Fighting Two Wars: The Serbian Army Medical Corps and Malaria on the Salonika Front

by

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Abstract

This thesis examines the efforts of the Serbian Army Medical Corps to combat and control malaria on the Salonika front. It also focuses on the efficacy of both prophylactic and therapeutic approaches, as well as alternative measures such as mosquito destruction.

The research fills a significant gap in the literature on malaria among Serbian troops during the Macedonian campaign of the First World War. Existing secondary sources often address malaria broadly or focus narrowly on certain aspects of the Serbian Army's experience, primarily the Šumadija and Timok Divisions, leaving other divisions underrepresented. This thesis examines the predominant focus on malaria cases among the Šumadija and Timok Divisions of the Second Serbian Army in existing literature. It investigates the reasons for this selective focus in the historiography and highlights its broader implications.

Using primary sources—including writings, accounts, and reports by Serbian Army doctors and officers directly involved in malaria prevention and treatment—this research contextualizes their efforts within the broader framework of Allied antimalarial strategies. Through a comparative perspective, it offers new insights into the challenges faced, approaches adopted, and results achieved in combating one of the most persistent health crises on the Salonika front.

General Summary

Malaria was the greatest challenge on the Salonika front during the First World War, halting combat for almost two years and turning the Macedonian campaign into what is often called the “Medical Front,” as all armies stationed in the region were severely impacted by the disease.

This research focuses on the Serbian Army Medical Corps, covering its structure, role, and efforts to combat malaria. It investigates the origins of the disease in the area and its first occurrences among Serbian troops. The study also explores the strategies the Serbian Army adopted to prevent malaria, including mosquito destruction and quinine use, as well as the approaches used to treat infected soldiers.

What makes this study unique is its comprehensive analysis of all aspects of the Serbian Army’s experience with malaria, contextualized within the broader Allied efforts.

Acknowledgements

I would like to express my deepest gratitude to my supervisor, Professor Justin Fantauzzo, for his invaluable help, guidance, and patience throughout this journey. It has been a great honor to work and learn under his mentorship.

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Introduction

"Immediately upon the troops' arrival, swarms of mosquitoes left horrifying marks on the unprotected soldiers; the bitten areas on their faces, hands, and legs were the size of walnuts. The infection was already widespread."[1] These are the words that Dr. Dobrivoje Ger Popović (Popovich), the medical officer of the Šumadija Division of the Serbian Army, used to describe his first impressions upon arriving at Salonika, where Serbian troops were to fight to liberate their occupied homeland.

"The infection" that Popović referred to was malaria. This disease, an old foe to the people in Macedonia and the soldiers stationed there, chose no sides and spared no one. Regardless of the flag they fought under, malaria was their enemy on the Macedonian front. It was the main reason why, in history books, the Macedonian front is often referred to as the "medical front," as from 1916 to 1918, the majority of the time was spent by all troops in the area—both Allied and enemy—fighting not each other but a vicious common enemy.

Macedonia has long been home to an overwhelming mosquito population—an inevitable component of every malaria epidemic. These insects, which were the primary carriers of the disease, thrived in the region, where abundant water sources and dense vegetation provided ideal breeding grounds for mosquitoes, turning it into a nightmare for the troops stationed there. As Popović's statement illustrates, the soldiers faced relentless attacks from these tiny adversaries, carrying the deadly parasite that would paralyze entire divisions and prolong the agony of the war.

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[1] Dobrivoje Ger. Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu" in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 433.

During the First World War, all the armies in the region were affected by malaria; however, this research specifically focuses on malaria within the Serbian Army. The scope of the study is confined to the Salonika front, particularly during the years 1916–1918, when the Serbian Army was actively engaged in the region. For this research, it is also important to understand the significance and historical role of the Salonika front of the Macedonian campaign, as well as the differences in perspectives in global and Serbian collective memory.

In the West, the Macedonian front, also known as the Salonika front, was often overlooked and referred to as a "Cinderella theatre," deemed of little military importance compared to the Western Front, despite its critical contributions to the Allied victory in the First World War.[2] The efforts of Allied soldiers on this front were singlehandedly responsible for the capitulation of Bulgaria in September and the Ottoman Empire in October 1918, events that played a crucial role in breaking the Central Powers 'resistance. This sentiment reflects what former Lieutenant Harold James of the 3/2nd Battalion, Gurkha Rifles, described as "Forgotten Army Syndrome," a phenomenon that has affected many armies in the twentieth century. During the Second World War, Canadian soldiers in Italy faced criticism from home and were sometimes referred to as so-called "D-Day Dodgers" for not participating in the Normandy invasion.[3]

In contrast, in Serbian collective memory, the Salonika front is celebrated as one of the greatest military achievements in the nation's history. This perception is rooted in the front's crucial role for the liberation of Serbia, following the breakthrough on the Macedonian front. For the Serbs Salonika symbolizes not only military success but also resilience and sacrifice.

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[2] Mark Harrison, *The Medical War: British Military Medicine in the First World War* (Toronto: Oxford University Press, 2010), 235.

[3] Justin Fantauzzo, *The Other Wars: The Experience and Memory of the First World War in Macedonia and the Middle East* (Cambridge: Cambridge University Press, 2020), 142.

This theatre of the First World War is remembered as a testament to the determination and bravery of the Serbian Army and its allies, who overcame immense challenges to achieve the crucial victory that saved Serbia.

As a result, the Salonika front is thoroughly analyzed in Serbian historiography. However, despite this attention, the impact of malaria on Serbian forces remains surprisingly overlooked, with very few contemporary publications dedicated to the subject. This naturally raises the question: where does this research fit into both Serbian historiography and the larger body of work on malaria during the First World War? By addressing this gap, this thesis has the potential to be one of the first comprehensive analyses of malaria among Serbian forces on the Salonika front.

The limited availability of both primary and secondary sources posed the greatest challenge in writing this thesis, making it essential to carefully examine the existing literature on the subject. To better understand where this thesis fits within the broader historiographical framework, several key works have been instrumental in shaping this research and provide the foundation for a deeper exploration of the topic.

With that being said, we should start the literature analysis with the works of Vladimir Stanijević (Stanoyevitch). Stanojević (1886–1978) was a Serbian military doctor and participant in the Balkan Wars and World War I. He was also a brigadier general of the Yugoslav Army Medical Corps, a medical historian, part-time professor of medical history, founder of the Museum of the Serbian Medical Society, and recipient of numerous military honors. In addition to these roles, Stanojević authored many publications, some of which have significantly influenced Serbian historiography on medical history.

