictors of the disease experience; however, the exact set of vulnerabilities that will be center stage in the next pandemic is unforeseeable. The 1918 strain of influenza, 1918 A(H1N1), was a novel strain because, like all pandemic influenza viruses, it contains hemagglutinin (HA) against which there is little or no existing immunity in human populations (Garten et al., 2009). This particular strain caused unprecedented mortality in influenza resulting in approximately fifty million deaths worldwide (Taubenberger & Morens, 2006), mostly over a protracted period during the months of September to November 1918. Since 1919, there has been concern in the public health care community that another novel strain,

such as H5N1, could emerge and result in exceptional morbidity and mortality and the upheaval of the economy. In 2009, such a novel strain surfaced in Mexico: 2009 A(H1N1). It was a derivation of the 1918 A(H1N1) lineage and another swine virus, both of which had avian origins (Garten et al., 2009). Although the impact of the 2009 pandemic was muted compared to 1918 where the highest estimates of mortality fall between 123 000 and 203 000 people worldwide (Simonsen et al., 2013), there are parallels to the 1918 influenza pandemic experience. The 2009 pandemic disproportionately infected young adults and, in the United States alone, because employers did not provide paid sick leave, there were five million additional cases of influenza or influenza-like illness (Kumar, Crouse Quinn, Kim, Daniel & Freimuth, 2010).

The World Health Organization (2015) has declared tuberculosis along with HIV as one of the leading cause of infectious disease mortality in adults. Although typically associated with resource-poor countries, respiratory tuberculosis is endemic in many prisons and among the homeless as well as in First Nation reserves in developed nations. The recrudescence of tuberculosis in the twenty-first century first world countries is largely attributed to immigration from countries with high rates (Farmer, 1996). Similar to my findings in Chapter 4 on twentieth century tuberculosis in Malta, economics is the underlying factor for trends in tuberculosis rates. In the present-day context, the risk of contracting tuberculosis in first world countries occurs almost exclusively among the poor (Farmer, 1996). Burdening the struggle to eradicate tuberculosis is the emergence of multi-drug resistant strains along with TB's opportunistic nature in infecting those who are immunosuppressed, especially those who are HIV positive.

5.2.1 Future studies

Building on the three papers in this thesis, there a few avenues of research that will answer questions left unresolved here. With the recent acquisition of undulant fever reports and the notification records, I can now compare morbidity rates in Gozo rates to Malta and Gibraltar, because it is has be postulated that half of Maltese cases arose in Gozo alone (Wyatt, 2013). The influence of undulant fever cases on reproductive ability can now be examined through age and sex breakdown of cases in Malta. Similar to the study on tuberculosis in chapter 4, I will explore

urban/rural differences in influenza mortality rates, and employ Arriaga's decomposition of life table analysis to assess impact of the contribution of diseases to life expectancy. Furthermore, the unique impact of 1918 influenza and World War I on fertility, resulting in the baby boom and bust, is a phenomenon I plan to examine in the Maltese islands. The revelation that infants were most at risk of dying of 1918 influenza in Gozo begs the question why. Exploration of the honeymoon effect, and the possibility of scaring effect of other childhood diseases such as whooping cough and measles will be the beginnings of the study the unique age distribution of influenza in Gozo. Finally, the changes in the sex differences in tuberculosis rates overtime warrants more exploration, especially the reasons for why male rates exceeded female rates from 1928 to 1931.

5.3 References

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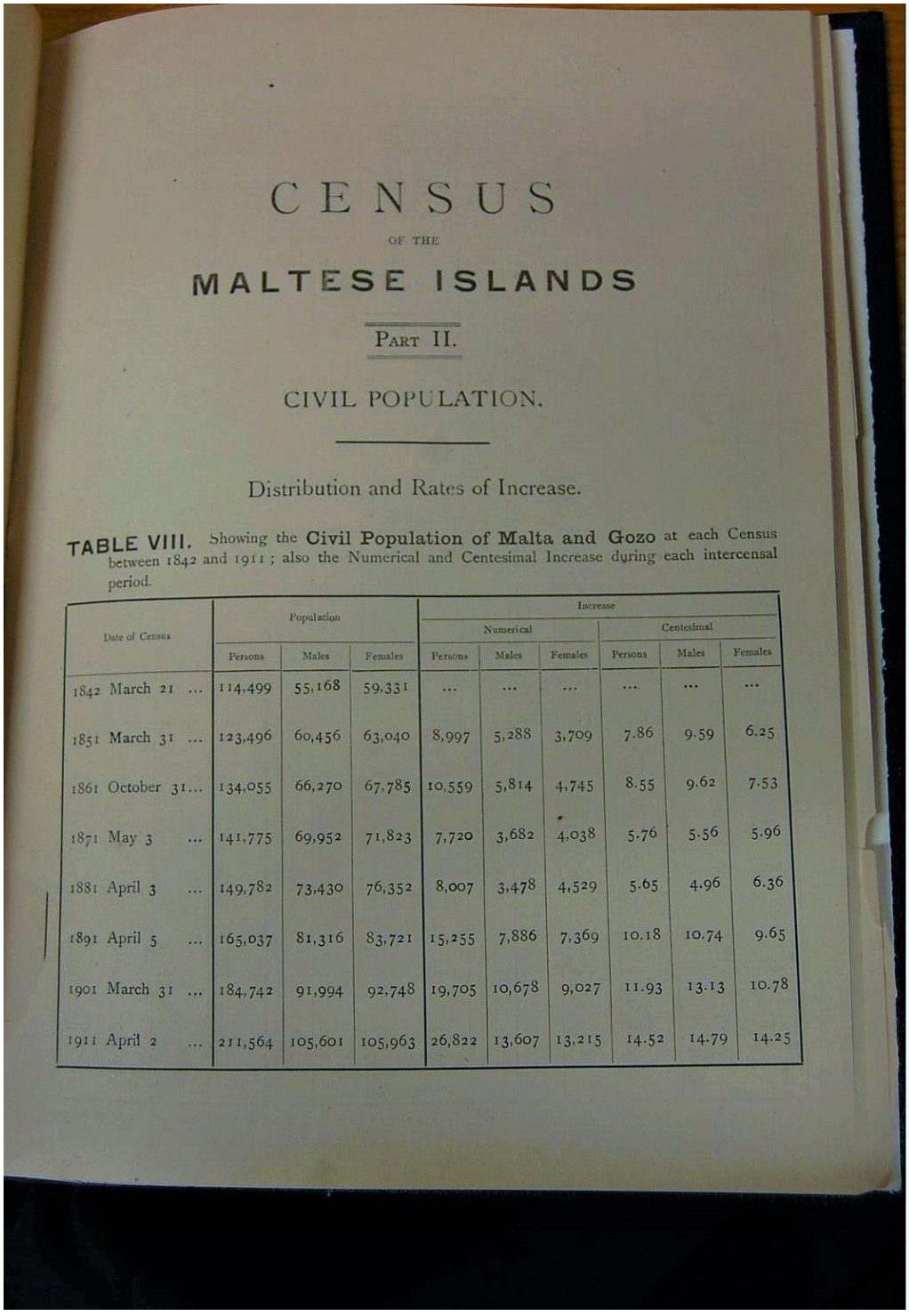
Appendices

Appendix I: Photos of research documents

A. Malta Census, 1911



CENSUS

OF THE

MALTESE ISLANDS

PART II.