The first book of his we should mention is *Istorija srpskog vojnog saniteta: Naše ratno iskustvo (History of Serbian Military Medicine; Our Wartime Medical Experience)*, published in 1925, as it serves as an essential primary historical source on malaria among Serbian troops

on the Salonika front.[4] As such, the book represents a foundation of modern research on the subject and is frequently cited in related literature. This research also relies on the book as a core source of information; therefore, it is frequently referenced throughout the thesis.

The book provides a detailed account of the Serbian military medical service's experiences, including those during the Balkan Wars and World War I, highlighting both the challenges faced and the achievements made in wartime medical practice. Other than Stanojević's own chapters, it consists of collected works by doctors and medical officers, including the highest officials of the Serbian Army medical services, with each author contributing a dedicated chapter based on their firsthand experiences. By compiling these works, Stanojević made an immense contribution to historiography, ensuring these invaluable records were preserved for future generations. This is especially true for the chapters on malaria among Serbian troops on the Salonika front, as the accounts of medical officers and doctors in these chapters are among the only sources available on the subject.

As for some of the challenges posed by the book, its structure reflects the unique approach taken by each of its contributors. Since the chapters were individually authored, they naturally lack interconnectedness. This is particularly evident in the chapters on malaria among Serbian troops, where one might find it challenging to comprehensively grasp the topic. Additionally, some writings include report-like sections, making it difficult to determine the specific year, unit, or location being referenced. Nonetheless, although the chapters sometimes require careful analysis to piece together the full picture, they contain crucial information and data that are indispensable for this research.

Another book by Stanojević used in this research is *Istorija ratnih zaraza: Od Napoleona do Evropskog rata završno (The History of Wartime Epidemics: From Napoleon to*

[4] Vladimir Stanojević, *Istorija srpskog vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925).

the European War), published in 1924.[5] In this book, Stanojević analyzes the history of various infectious diseases, including malaria, and their impact on military operations from the Napoleonic Wars to the First World War. The chapter on malaria is particularly relevant to this research, as it provides detailed information and statistics on the disease's impact on military operations worldwide during that period, with special attention to the section on its effect on the Serbian Army during the First Balkan War, as it was the first time Serbian forces faced a malaria epidemic. Notably, the strain of malaria that affected the Serbs in Albania in 1912 was similar to the one they would face again a few years later during the Salonika operation.

As for more recent publications on the subject, works by Aleksandar Nedok (1925–2024) deserve special recognition. He came from a Slovenian family with a long history of service in the Serbian Army's Medical Corps. His grandfather served as a medical officer on the Salonika front during the First World War, where he took part in combating malaria. This family legacy likely influenced Nedok's distinguished career in medicine. He was an internist, primarius, and Doctor of Medical Sciences at the University of Belgrade, where he also served as a scientific advisor at the Faculty of Medicine. He served as the Head of the Internal Medicine Department in Belgrade from 1972 to 1987 and as the Director of the Institute for Emergency Internal and Cerebrovascular Diseases (now the "Sveti Sava" Hospital) in Belgrade from 1979 to 1987. Among his many accomplishments, Nedok was the founder of Serbia's first Coronary Unit and the first chief of Emergency Cardiology at the Emergency Center of Serbia in Belgrade. He was a regular member of the Serbian Medical Society's Academy of Medical Sciences as well as the New York Academy of Sciences.

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[5] Vladimir Stanojević, *Istorija ratnih zaraza: Od Napoleona do Evropskog rata završno* (Belgrade: Zlatibor, 1924).

Nedok authored numerous publications on the history of Serbian military medicine, with a focus on the First World War. However, none of these works focused specifically on malaria; instead, the disease was usually mentioned within the broader context of infectious diseases, with limited scope of research. Despite its broader scope, Nedok's analyses of malaria among Serbian troops provided valuable insights for this thesis, especially through the book *Srpski vojni sanitet u Prvom svetskom ratu (Serbian Military Medical Corps in the First World War)*.[6] Published by the Serbian Ministry of Defence in 2014, this work, co-authored with retired Serbian Army Medical Corps Generals Branislav Popović (Popovich) and Veljko Todorović (Todorovich), brings together many of Nedok's previous publications from journals and books into a single volume. This consolidation of his research combined with an extensive overview of the challenges faced by the Serbian medical service during the war, offers essential context and important details.

To fully understand the challenges malaria posed to the Serbian Army and achieve a comprehensive analysis, it is crucial to examine the experiences and antimalarial efforts of the British and French allies, as both nations invested significant resources in combating this widespread disease. Approaches, achievements, and insights of the British and French scientists, pioneers in the fight against malaria, offer valuable context and comparative perspectives.

In that regard, Bernardino Fantini's chapter "Malaria and the First World War," from *Die Medizin Und Der Erste Weltkrieg*, deserves special attention.[7] Fantini, an Italian expert in

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[6] Aleksandar Nedok, Branislav Popović, and Veljko Todorović, *Srpski vojni sanitet u Prvom svetskom ratu* (Belgrade: Medija Centar Odbrana, 2014).

[7] Bernardino Fantini, "Malaria and the First World War," in *Die Medizin und Der Erste Weltkrieg,* ed. Wolfgang U. Eckart, and Christoph Gradmann (Pfaffenweiler: Centaurus-Verlagsgesellschaft, 1996), 241–272.

the history of epidemics, provides a comprehensive analysis of malaria's impact not only on Allied British and French forces but also on the enemy German forces in Macedonia. He also examines the Allied antimalarial efforts during the Salonika operation, shedding light on strategies employed to mitigate the disease's devastating effects on troop readiness. Of particular value to this research is his discussion on the use of quinine, a key medicine for combating malaria at the time. Fantini's analysis includes the perceptions and contributions of leading doctors and malariologists such as W. H. Sutcliffe, C. H. Treadgold, W. G. Willoughby, L. Cassidy, P. Abrami, R. Ross, and G. B. Grassi, among others. Their work provides critical insights into the scientific debates and innovations surrounding malaria treatment during the First World War and allows us to contextualize the antimalarial medical practices of Serbian doctors in Salonika within the broader medical debate on the uses and limitations of quinine as both a prophylaxis and treatment during that time.

Another work on Allied antimalarial efforts in Macedonia that significantly contributed to this research is *The Medical War: British Military Medicine in the First World War* by British historian Mark Harrison.[8] Published in 2010, Harrison's book includes a chapter dedicated to the British experience with malaria during the First World War. While he examines malaria across various theatres of war, including East Africa and the Middle East, his analysis places particular emphasis on Macedonia and the efforts of the British Army. Harrison explores antimalarial measures and the challenges associated with using quinine for both prophylaxis and treatment. The book further addresses malaria's impact and the ongoing internal debates surrounding quinine use on the Salonika front, providing essential context.

[8] Mark Harrison, *The Medical War: British Military Medicine in the First World War* (Toronto: Oxford University Press, 2010).

Having reviewed the key publications that significantly influenced this research, it is now essential to outline its methodology, research questions, objectives and structure. This traditional-style thesis combines historical analysis, comparative research, and primary source interpretation and evaluation to address the central research questions: How did malaria impact the Serbian Army on the Salonika front? What antimalarial strategies were employed, and how effective were they? And what was the Serbian Army's approach to malaria treatment?

The primary objectives are to assess the role of the Serbian Army Medical Corps in combating malaria and to situate these efforts within the broader framework of wartime medical practices. To achieve this, the research examines how the Medical Corps identified, managed, and treated malaria among troops on the Salonika front and compares these efforts to those of Allied forces. By doing so, the study seeks to bridge gaps in existing literature.

To answer the research questions and achieve these objectives, the thesis is organized into three chapters, each systematically exploring key aspects of the topic.

When an infectious disease strikes a battling army, the medical corps is usually the only unit capable of combating it. Consequently, the ability to avoid epidemic catastrophes directly depends on its condition and effectiveness, highlighting the role of the medical branch in studies of wartime epidemics. For this reason, the first chapter of this thesis is devoted to analyzing the Serbian pre-war military medical service. This chapter examines the structure of the Serbian Army's Medical Corps, its relations with other branches of the army, and the challenges that affected its capabilities during the First World War. Additionally, it provides readers with the historical context necessary for fully understanding the topics discussed in the subsequent chapters.

The second chapter focuses specifically on malaria on the Salonika front while also providing a broader historical context of malaria's impact on military operations across the world. It examines malaria morbidity and mortality rates and addresses issues related to quinine

prophylaxis and other antimalarial measures among Allied forces in Macedonia. Special attention is given to the Serbian Army, with a thorough analysis of malaria cases among Serbian troops and the efforts of the Medical Corps to counter the disease. This analysis relies primarily on reports and firsthand accounts from Serbian doctors and medical officers who actively participated in combating malaria. Additionally, the chapter explores the unique aspects of Macedonian malaria and the challenges it posed, laying the groundwork for the next chapter.

Since treatment is an inevitable aspect of any disease-related research, the third chapter is dedicated to analyzing malaria treatment within the Serbian Army. At the heart of this chapter are the doses and regimens employed by Serbian doctors for malaria therapy. A key source of information on this topic is the work of Dr. Ljubomir Stojanović (Stoyanovich), the head of the Internal Medicine Department at the Serbian hospital in Salonika. His insights were published in the chapter "Terapija malarije u srpskoj vojsci na Makedonskom ratištu (Therapy of Malaria in the Serbian Army on the Macedonian Front)" in Stanojević's book *Istorija srpskog vojnog saniteta: Naše ratno iskustvo*.[9]

Stojanović provided a detailed account of the challenges associated with treating Macedonian malaria. He also discussed all the tests and experiments he and his team conducted to determine the optimal form and dosage of quinine for therapy. To provide better context, the chapter also examines quinine therapy practices in Allied armies, offering a comparative perspective, and explores the medical debates during that period on the therapeutic efficacy of quinine.

It should be noted that all translations from Serbian, including titles, excerpts, and citations, used in this thesis were provided by the author.

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[9] Ljubomir D. Stojanović, "Terapija malarije u srpskoj vojsci na Makedonskom ratištu" in *Istorija srpskog vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 453–469.

Chapter I: Serbian Army Medical Corps 1878–1918

"One day in Valjevo, there were 8,000 wounded soldiers gathered, but only 2,500 hospital beds were available… At that time, there were only 26 doctors working in Valjevo, of whom only 10 had more or less specialized surgical training, while the remaining 16, including doctors from the Health Department of the Supreme Command, were mainly occupied with administrative duties."[10] This statement made by Dr. Lazar Genčić, the Head of the Health Department of the Supreme Command of the Serbian Army, illustrates the helplessness of the situation that the Serbian Army and people found themselves in at the beginning of the First World War.

The First World War was arguably one of the most devastating wars in Serbian history in every aspect. It was the most severe existential crisis for Serbia since the fifteenth century, when it was conquered along with other Balkan nations by the Ottomans. A new invasion by the Germans, Austrians, and Bulgarians during the First World War once again threatened the very existence of the Serbian state.

The war also claimed enormous casualties, both military and civilian. In fact, the Serbs suffered percentage-wise the biggest casualties in the First World War. According to different research and estimates, Serbia lost approximately 28% of its total population during the war. The official Report of the Delegation of the Kingdom of Serbs, Croats and Slovenes at the Paris Peace Conference 1919 indicates that Serbia had a population of approximately 4,500,000

[10] Lazar Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 778–779.

before the war; the war caused 402,435 military deaths and 845,000 civilian deaths.[11] Although it might come as a surprise to some, many of those deaths were caused by diseases. This was particularly the cases with the civilian casualties. The official report from 1919 estimated that 360,000 civilian deaths were caused by epidemic diseases, which is 42.6% of the total civilian casualties.[12]

Before we get further into the analysis of the state and the specific issues of the Serbian medical and health services, I feel I should first clarify the terminology and the timeframe I used for this chapter's headline. The term "Serbian Army Medical Corps" is used to refer to all Serbian military medical services, as there was no unified military medical service at the time. Since the early years of independence, the Serbian Army was under the jurisdiction of the Ministry of Defence. However, both the Army and the Ministry had their own health services, which were classified as departments. So, there was the Health Department of the Supreme Command of the Army and the Health Department of the Ministry of Defence.[13]

This system was proposed by the Serbian Army General Staff and approved by Defence Minister Sava Grujić in November 1877. Dr. Vladan Djordjević, in his book *Istorija srpskog vojnog saniteta (History of the Serbian Military Medical Service),* published in 1880, provided a detailed description of the roles and responsibilities of each department.[14] We should note that Djordjević himself at that time was a very influential person. In 1877 he was the Head of

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[11] Biljana Radivojević, and Goran Penev, "Demographic Losses of Serbia in The First World War and Their Long-Term Consequences," *Economic Annals,* Volume LIX, No. 203 (October – December 2014): 35–36.

[12] Radivojević, and Penev, "Demographic Losses of Serbia in The First World War and Their Long-Term Consequences," 36.

[13] Jelica Ilić, *Na vetrometini epidemija: Dr. Lazar Genčić* (Zaječar: Maticna Biblioteka "Svetozar Marković," 2019), 49.