CIVIL POPULATION.

Distribution and Rates of Increase.

TABLE VIII. Showing the **Civil Population of Malta and Gozo** at each Census between 1842 and 1911; also the Numerical and Centesimal Increase during each intercensal period.

Date of Census	Population			Increase					
				Numerical			Centesimal		
	Persons	Males	Females	Persons	Males	Females	Persons	Males	Females
1842 March 21 ...	114,499	55,168	59,331	...	...	...	...	...	...
1851 March 31 ...	123,496	60,456	63,040	8,997	5,288	3,709	7.86	9.59	6.25
1861 October 31...	134,055	66,270	67,785	10,559	5,814	4,745	8.55	9.62	7.53
1871 May 3 ...	141,775	69,952	71,823	7,720	3,682	4,038	5.76	5.56	5.96
1881 April 3 ...	149,782	73,430	76,352	8,007	3,478	4,529	5.65	4.96	6.36
1891 April 5 ...	165,037	81,316	83,721	15,255	7,886	7,369	10.18	10.74	9.65
1901 March 31 ...	184,742	91,994	92,748	19,705	10,678	9,027	11.93	13.13	10.78
1911 April 2 ...	211,564	105,601	105,963	26,822	13,607	13,215	14.52	14.79	14.25

B. Health Report of the Maltese Islands, 1921 (monthly deaths by cause, sex, and age/or location).

Table No. 2. STATEMENT of Mortality, Civil Population, in MALTA & GOZO—Causes of death at different periods of life, from 1st to 31st January, 1921.

AGES AT DEATH

Causes of Death	All Ages Males	All Ages Females	All Ages Both Sexes	Total under 1 Year M	Total under 1 Year F	1 M	1 F	2 M	2 F	3 M	3 F	4 M	4 F	Total under 5 Years M	Total under 5 Years F	5- M	5- F	10- M	10- F	15- M	15- F	20- M	20- F	25- M	25- F	35- M	35- F	45- M	45- F	55- M	55- F	65- M	65- F	75- M	75- F	85- M	85- F	95- & Upwards M	95- & Upwards F
	185	177	362	61	47	7	12	1	5	1	...	1	2	71	66	2	...	...	4	1	8	...	7	7	8	7	4	11	6	27	17	23	29	31	20	5	8	...	...
I. *General Diseases.*																																							
1. Enteric fever	1	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...
3b. Undulant fever	...	3	3	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...
7. Scarlet fever	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9a. Diphtheria	2	...	2	...	...	2	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14. Dysentery	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18. Erysipelas	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
24. Tetanus	2	...	2	2	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28a. Pulmonary tuberculosis	8	11	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	3	...	3	3	2	1	...	3	1	1	1	...	...	...	...	...	...	...	...
30. Tuberculous meningitis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
31b. Other peritoneal & intestinal tubercle	...	1	1	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32. Tuberculosis of spinal column	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
34a. Lupus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
36a. Rickets	1	...	1	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
37. Syphilis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
39. Cancer of the buccal cavity	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...
40. Cancer of the stomach, liver, etc.	5	1	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	3	...	...	1	...	...	...	...	...	...
41. Can. of peritoneum, intestines & rectum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
42. Cancer of the female genital organs	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
43. Cancer of the breast	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
44. Cancer of the skin	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
45. Cancer of other or unspecified organs	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
47. Rheumatic fever	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
48a. Chronic rheumatism	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
50. Diabetes	3	6	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	2	3	1	1	...	1	...	...	...	...
52. Addison's disease	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
53a. Leucocythæmia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
53b. Lymphadenoma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
54. Anæmia, Chlorosis	1	1	2	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
II. *Diseases of the Nervous System and of the Organs of Special Sense.*																																							
60. Encephalitis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
61c. Meningitis, other forms	...	2	2	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
63b. Other diseases of the spinal cord.	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64a. Apoplexy	7	5	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	2	...	2	3	...	2	2	...	...	...
64b. Serous apoplexy and œdema of brain	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64c. Cerebral congestion	4	1	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	1	...	1	1	...	...	...	...
64d. Cerebral atheroma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64e. Cerebral hæmorrhage	9	2	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	1	3	...	4	1	...	...	...	...
65. Softening of brain	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
66a. Hemiplegia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
66b. Paraplegia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
68. Other forms of mental alienation	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
69. Epilepsy	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
71b. Other inf. convulsions (under 5 years)	...	2	2	...	2	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
73a. Hysteria	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
74c. Cerebral tumour	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
III. *Diseases of the Circulatory System.*																																							
78a. Acute myocarditis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
78c. Other acute endocarditis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
79a. Valvular disease	12	19	31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	1	3	2	7	8	1	6	1	...	...	...
79b. Fatty degeneration of the heart	2	6	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	1	...	2	1	1	...	1	...	...
79c. Other organic diseases of the heart	1	9	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	5	1	2	...	1	...	...
80. Angina pectoris	2	2	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1	...	1	...	...	...	...	...	...
81a. Aneurysm	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
81b. Arterial sclerosis	8	6	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	2	2	5	1	...	3	...	...
82a. Cerebral embolism and thrombosis	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...
IV. *Diseases of the Respiratory System.*																																							
89-90b. Other bronchitis	8	9	17	6	2	1	2	...	2	...	...	...	...	7	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	2	...	...	...	1	...	...
91. Broncho-pneumonia	5	...	5	...	...	2	...	...	...	...	...	1	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...
92a. Lobar pneumonia	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...
92b. Pneumonia (type not stated)	1	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
93a. Empyema	1	...	1	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
93b. Other pleurisy	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
94b. Pulmonary œdema and congestion	2	1	3	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
96. Asthma	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
98a. Fibroid diseases of the lung	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