[14] Djordjević Vladan, *Istorija srpskog vojnog saniteta* (Belgrade: State Printing House, 1880).

the Health Department of the Supreme Command, therefore it is very likely that he personally contributed to establishing that dual-service system.[15]

According to the correspondence between the Minister and the General Staff that Djordjević included in his book, on the one hand, the main responsibility of the Health Department of the Supreme Command was to oversee all medical troops and field military medical units, including ambulances and hospitals. Its duties included allocating medical personnel to troops, inspecting medical services in the field, managing transport services to reserve hospitals, relocating medical units as needed, removing unsuitable personnel from field service, and commanding stretcher-bearers and hospital orderlies to ensure their proper assignment and care. On the other hand, the Health Department of the Ministry of Defence was responsible for managing the deployment of military medical personnel, procuring medical supplies and equipment, and overseeing all reserve hospitals in the state. It also managed the central medical depot and ensured that all field military medical units were supplied on time. This department supervised services in reserve hospitals, conducted inspections, and had the authority to increase, relocate, or close these hospitals as needed, including managing their personnel.[16]

The main flaw of this rather complex structure was that it left room for policy interference and authority disputes between the two independent military medical services. To minimize such risks, the General Staff, along with the announcement of the structure, duties, and responsibilities of the two health services, issued an order signed by the Defence Minister. This order mandated that both health departments inform each other of every order and

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[15] "Serbian Academy of Sciences and Arts," *The Year of Academician Vladan Djordjević,* accessed on 25 August 2024, https://www.sanu.ac.rs/godina-akademika-vladana-djordjevica/

[16] Djordjević, *Istorija srpskog vojnog saniteta,* 61–62.

significant action they undertook to ensure coordination in all medical activities.[17] Despite expectations, this simple clause was not sufficient to synchronize these two departments.

To address this complexity and refer to the overall medical activities within the Serbian Army more cohesively, I have decided to use terms such as "medical corps," "military medical services," or simply "medical service" to encompass both departments whenever possible.

As for the chapter's timeframe, I decided to focus on the period from 1878 to 1918 to ensure its relevance to the rest of the thesis. I chose 1878 as the starting point because it was the year when Serbia officially gained its independence from the Ottomans. Even though the establishment and development of a dedicated medical service in the Serbian Army had begun earlier, the most significant changes in the history of the Serbian military medical service that impacted its capabilities in the First World War occurred after independence. One particularly important event in this regard was the Serbian-Bulgarian War in 1885, as it was the first war that Serbia fought as an independent state with a dedicated military medical service. The nature of this conflict had a profound impact on post-war military medicine in Serbia, as it dictated the direction of the service's further development. Later in this chapter we will analyze how this war specifically influenced the evolution of Serbian military medicine.

When researching about the state of the Serbian Army medical service before and during the First World War, it often feels more like a critique than a discussion. This is primarily because Serbian medicine, in general, faced numerous challenges during that period, both internally and externally, that the state struggled to address. In the process, I worked with many reports and writings from doctors who personally participated in the events in question. What stood out in most of these accounts were the common issues they faced and the failure of both the state and the army to address those issues adequately.

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[17] Djordjević, *Istorija srpskog vojnog saniteta,* 61–62.

The biggest issue that Serbian medicine, both military and civilian, faced has traditionally been an insufficient number of doctors. In the early 20th century and before the First World War regiments in well-organized and equipped European armies in France, Britain, Germany, Russia, and Austria-Hungary had at least three, sometimes five, or even six doctors and several medical assistants. In contrast, the Serbian Army had only one doctor for every two, and sometimes even three, regiments and many other smaller units. There were also many garrisons where the military medical service did not have a single doctor of its own but had to hire civilian doctors.[18]

This fact is illustrated when presented in numbers and in broader context. According to Dr. Lazar Genčić (Genchich), a former Head of the Health Department of the Supreme Command, the peacetime Serbian Army during that period had 32.000 soldiers and 54 doctors, which equates to 1 doctor per 593 soldiers.[19] Meanwhile, in July 1914 Serbia had a population of 4.500.000 people and approximately only 400 civilian doctors in total.[20] This meant that, at the beginning of the First World War, Serbia had only 1 doctor per 11,250 people. While these figures represent different contexts—the military and the civilian population as a whole—they both underscore the critical shortage of medical personnel in Serbia at the time, which left the country ill-prepared to meet the demands of both its military and civilian populations during a time of crisis.

The likely cause of such a severe shortage of doctors was the fact that Serbia did not have its own medical educational institution at the time. Therefore, most of the Serbian doctors earned their degrees in medicine at Austrian, German, Polish, Czech and Russian universities.

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[18] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 774.

[19] Ibid., 773.

[20] Ibid., 777.

The question of establishing the first medical educational institution was first raised in the Serbian parliament in 1879 during the debate on the urgent need to increase the number of doctors in the country. The Member of Parliament Vasilije Pavić made a proposal for the Great School of Belgrade to first be elevated to the level of a University so that "our sons can be trained as doctors at the school and treat their own people."[21]

Contrary to expectations, Dr. Vladan Djordjević, known as one of the most prominent doctors in the country, challenged Pavić's proposals and effectively ended any further discussion on the establishment of a Medical Faculty. In opposing the idea of establishing the faculty, Dr. Djordjević stated: "A Medical Faculty requires, above all, an enormous educational force, it requires a professorial corps that we do not have and cannot have for another thirty years. A Medical Faculty demands such enormous and costly scientific collections, which we cannot obtain for a long time, even if we had the money for it."[22] Besides opposing the demand for the establishment of a Medical Faculty, Dr. Djordjević supported those who advocated for sending "our sons to study medicine," as it would be "better for us to send 20-30 scholars to foreign universities at state expense for medical studies, and in 5-6 years, we will have all our sons as doctors."[23]

After this failed attempt to establish the University of Belgrade and the Medical Faculty the issue was not raised for another 20 years. The debate returned to the agenda only in 1898 when the Serbian parliament decided to elevate the Great School of Belgrade to the status of a university, a change that was finalized in 1905. That same year, the decision to establish a Medical Faculty was also made. However, this decision again faced opposition from a part of

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[21] "Medical Faculty of the University of Belgrade," *The History of the Faculty*, accessed on 22 August, 2024, http://med.bg.ac.rs/?page_id=12061&script=lat

[22] Ibid.

[23] Ibid.

the Serbian medical and academic community, leading to disagreements and, at times, tense relations within the community.[24]

The devastating impact of the First World War further underscored the necessity of such an institution, accelerating its establishment and highlighting the critical importance of a well-trained medical workforce. On 9 December 1920, the Medical Faculty of the University of Belgrade was finally established, marking the culmination of decades of debate and effort to address Serbia's severe shortage of doctors and the pressing need for a domestic medical education system.[25]

When analyzing the issue deeper we can see that those who opposed the establishment of the Medical Faculty, including Dr. Djordjević, other than their own beliefs, concerns and sometimes ego, they did not provide any real data or arguments to support their claims. Those who were in favour of the establishment of such institution, such as the famous doctors in Serbia Djordje Nikolić and Milan Jovanović – Batut, often published articles and even books on the significance of the national medical school.

The debate was further fuelled by the fact that neighbouring Zagreb was actively working on establishing a Medical Faculty. On 24 May 1888, an article sharply criticizing the newly appointed Minister of Education, Dr. Vladan Djordjević, was published in the journal *Srpske Novine* (Serbian Newspaper). The article highlighted that the same man who, ten years earlier, had directly hindered the educational development of the state was now serving as Minister of Education. It also pointedly remarked that "the Croats have had a University for 14 years," and that "Zagreb has already allocated 100,000 dinars for the establishment of a Medical Faculty, while Belgrade, five times wealthier has allocated nothing." The article emphasized

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[24] "Medical Faculty of the University of Belgrade," *The History of the Faculty*, accessed on 22 August, 2024, http://med.bg.ac.rs/?page_id=12061&script=lat

[25] Ibid.

that work was well underway in Zagreb to "complete the Croatian University with a Medical Faculty."[26]

It was very confusing why would some doctors and academics oppose the idea of establishing a national medical educational institution. Their claims that the state could not afford it did not seem very convincing nor accurate, but rather exaggerated, especially since other cities and nations in the region with similar economic situation were already actively working on establishing such institution. Another confusing aspect of that debate was why the issues of state scholarships for 20-30 students and the development of a national educational center were posed as mutually exclusive. I believe the answer to this question shares the same root cause as other difficulties the Serbian military service faced, which eventually contributed to the massive casualties in the First World War. To fully understand this, we need to approach the question from a different perspective.

This resistance to establishing a national medical educational institution, and the broader neglect of systemic medical and military needs, was well identified and explained by Dr. Tihomir Simić (Simich), a medical officer in the Serbian Army during the Balkan Wars and the First World War, and one of the co-authors of Stanojević's book. In his chapter "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti" (Critical Views on the Work of Our Medical Service in the Past and Present), he provided a critical analysis of the factors that shaped and directed the entire medical service. He highlighted that the professional education of many Serbian doctors was quite "one-sided, and consequently, all their work was confined within the narrow limits of their rather one-dimensional views and understandings."[27]

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[26] "Medical Faculty of the University of Belgrade," *The History of the Faculty*, accessed on 22 August, 2024, http://med.bg.ac.rs/?page_id=12061&script=lat

[27] Tihomir Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," in *storija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 792.

This perspective was typically limited to the boundaries of practical curative medicine, and anything beyond that rarely attracted their interest. According to Dr. Simić, individualistic perspectives largely shaped the views of Serbian doctors, leaving issues of general and collective importance, such as preventive medicine, with little attention or interest.[28] This narrow-sighted approach can be seen in the debate over establishing a national medical educational institution. The fact that some doctors, academics, and politicians insisted on sending students to foreign institutions simply because it was more cost-effective than founding a national medical school reveals a limited understanding of the broader role such an institution could play.

They saw its sole purpose as educating future doctors, when educational institutions—especially in the medical field—provide much greater value. Universities not only train professionals but also conduct essential research, fostering scientific development. They also collaborate with other universities and institutions worldwide, staying up to date with the latest scientific advancements. Medical educational institutions are, therefore, a crucial part of a nation's healthcare infrastructure. Serbia's failure to fully recognize the importance of establishing its own medical school came at a significant cost to the country and its people.

According to Dr. Simić, individualistic perspectives largely shaped the views of Serbian doctors, leaving issues of general and collective importance, such as preventive medicine, with little attention or interest. In the late 19th and early 20th centuries, doctors in Serbia tended to have a very pragmatic approach to medicine. As he explained, the majority of doctors focused solely on addressing the immediate issues of the patient in front of them. This narrow perspective led to a lack of attention to broader medical concerns that were already being addressed in other parts of the world at the time—particularly in the areas of hygiene, infectious

[28] Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 792.

disease control, and general prophylaxis. These issues were often viewed as secondary problems, believed to require little effort, special sacrifices, or professional expertise to resolve.[29] He explained how this narrow view of the role and duties of a physician led to a single perspective permeating all social circles, both medical and the general public. The prevailing belief was that a doctor's main duty was solely to treat sick people. As a result, a doctor's ability was assessed exclusively on their skill in treating illnesses, with little emphasis placed on preventive medicine or broader public health responsibilities.

This belief significantly influenced and shaped the work of both civilian and military medical services. In civilian healthcare, most doctors concentrated on curative medicine, prioritizing treatments aimed at curing individual illnesses or conditions. In the military, the most developed branch of medicine was surgery. However, unlike the civilian sector, where nearly all branches of curative medicine were equally underdeveloped, the exclusive focus on surgery within the Serbian military medical service negatively impacted other areas.[30]

Since the Serbian–Bulgarian war in 1885, the primary concern of the military medical service was to have as many skilled surgeons as possible, with well-organized surgical departments and sufficient supplies. This resulted in a well-equipped and efficient surgical service, but the issue of health preservation remained secondary. As Dr. Simić satirically noted, it was considered important "to skillfully operate on a soldier's hernia, set a fracture, or dress a wound, but it was of lesser concern if that soldier later fell victim to an infectious disease due to poor hygiene."[31]

The direct consequence of such views on the role of doctors and medicine, which Dr. Simić frequently criticized, was the absence of children's hospitals and bacteriological clinics

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[29] Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 792.

[30] Ibid., 792–793.

[31] Ibid., 793.

in Serbia, despite the alarmingly high mortality rate among children and the prevalence of infectious diseases such as tuberculosis, typhoid fever, and diphtheria. According to him, there was a prevailing belief in Serbia at the time that matters related to combating infectious diseases, water quality, and promoting hygiene fell under the responsibility of the military, police, and similar organizations. He also observed that it was not uncommon for the police to be involved in efforts to suppress infectious diseases.[32] Within this context it becomes clear that the importance of hygiene and dangers posed by the infectious diseases to society were consistently neglected by both military and civilian health authorities. Any attempts to improve the situation were confronted, much like the idea of establishing a national medical school was confronted.

Before we proceed to the analysis of the Serbian military medical service during the Balkan Wars and the First World War, it is important to address a few more key characteristics of the pre-war period. First, we must examine the relationship between the military medical service and other branches of the army. This topic was thoroughly covered by Dr. Miloš Borisavljević (Borisavljevich), who belonged to the oldest generation of the Serbian military medical service. He started his career as a regimental doctor in 1883 and later became the Head of the Health Department of the Ministry of Defence in 1901. During various conflicts, including the Bulgarian War of 1885, he served as a regimental doctor, and in the Balkan and World Wars, he was the Chief Medical Officer of the First Army. After the First World War, he contributed as a co-author to Stanojević's book. In his chapter "Vojni sanitet u miru i ratu od 1884 do 1921" (Military Medical Service in Peace and War from 1884 to 1921),

[32] Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 793.