B. Health Report of the Maltese Islands, 1921 (monthly deaths by cause, sex, and age/or location).

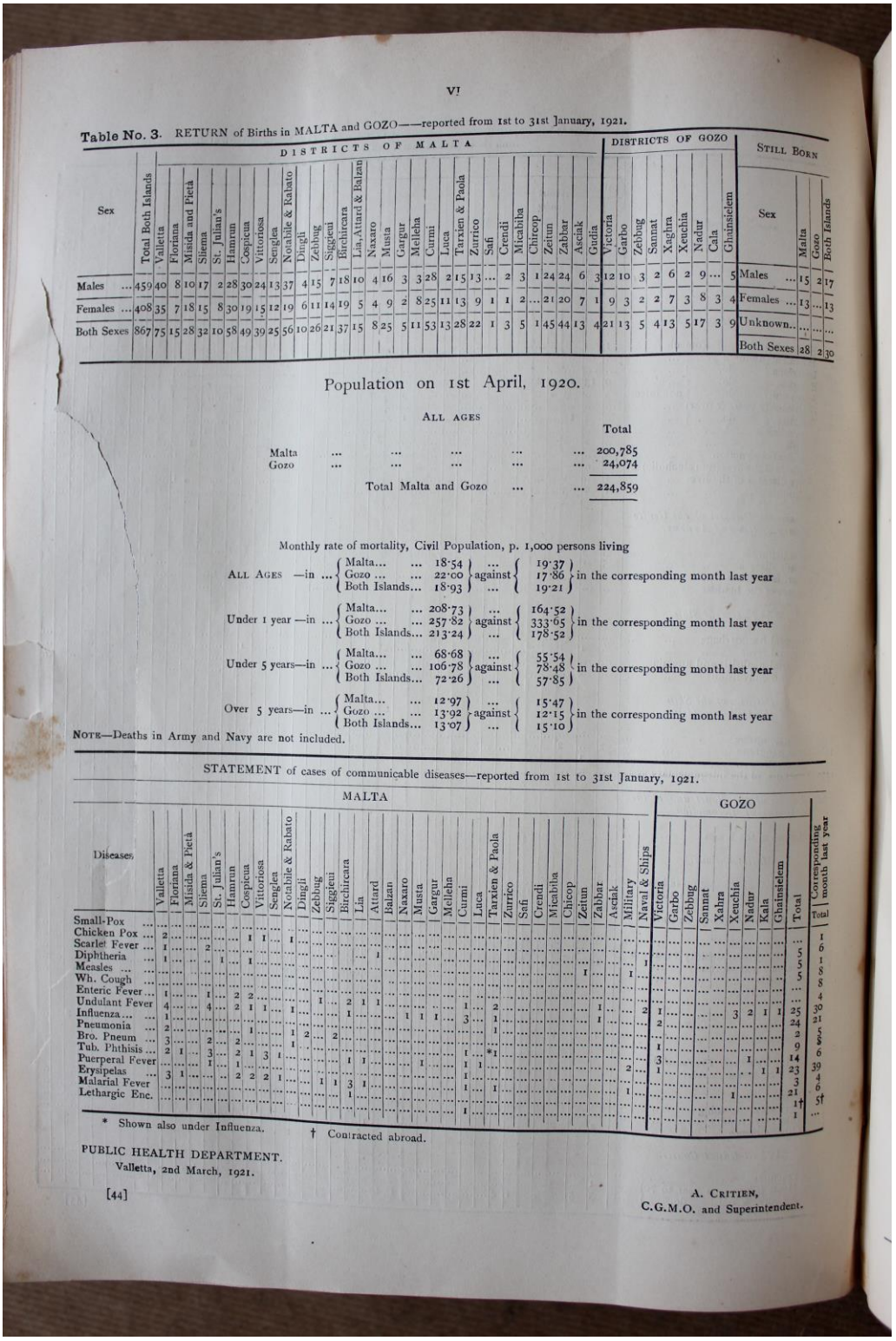
V

Table No. 2.—*continued.* STATEMENT of Mortality, Civil Population, in MALTA & GOZO—Causes of death at different periods of life, from 1st to 31st January, 1921.

Causes of Death	All Ages			AGES AT DEATH: Total under 1 Year		1		2		3		4		Total under 5 Years		5–		10–		15–		20–		25–		35–		45–		55–		65–		75–		85–		95– & Upwards	
	Males	Females	Both Sexes	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
V. *Diseases of the Digestive System.*																																							
102. Perforating ulcer of stomach	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
104a. Infect.ent.(under 2 years)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104b. Diarrhœa (do.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104c. Enteritis (do.)	9	13	22	9	8	...	5	...	...	...	...	...	...	9	13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104d. Gastro-ent.(do.) non infect	3	...	3	2	...	1	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
105b. Diarrhœa (2 years & over)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
105c. Enteritis (do.)	8	4	12	...	...	...	...	...	2	1	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	5	...	1	...	...	...
108. Appendicitis	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
109a. Hernia	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...
109b. Intestinal obstruction	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...
113a. Cirrhosis of the liver (non alcoholic)	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...
115. Other diseases of the liver	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
117. Peritonitis	1	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...
VI. *Non-venereal Diseases of the Genito-Urinary System and Annexa.*																																							
119. Acute nephritis	3	5	8	1	1	...	...	...	1	...	...	...	...	1	2	...	...	...	1	...	...	...	...	...	2	1	...	...	...	...	...	...	...	1	...	...	...	...	...
120a. Bright's disease	5	1	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	1	...	2	1	...	...	...	...
120b. Nephritis-Uræmia	2	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	1	...	...	...	...	...	...	...
124. Diseases of the bladder	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
VII. *The Puerperal State.*																																							
135. Puerperal hæmorrhage	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
137. Puerperal fever	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
138a. Puerperal nephritis and uræmia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
138c. Puerperal convulsions	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
VIII. *Diseases of the Skin and of the Cellular Tissue.*																																							
142a. Senile gangrene	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
142d. Other gangrene	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...
144a. Phlegmon	...	1	1	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145d. Other dis. of the integumentary syst.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
IX. *Diseases of the Bones and of the Organs of Locomotion.*																																							
146. Diseases of the bones	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
X. *Malformations.*																																							
150c. Congenital malformation of heart	3	...	3	2	...	...	...	...	...	...	...	...	...	2	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
150d. Other congenital malformations	...	1	1	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XI. *Diseases of Early Infancy.*																																							
151a. Premature birth	3	2	5	3	2	...	...	...	...	...	...	...	...	3	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
151b. Infantile atrophy, debility & marasmus	28	22	50	28	22	...	...	...	...	...	...	...	...	28	22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
151d. Scleroma neonatorum	1	1	2	1	1	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
152b. Atelectasis	...	5	5	...	5	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
152c. Injuries at birth	5	1	6	5	1	...	...	...	...	...	...	...	...	5	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XII. *Old Age.*																																							
154b. Senile decay	7	7	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	6	2	1	2	...	...
XIII. *Affections Produced by External Causes.*																																							
167. Burns	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
169. Accidental drowning	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
175. Injury by crushing	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
186. Other violence	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XIV. *Ill-defined Causes.*																																							
185. Fractures	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
189a. Heart failure (1 year to 70)	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
189b. Atr., deb. & mar. (do.)	3	5	8	...	...	1	4	...	...	...	...	...	...	1	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	...	...	...	...	...	...	...

[43]

B. Health Report of the Maltese Islands, 1921 (monthly deaths by cause, sex and age/or location).



VI

Table No. 3. RETURN of Births in MALTA and GOZO——reported from 1st to 31st January, 1921.

Sex	DISTRICTS OF MALTA: Total Both Islands	Valletta	Floriana	Misida and Pietà	Sliema	St. Julian's	Hamrun	Cospicua	Vittoriosa	Senglea	Notabile & Rabato	Dingli	Zebbug	Siggieui	Birchircara	Lia, Attard & Balzan	Naxaro	Musta	Gargur	Melleha	Curmi	Luca	Tarxien & Paola	Zurrico	Safi	Crendi	Micabiba	Chircop	Zeitun	Zabbar	Asciak	Gudia	DISTRICTS OF GOZO: Victoria	Garbo	Zebbug	Sannat	Xaghra	Xeuchia	Nadur	Cala	Ghainsielem
Males ...	459	40	8	10	17	2	28	30	24	13	37	4	15	7	18	10	4	16	3	3	28	2	15	13	...	2	3	1	24	24	6	3	12	10	3	2	6	2	9	...	5
Females ...	408	35	7	18	15	8	30	19	15	12	19	6	11	14	19	5	4	9	2	8	25	11	13	9	1	1	2	...	21	20	7	1	9	3	2	2	7	3	8	3	4
Both Sexes	867	75	15	28	32	10	58	49	39	25	56	10	26	21	37	15	8	25	5	11	53	13	28	22	1	3	5	1	45	44	13	4	21	13	5	4	13	5	17	3	9

Sex	STILL BORN: Malta	Gozo	Both Islands
Males ...	15	2	17
Females ...	13	...	13
Unknown..	...	...	...
Both Sexes	28	2	30

Population on 1st April, 1920.

ALL AGES

	Total
Malta	200,785
Gozo	24,074
Total Malta and Gozo	224,859

Monthly rate of mortality, Civil Population, p. 1,000 persons living

ALL AGES —in ...	Malta... ...	18·54	... against	19·37	in the corresponding month last year
	Gozo	22·00		17·86	
	Both Islands...	18·93	...	19·21	
Under 1 year —in ...	Malta... ...	208·73	... against	164·52	in the corresponding month last year
	Gozo	257·82		333·65	
	Both Islands...	213·24	...	178·52	
Under 5 years—in ...	Malta... ...	68·68	... against	55·54	in the corresponding month last year
	Gozo	106·78		78·48	
	Both Islands...	72·26	...	57·85	
Over 5 years—in ...	Malta... ...	12·97	... against	15·47	in the corresponding month last year
	Gozo	13·92		12·15	
	Both Islands...	13·07	...	15·10	

NOTE—Deaths in Army and Navy are not included.

STATEMENT of cases of communicable diseases—reported from 1st to 31st January, 1921.

Diseases	MALTA: Valletta	Floriana	Misida & Pietà	Sliema	St. Julian's	Hamrun	Cospicua	Vittoriosa	Senglea	Notabile & Rabato	Dingli	Zebbug	Siggieui	Birchircara	Lia	Attard	Balzan	Naxaro	Musta	Gargur	Melleha	Curmi	Luca	Tarxien & Paola	Zurrico	Safi	Crendi	Micabiba	Chicop	Zeitun	Zabbar	Asciak	Military	Navel & Ships	GOZO: Victoria	Garbo	Zebbug	Sannat	Xahra	Xeuchia	Nadur	Kala	Ghainsielem	Total	Corresponding month last year: Total
Small-Pox ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Chicken Pox ...	2	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
Scarlet Fever ...	1	...	...	2	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Diphtheria ...	1	...	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	1
Measles ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	8
Wh. Cough ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	5	8
Enteric Fever ...	1	...	...	1	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
Undulant Fever	4	...	...	4	...	2	1	1	...	...	...	1	...	2	1	1	...	...	...	...	...	...	1	...	2	...	...	...	...	1	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	4
Influenza	1	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	1	1	1	...	3	...	1	...	...	...	...	1	...	...	...	2	1	...	...	...	3	2	1	1	25	38
Pneumonia ...	2	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	24	21
Bro. Pneum ...	3	...	...	2	...	2	...	...	...	1	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	5
Tub. Phthisis ...	2	1	...	3	...	2	1	3	1	...	...	...	...	...	...	...	...	...	...	...	...	1	...	*1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	9	6
Puerperal Fever	...	...	...	1	...	1	...	1	...	...	...	...	...	...	1	1	...	...	...	1	...	...	1	1	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	1	...	...	14	39
Erysipelas ...	3	1	...	...	...	2	2	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	2	...	1	...	...	...	...	1	1	...	23	4
Malarial Fever	...	...	...	...	...	...	...	...	...	...	...	1	1	3	1	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	3	6
Lethargic Enc.	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	21	5†
																							1	...																				1†	...
																																												1	...

* Shown also under Influenza. † Contracted abroad.

PUBLIC HEALTH DEPARTMENT.
Valletta, 2nd March, 1921.

[44]

A. CRITIEN,
C.G.M.O. and Superintendent.

B. Health Report of the Maltese Islands, 1921 (monthly deaths by cause, sex, and age/or location).

Table No. 1.

STATEMENT of Mortality in MALTA and GOZO—from 1st to 28th February, 1921.