Borisavljević chose to discuss the medical service "with competence, but also with strict objectivity."[33]

One of the greatest challenges the military medical service faced for a long time was its relationship with the rest of the military. A key aspect of this dynamic, which affected the development of military medicine in Serbia, was the attitude of regular army officers towards their medical counterparts. They often looked down on medical officers, perceiving them as not being "real" soldiers. This perception hindered the progress of military medicine, as regular officers held higher authority. Consequently, suggestions and recommendations from army doctors were subject to the approval and understanding of regular officers, especially regarding the importance of medical practices and advancements.

Borisavljević provided compelling real-life examples, including his own, that illustrated the power dynamics between regular and medical officers. For instance, when he was serving as a medical officer in Niš (Nish), he suggested to the then-commander, General Mostić (Mostich), that soldiers should bathe at least once every 15 days in the new town bathhouse. The General dismissively replied, "They (the soldiers) are not fish, so they do not need to swim in the water." No explanation about the benefits of cleanliness could persuade the General to change his mind, as it would have cost 100 dinars for the bathing.[34]

Simić shared a similar experience during the cholera epidemic in the Second Balkan War. When he requested a more effective disinfectant from his superiors, he was simply told to make quicklime himself.[35] Borisavljević also emphasized that whenever the military health

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[33] Miloš Borisavljević, "Vojni sanitet u miru i ratu od 1884 do 1921," in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 800.

[34] Borisavljević, "Vojni sanitet u miru i ratu od 1884 do 1921," 800.

[35] Quicklime has traditionally been used for various purposes, including disinfection. The process of preparing quicklime for disinfection took 24–72 hours. Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 798.

departments requested funding to purchase sanitary equipment, such as disinfectants for the barracks, their requests were often denied with the simple response, "There are no sufficient funds in the budget."[36]

The poor reputation of the medical service among the rest of the army was an ongoing issue for a long period of time, despite the best efforts of many medical service chiefs to improve its status. Apparently, one of the reasons regular army officers looked down on medical officers was that, unlike the "real" officers, the doctors did not have a sword as part of their uniform, which symbolized military authority and status. Borisavljević's predecessor, Dr. Mihajlo "Mika" Marković (Markovich), who was the Head of the Health Department of the Defence Ministry, managed to resolve this particular case of unfair treatment and humiliation of military doctors by intervening with the Serbian royal family, the Obrenović dynasty, with whom he had a good relationship. As a result, medical officers were also issued a sword, symbolizing their equal status with the regular army.[37]

During a parliamentary debate, when an initiative was proposed to amend the Law on the Organization of the Army by introducing a provision that would allow for the appointment of a general in the medical corps—specifically as the Chief of the Medical Corps—everyone was in favour except for the then Minister of Defence, General Atanasijević. He insisted that this general be referred to as a "medical general" to distinguish him from other generals. Dr. Vladan Djordjević, who had previously blocked the proposal to establish a national medical school and now was the Prime Minister, along with Dr. Mihajlo Marković, did not agree to this unfair distinction, and as a result, the initiative failed.[38] This incident highlighted how even the highest military circles viewed the status and prestige of the military medical service.

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[36] Borisavljević, "Vojni sanitet u miru i ratu od 1884 do 1921," 801.

[37] Ibid.

[38] Ibid.

Another key characteristic of the pre-war period for Serbian medicine that we should consider is the relationship between military and civilian doctors. As previously noted, before the First World War, Serbia had 32,000 soldiers and only 54 military doctors, which was insufficient even for a peacetime army.[39] As a result, civilian doctors played a crucial role in the military medical service during the First World War. Because of this, it is important to analyze the key aspects of peacetime civilian medicine and how it compared to the military medical service. The specifics of their involvement in the subsequent wars will be examined later in this chapter.

As we already know from Dr. Simić, many civilian doctors in Serbia were highly pragmatic, focusing primarily on curative medicine—treating the individual patient in their care. This approach can partly be explained by the fact that, although there were more civilian than military doctors, their numbers were still far from sufficient to meet the national demand. Due to the shortage of civilian doctors in pre-First World War Serbia, they were as overwhelmed with work as their military counterparts. However, Borisavljević highlighted a few interesting differences in the work of civilian and military doctors. Firstly, he emphasized the fact that civilian doctors had much greater experience than military doctors. This was mainly due to the fact that, unlike military doctors who worked mainly with the young men, who are generally the healthiest population group, the civilian doctors had access to a much greater pool of patients, providing physicians with better opportunities to gain practical knowledge. Another important difference was the pay gap. According to Borisavljević, military doctors were underpaid in comparison to their civilian colleagues. He also explained that this pay gap, combined with better opportunities for practical experience, negatively impacted the army, as

[39] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 773.

many military doctors, when given the chance, tended to leave the military for higher-paying civilian jobs.[40]

We can notice that the financial aspect frequently accompanied many of the difficulties experienced by the military medical service. Although insufficient funds might seem like a reasonable and justified explanation, both Simić and Borisavljević agreed that it was often just a convenient excuse used by military and state authorities. When speaking about the issue, Dr. Simić noted: "Just as funds could be secured for treatment, the necessary resources could also have been obtained for implementing preventive medical measures, which are equally important and beneficial to the population as the curative branch of medical science."[41] Similarly, Borisavljević observed: "For the Defence Minister, the primary concern was to procure weapons, cannons, ammunition, and other equipment, while medical supplies were the least priority and were only considered if there were any funds left over."[42] Therefore, it appears that many of the problems within the Serbian military medical service were not due to a lack of finances, but rather issues of priority.

The Balkan Wars

The three wars—the two Balkan Wars and the First World War—can arguably be regarded as some of the most significant events in recent Serbian history, which had a lasting impact not only on Serbia but also on the entire Western Balkans. These devastating conflicts also presented immense challenges for the country's medical services. However, before we get into a deeper analysis, it is essential to first outline the basic history behind these events, as this will provide a clearer context for the entire thesis.

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[40] Borisavljević, "Vojni sanitet u miru i ratu od 1884 do 1921," 802.

[41] Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 794.

[42] Borisavljević, "Vojni sanitet u miru i ratu od 1884 do 1921," 806.