Causes of Death	Males	Females	Both Sexes	Valletta	Floriana	Misida & Pietà	Sliema	St. Julian's	Hamrun	Cospicua	Vittoriosa	Senglea	Notabile & Rabato	Dingli	Zebbug	Siggieui	Birchircara	Lia, Attard & Balzan	Naxaro	Musta	Gargur	Melleha	Curmi	Luca	Tarxien & Paola	Zurrico	Safi	Crendi	Micabiba	Chircop	Zeitun	Zabbar	Axiak	Gudia	Naval and Ships	Military	Victoria	Garbo	Zebbug	Sannat	Xaghra	Xeuchia	Nadur & Cala	Ghainsielem
	Total both Islands			DISTRICTS OF MALTA — Valletta						Cottonera			1st		2nd		3rd		4th				5th			6th					7th						GOZO							
	176	148	324	31	9	7	8	5	23	25	11	15	9	2	8	1	22	11	1	12	1	4	13	15	12	3	1	2	3	..	16	9	2	...	1	1	10	7	4	1	8	4	6	1
I. *General Diseases.*																																												
1. Enteric fever...	5	1	6	...	...	...	...	...	2	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
3b. Undulant fever	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9a. Diphtheria	1	1	2	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17. Leprosy	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18. Erysipelas	1	2	3	...	...	...	...	...	...	1	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20b. Septicæmia	3	...	3	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24. Tetanus	1	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	1	...	...	...	...	...	...
28a. Pulm: tuberculosis	4	9	13	1	...	...	1	1	1	...	1	1	2	...	...	...	1	...	1	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
30. Tuberculous meningitis	1	2	3	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
31a. Tabes mesenterica	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
31b. Other perit. & int. tub.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32. Tub. of spinal column	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
34a. Lupus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
36a. Rickets	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
39. Cancer of buccal cavity	1	1	2	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
40. Cancer of stomach, etc.	...	3	3	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
41. Can. of perit. int. & rect.	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
42. Canc. of fem. gen. org.	...	2	2	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
43. Cancer of the breast...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
44. Cancer of the skin	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
45. Canc. other or uns. org.	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
47. Rheumatic fever	1	1	2	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
48a. Chronic rheumatism...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
50. Diabetes	6	5	11	2	...	...	...	1	...	...	...	...	1	...	1	...	2	...	...	...	...	...	...	...	1	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	1	...
52. Addison's disease	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
53a. Leucocythæmia	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
53b. Lymphadenoma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
54. Anæmia, Chlorosis	4	1	5	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	...
II. *Diseases of the Nervous System and of the Organs of Special Sense.*																																												
60. Encephalitis	1	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
61c. Mening. other forms...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
63b. Oth. dis. of spinal cord.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64a. Apoplexy	2	6	8	1	...	...	...	...	1	1	...	...	1	...	...	...	...	2	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64b. Ser. ap. & œdema of br.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64c. Cerebral congestion	1	1	2	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64d. Cerebral atheroma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64e. Cerebral haemorrhage	7	1	8	1	...	...	...	...	3	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...
65. Softening of brain	1	1	2	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
66a. Hemiplegia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
66b. Paraplegia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
68. Oth. forms of men. alien.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
69. Epilepsy	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
71b. Oth. inf. conv. (und. 5 yrs.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
73a. Hysteria	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
74c. Cerebral tumour	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
III. *Dis. of the Circul. Syst.*																																												
78a. Acute myocarditis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
78c. Other acute endocar.	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
79a. Valvular disease	17	13	30	...	2	...	1	...	3	2	1	2	2	...	2	...	...	2	...	...	...	1	...	...	...	...	...	...	...	...	3	2	...	...	...	...	3	3	...	...	1	...	...	...
79b. Fatty degn. of heart...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
79c. Other org. dis. of heart	4	5	9	...	...	...	2	...	1	1	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	1	...	...
80. Angina pectoris	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
81a. Aneurysm	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
81b. Arterial sclerosis	9	3	12	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	2	...	...	1	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82a. Cereb. emb. & thromb.	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...
IV. *Dis. of the Resp. Syst.*																																												
87c. Other dis. of larynx	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
89-90b. Other bronchitis	12	8	20	5	...	1	...	...	...	2	...	1	...	...	...	1	4	...	...	1	...	...	...	...	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	1	...	...
91. Broncho-pneumonia...	3	2	5	1	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...
92a. Lobar pneumonia	1	1	2	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
92b. Pneum. (type not stated)	1	1	2	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
93a. Empyema	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
93b. Other pleurisy	1	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
94b. Pulm. œdema & cong.	2	1	3	2	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
96. Asthma	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

[62]

B. Health Report of the Maltese Islands, 1921 (monthly deaths by cause, sex, and age/or location).

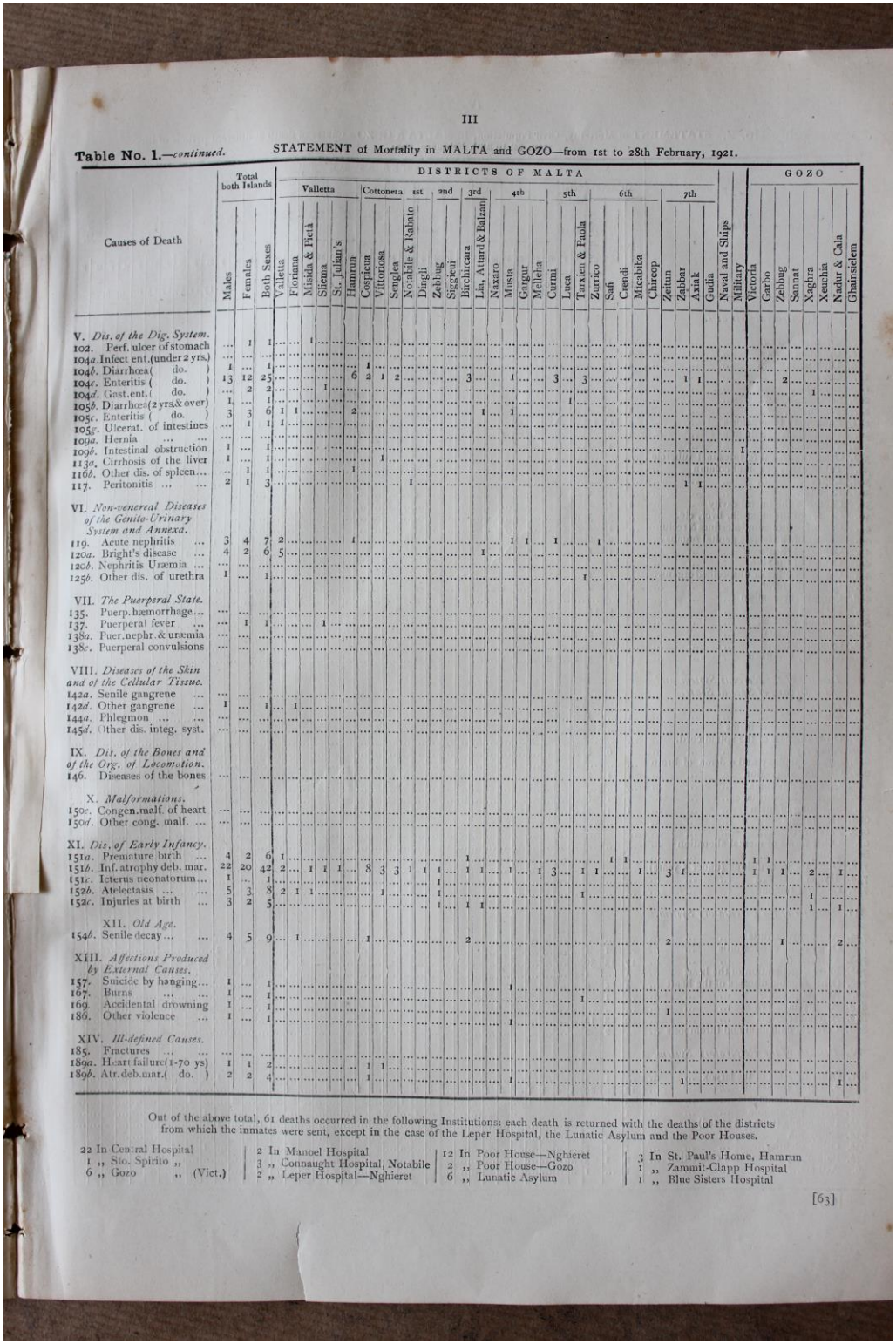


Table No. 1.—*continued.* STATEMENT of Mortality in MALTA and GOZO—from 1st to 28th February, 1921.