The term “Balkan Wars” refers to two successive military conflicts. The First Balkan War was fought between the members of the Balkan League—Serbia, Bulgaria, Greece, and Montenegro—and the Ottoman Empire. The League, formed in the spring of 1912, aimed to seize Macedonia from Turkey, which was already engaged in a war with Italy in North Africa. The Balkan League fielded a combined force of 750,000 men. Montenegro initiated hostilities by declaring war on Turkey on October 8, 1912, with the other members of the League following suit 10 days later. Within a few months, the Turkish army was devastated, leading to the proposal of an armistice on December 3, 1912. However, a coup d’état by the Young Turks in January 1913 reignited the conflict. Despite this, the Turks were once again defeated, and a peace treaty was signed in London on May 30, 1913. As a result, the Ottoman Empire lost almost all its remaining territories in Europe, including Macedonia and Albania. The European powers insisted on Albanian independence, while Macedonia was to be divided among the Balkan allies.[43]

The Second Balkan War was a brief armed conflict arising from disputes over the division of Macedonia among the Balkan League allies. The war began on the night of June 29–30, 1913, when Bulgarian troops attacked Serbian and Greek forces in Macedonia. Although the sudden Bulgarian attack was initially successful, the Serbian and Greek forces quickly reorganized and launched a counteroffensive. In mid-July, Romania and Turkey joined the war, with Turkey regaining some of its previously lost territories. Severely outnumbered, Bulgaria stood no chance and agreed to an armistice on July 30. A peace treaty was signed on

[43] “Britanica,” *Balkan Wars*, Last Updated on 01 August, 2024, https://www.britannica.com/topic/Balkan-Wars

August 10, 1913, under which Bulgaria lost most of its newly conquered territories in Macedonia, which were then divided between Greece and Serbia.[44]

The Balkan Wars were a crucial test for Serbian military medicine before the subsequent First World War. Before we further analyze the medical front of the Balkan wars, it's important to highlight that during both conflicts, combat occurred in newly acquired territories that had not been part of Serbia before, creating a clear distinction between the front lines and the rear. As a result, most of the civilian population in the old Serbian territories was spared from the main hardships of the war. The primary exception was that some cities became medical centres where wounded and sick soldiers were brought for treatment, or where Turkish, and later Bulgarian, prisoners—often wounded and ill—were stationed.

From a medical perspective, all the warring nations in the Balkan Wars faced a common challenge: poorly organized or nonexistent military medical services. In Serbia, however, the nearly 30-year emphasis on developing surgical capabilities proved to be a significant advantage. Compared to other nations in the region, Serbia had one of the best-organized military medical services, mainly thanks to its well-trained and well-equipped surgeons. Some of the achievements of Serbian surgeons during the war were particularly remarkable.

At the International Surgical Congress in London in 1913, Dr. Rudolph Matas, a renowned American surgeon and pioneer in vascular surgery, praised the achievements of Serbian surgeons at the military hospital in Belgrade. He specifically commended Vojislav Subbotitch for his groundbreaking success in repairing injured arteries and veins. Subbotitch, Senior Surgeon at Belgrade State Hospital, a Lieutenant Colonel in the Serbian Army Reserve during the Balkan Wars, and one of the founders of the first medical faculty in Serbia, initiated

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[44] "Britanica," *Balkan Wars*, Last Updated on 01 August, 2024, https://www.britannica.com/topic/Balkan-Wars

one of the earliest clinical programs emphasizing repair, rather than ligation, of injured arteries and veins.[45]

Despite a well-organized and equipped surgery, Serbia, like all other warring nations, still struggled with a shortage of doctors, especially bacteriologists. As a result, all the nations involved were desperate for international medical aid. This aspect of the war was well described and analyzed by Dmitry Neklyudov, a Russian neurologist from St. Petersburg State University. In his article "Issues of Serb Military Medicine and Russian Assistance in the Balkan Wars of 1912–1913," published in the *Military–Historical Journal,* Neklyudov offers valuable insight into the medical front from the perspective of foreign doctors, specifically Russian physicians, who participated in these historical events.[46]

At the beginning of the war, the Serbian Red Cross Society requested assistance from the Red Cross headquarters in Switzerland. Soon, medical missions and individual doctors began arriving in the Kingdom of Serbia. During the First Balkan War, approximately 100 doctors came to Serbia as part of these missions, along with volunteer doctors who joined the Serbian Army, most of whom were Russians and Serbs living in Austria. Seven missions were sent by the Russian Red Cross. Additionally, three missions from the Swiss Red Cross arrived in Serbia, along with individual missions and doctors from the Belgian, Italian, British, French, German, and Austro-Hungarian Red Cross, including Czech and Polish doctors.[47]

A similar need for assistance existed in every army during the Balkan Wars, with the main difference being the severity of conditions. According to Neklyudov, the Bulgarian army

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[45] N. M. Rich et al., "The Matas–Soubbotitch Connection," NIH National Library of Medicine, accessed on August 30, 2024, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7223625/

[46] Dmitry Neklyudov, "Issues of Serb Military Medicine and Russian Assistance in the Balkan Wars of 1912–1913," *Military-Historical Journal*, no. 5 (2019).

[47] Ibid., 80.

faced the most challenging circumstances, as reflected in the allocation of Russian Red Cross funds for medical aid across the region. According to Neklyudov, 50.36% of the total expenses were allocated to aid Bulgaria, 33.60% to Serbia, 7.48% to Montenegro, 6.96% to Greece, and 1.57% to Turkey. The writer V.I. Nemirovich-Danchenko, a war reporter present on the ground during the Balkan Wars, also commented on the difficult sanitary and medical conditions in the Bulgarian army. In one of his reports, he noted: "This country seems to have forgotten that in war, not only do they fight and win, but people also get wounded and fall ill… I do not know what they would have done if not for the foreign hospitals, especially the Russian ones."[48]

Regarding the Serbian Army's medical service, foreign doctors had mixed impressions, as noted by Neklyudov. On one hand, Dr. S.K. Sofoterov, who participated in the Balkan Wars and the First World War alongside the Serbs, praised the well-organized medical evacuation system, noting that, in theory, everything was planned correctly. On the other hand, M.A. Strizover, a member of the Russian medical mission, was critical of the handling of infections, stating, "The medical personnel did not understand their tasks. In most cases, there was no question of providing any treatment."[49] Dr. Tihomir Simić shared similar observations to Strizover. According to Simić, the outbreak of epidemics caused surprise, confusion, and disorientation within the Serbian medical service. The sudden influx of patients overwhelmed the system, as it faced an unfamiliar and unsolvable problem for which it lacked both professional expertise and adequate resources.[50]

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[48] Neklyudov, "Issues of Serb Military Medicine and Russian Assistance in the Balkan Wars of 1912–1913," 78.

[49] Ibid., 79.

[50] Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 797.