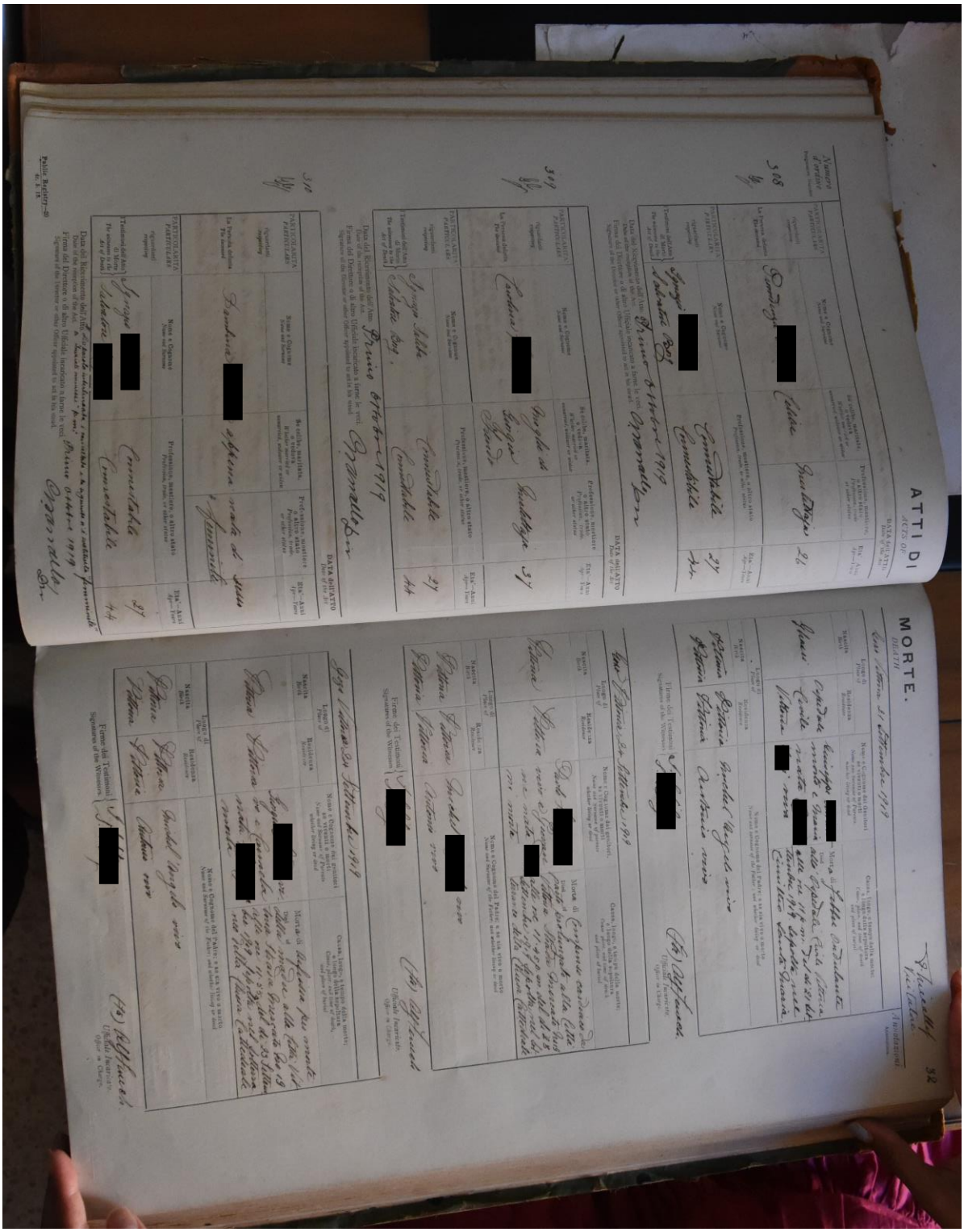
Causes of Death	Total both Islands			DISTRICTS OF MALTA																																				GOZO						
				Valletta						Cottonera			1st		2nd		3rd		4th		5th		6th			7th			Naval and Ships	Military	Victoria																	
	Males	Females	Both Sexes	Valletta	Floriana	Msida & Pietà	Sliema	St. Julian's	Hamrun	Cospicua	Vittoriosa	Senglea	Notabile & Rabato	Dingli	Zebbug	Siggiewi	Birchircara	Lia, Attard & Balzan	Naxaro	Musta	Gargur	Mellieha	Curmi	Luca	Tarxien & Paola	Zurrico	Safi	Crendi	Micabiba	Chircop	Zeitun	Zabbar	Attard	Gudia			Victoria	Garbo	Zebbug	Sannat	Xaghra	Xeuchia	Nadur & Cala	Ghajnsielem
V. *Dis. of the Dig. System.*																																														
102. Perf. ulcer of stomach	...	1	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104*a*. Infect ent. (under 2 yrs.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104*b*. Diarrhœa (do.)	1	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104*c*. Enteritis (do.)	13	12	25	...	...	...	...	...	6	2	1	2	...	...	...	...	3	...	1	...	3	...	3	...	...	...	...	...	1	1	...	...	...	...	...	2	...	...	...	...	...	...	...	...
104*d*. Gast. ent. (do.)	...	2	2	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
105*b*. Diarrhœa (2 yrs. & over)	1	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
105*c*. Enteritis (do.)	3	3	6	1	1	...	...	...	2	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
105*g*. Ulcerat. of intestines	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
109*a*. Hernia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
109*b*. Intestinal obstruction	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
113*a*. Cirrhosis of the liver	1	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
116*b*. Other dis. of spleen...	...	1	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
117. Peritonitis	2	1	3	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
VI. *Non-venereal Diseases of the Genito-Urinary System and Annexa.*																																														
119. Acute nephritis ...	3	4	7	2	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
120*a*. Bright's disease ...	4	2	6	5	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
120*b*. Nephritis Uræmia ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
125*b*. Other dis. of urethra	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
VII. *The Puerperal State.*																																														
135. Puerp. hæmorrhage...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
137. Puerperal fever ...	...	1	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
138*a*. Puer. nephr. & uræmia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
138*c*. Puerperal convulsions	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
VIII. *Diseases of the Skin and of the Cellular Tissue.*																																														
142*a*. Senile gangrene ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
142*d*. Other gangrene ...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
144*a*. Phlegmon	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145*d*. Other dis. integ. syst.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
IX. *Dis. of the Bones and of the Org. of Locomotion.*																																														
146. Diseases of the bones	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
X. *Malformations.*																																														
150*c*. Congen. malf. of heart	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
150*d*. Other cong. malf. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XI. *Dis. of Early Infancy.*																																														
151*a*. Premature birth ...	4	2	6	1	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...
151*b*. Inf. atrophy deb. mar.	22	20	42	2	...	1	1	1	...	8	3	3	1	1	1	...	1	1	...	1	...	1	3	...	1	1	...	...	1	...	3	1	...	...	...	1	1	1	...	2	...	1	...
151*c*. Icterus neonatorum...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
152*b*. Atelectasis	5	3	8	2	1	1	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...
152*c*. Injuries at birth ...	3	2	5	...	...	...	...	...	...	...	...	...	...	1	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...
XII. *Old Age.*																																														
154*b*. Senile decay	4	5	9	...	1	...	...	...	...	1	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	1	...	...	...	2	...	...	...	...
XIII. *Affections Produced by External Causes.*																																														
157. Suicide by hanging...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
167. Burns	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
169. Accidental drowning	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
186. Other violence ...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XIV. *Ill-defined Causes.*																																														
185. Fractures	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
189*a*. Heart failure (1-70 ys)	1	1	2	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
189*b*. Atr. deb. mar. (do.)	2	2	4	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...

Out of the above total, 61 deaths occurred in the following Institutions: each death is returned with the deaths of the districts from which the inmates were sent, except in the case of the Leper Hospital, the Lunatic Asylum and the Poor Houses.

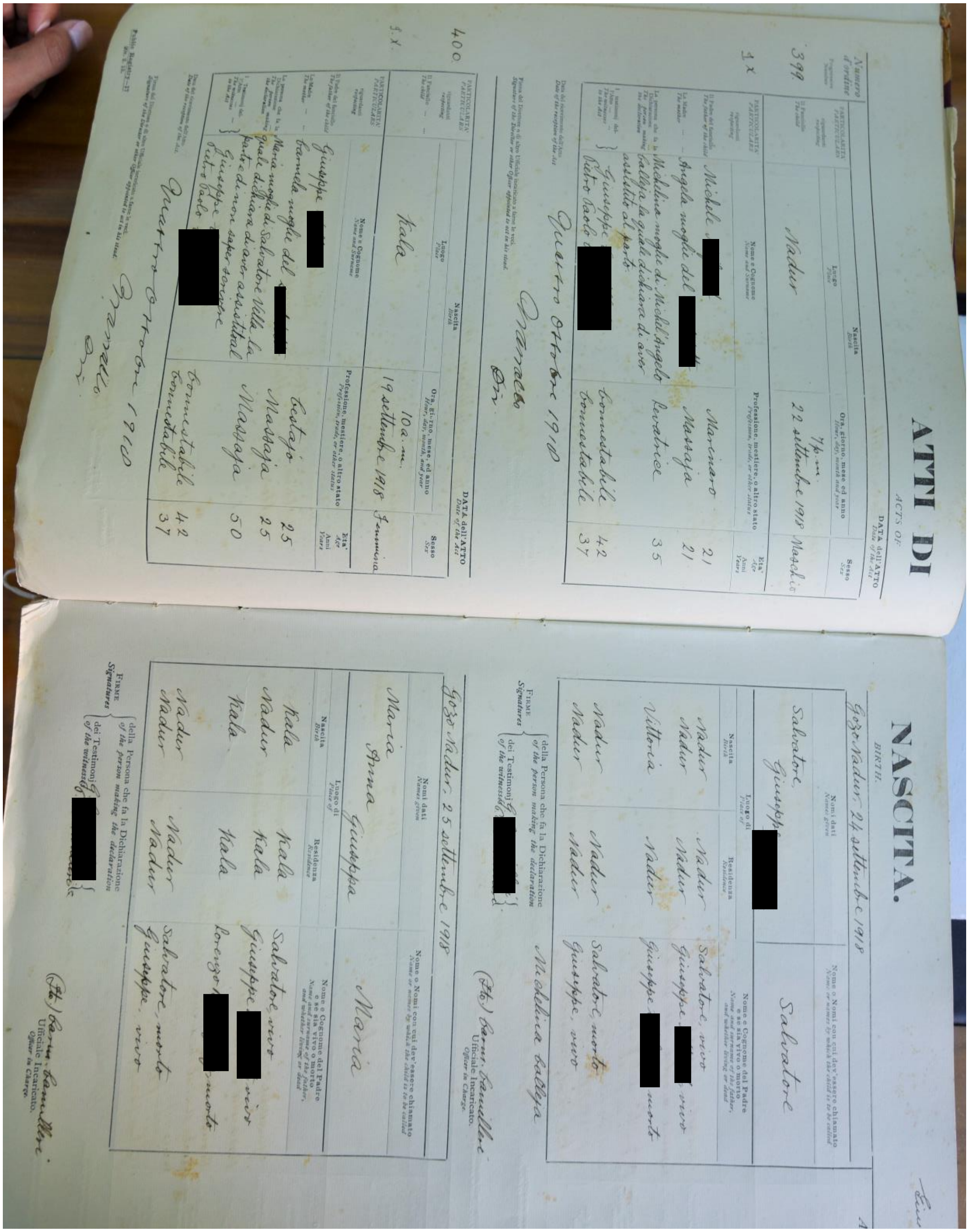
22 In Central Hospital
1 ,, Sto. Spirito ,,
6 ,, Gozo ,, (Vict.)
2 In Manoel Hospital
3 ,, Connaught Hospital, Notabile
2 ,, Leper Hospital—Nghieret
12 In Poor House—Nghieret
2 ,, Poor House—Gozo
6 ,, Lunatic Asylum
3 In St. Paul's Home, Hamrun
1 ,, Zammit-Clapp Hospital
1 ,, Blue Sisters Hospital

[63]

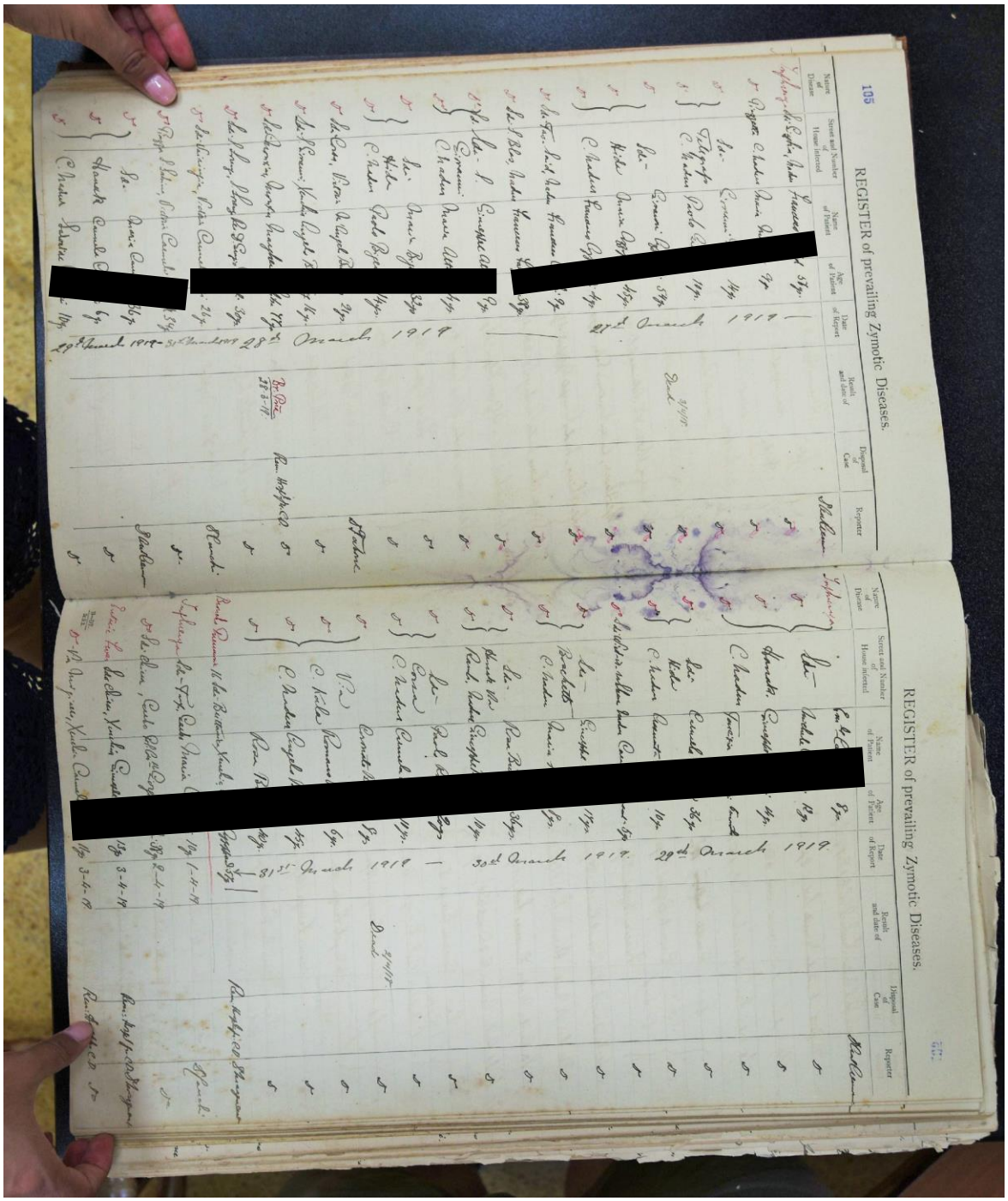
C. Death Record, Gozo September 1919



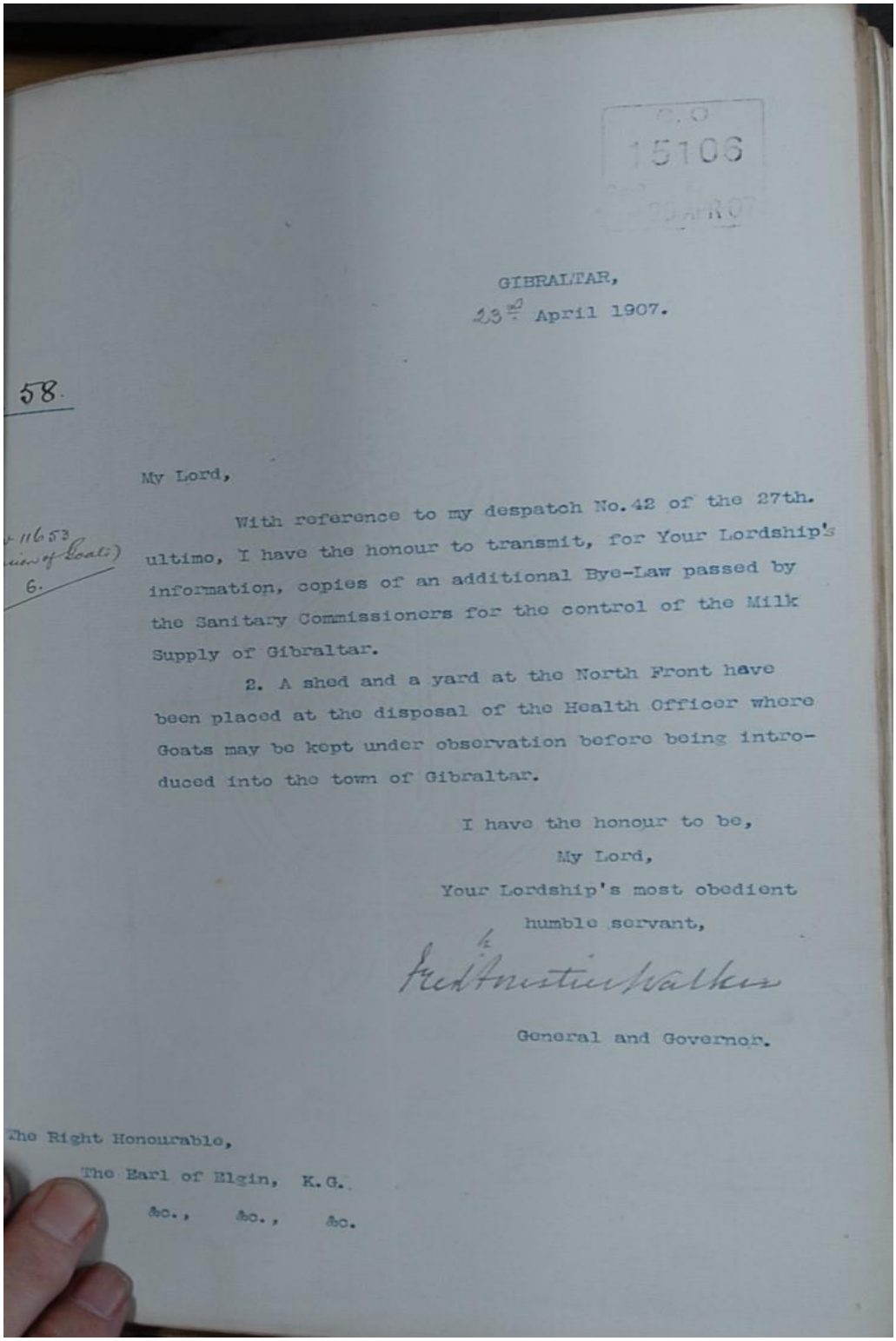
D. Birth Record, Gozo September 1919



E. Notification Record, Gozo 1919



F. Correspondence Report on Milk Supply in Gibraltar, April 1907



C.O.
15106
[illegible]07

GIBRALTAR,
23rd April 1907.

58.

My Lord,

With reference to my despatch No. 42 of the 27th. ultimo, I have the honour to transmit, for Your Lordship's information, copies of an additional Bye-Law passed by the Sanitary Commissioners for the control of the Milk Supply of Gibraltar.

2. A shed and a yard at the North Front have been placed at the disposal of the Health Officer where Goats may be kept under observation before being introduced into the town of Gibraltar.

I have the honour to be,
My Lord,
Your Lordship's most obedient
humble servant,

Fred Austin Walker

General and Governor.

The Right Honourable,
The Earl of Elgin, K.G.
&c., &c., &c.