Although the Serbian Army faced epidemic outbreaks of various diseases, such as dysentery and typhus, the biggest threat came from a cholera epidemic. Malaria was also present during the First Balkan War, but this will be addressed in the following chapter.

The first cases of cholera in the Serbian Army were recorded during the First Balkan War, but the largest outbreak occurred during the Second Balkan War. According to Dr. Genčić, the primary source of cholera among the Serbian troops during the war against Bulgaria were the Bulgarian soldiers. Cholera had already been widespread among the Bulgarian forces during the First Balkan War, as they had contracted the disease from infected Turkish soldiers.[51]

Stanojević emphasized that the majority of cholera cases occurred among the troops, with significantly fewer cases reported among the civilian population. According to Stanojević, during the Second Balkan War, the Serbian Army saw 15,000 cases of cholera infection, resulting in 5,000 deaths.[52]

The extremely high mortality rate of 33% demanded urgent action. In February 1913, as the epidemiological situation worsened, Roman Sondermayer, Head of the Health Department of the Defence Ministry, requested the Russian Red Cross Society to send five epidemiologists and 40 sanitarians to Serbia. However, since combating epidemics fell outside the Red Cross's mandate, the request had to be declined. Nonetheless, the St. Petersburg Slavic Benevolent Society was informed of Serbia's needs, and in the summer of 1913, epidemiologist M.A. Sopotko-Syrokomlya and his wife were included in the next group of doctors sent to

[51] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 776.

[52] Vladimir Stanojević, "Kolera u Balkanskim ratovima 1912–13," in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 309–313.

Serbia. Sopotko-Syrokomlya's medical unit was initially dispatched to Skopje and later to Kosovska Mitrovica, where only two doctors were available to care for 400 cholera patients.[53]

The Balkan Wars were among the most significant conflicts in the history of Serbian military medicine, serving as the first comprehensive test of the Serbian Army's medical service. Although similar in duration and combat style, the main difference between the Balkan Wars and the Serbian–Bulgarian War of 1885—Serbia's first war as an independent state—was the presence of infectious diseases and epidemics. The 1885 war underscored the importance of a well-equipped and organized surgical service but did not expose the dangers posed by epidemics. Since the majority of medical cases during the 1885 war were combat-related injuries, the Serbian Army subsequently prioritized developing surgical capabilities.[54] On the one hand, this decision proved wise, as Serbian surgeons performed exceptionally well during the Balkan Wars.

On the other hand, the failure to recognize the critical importance of infectious disease prevention led to significant consequences. The Balkan Wars, particularly the Second Balkan War, revealed the Serbian Army's vulnerabilities and deficiencies in managing epidemics. Only after these wars did Serbian authorities fully grasp the threat diseases posed to both the army and the civilian population. They realized that without bacterial laboratories, trained specialists, a clear emergency plan for epidemics, and the necessary equipment, the country would remain powerless in the face of another war, which came much sooner than expected.

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[53] Neklyudov, "Issues of Serb Military Medicine and Russian Assistance in the Balkan Wars of 1912–1913," 82.

[54] Ibid., 79.

The First World War

Almost exactly one year after the Balkan Wars, Serbia faced one of the greatest conflicts in history—the First World War. The Serbian Army entered this far more intense and threatening war with significantly weakened capabilities from the previous conflicts. The short gap between the wars was the primary reason for this. Although the Serbian Army had by then realized the importance of epidemiology and disease prevention, one year was simply not enough time to implement substantial changes, nor to secure adequate equipment resupply.

At the outset of the First World War, Serbia faced an incomparably larger enemy. Austria-Hungary had a population of 51 million people and could mobilize 6 million soldiers. In contrast, as mentioned earlier, Serbia had a population of 4.5 million and could mobilize approximately 450,000.

Although the Serbian Army gained valuable combat experience during the Balkan Wars, it was severely depleted in terms of supplies. At the start of the First World War, there was a critical shortage of weapons and ammunition, especially artillery, along with a general lack of military equipment. The camp and clothing supplies were merely the meager remnants of the previous Balkan Wars. Even soldiers of the First Call-Up lacked complete sets of uniforms; those of the Second Call-Up had only greatcoats and caps, while soldiers of the Third Call-Up were dressed in their civilian clothes.[55]

As for the medical situation after the Balkan Wars and the beginning of the First World War, Dr. Stanojević's statement describes the state of the Serbian military medical service: "Our military medical service entered this new war exactly as it had come out from the previous one, led by its former chief, Colonel Dr. Genčić, with the same old wartime organization, the

[55] A call-up is an order to report for active military service and, in this context, refers to the waves of conscription. Ilić, *Na vetrometini epidemija: Lazar Genčić,* 48.

same worn-out and depleted equipment, without any new supplies, repairs, or improvements; in reality, it entered the new war even weaker than it had come out from the previous one."[56]

The First World War era in Serbian history can be divided into three distinct periods. The first period, from 1914 to late 1915, saw the Serbian Army defending its own territory against the Austrians. The second period, from late 1915 to early 1916, occurred when the Serbian Army, confronted by a joint German-Austrian-Bulgarian attack, decided to retreat from the country and move to Greece to join British and French forces. The third period, from early 1916 to the end of the war in 1918, encompassed the Salonika Front and the subsequent liberation of Serbia. Since each period presented different challenges, we will analyze the characteristics and work of the Serbian military medical service during each phase individually.

During the first period, from 1914 to 1915, Serbia's primary medical issue remained the shortage of doctors. As previously mentioned, in 1914 there were only 450 doctors in the entire country, both military and civilian, which made it difficult for the medical service leadership to effectively distribute personnel.[57] Dr. Lazar Genčić, Head of the Health Department of the Serbian Army Supreme Command at the beginning of the war, often faced criticism for this issue. Two of his most vocal critics were Dr. Roman Sondermayer, formerly the head of the Defence Ministry's Health Department during the Balkan Wars, and Dr. Djordje "Djoka" Nikolić (Nikolich), a prominent advocate for the establishment of a national medical school.

Both of them were highly respected figures in the Serbian medical community and were critical of Dr. Genčić for what they perceived as his ineffective organization of the medical service during a crucial time. A key point of disagreement centered on the deployment and utilization of civilian and military doctors. The criticism of Dr. Genčić primarily focused on

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[56] Ilić, *Na vetrometini epidemija: Lazar Genčić,* 48.

[57] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 777.

two issues: excessive bureaucracy and the neglect of the civilian medical service. According to Dr. Nikolić, the army relied heavily on civilian doctors, who were often sent to the most challenging parts of the frontline, while too many military doctors were assigned to administrative duties far from the frontlines.[58] This approach had two major drawbacks: it left the civilian population without adequate medical care, and it resulted in too few doctors on the frontlines when more were available.

Even from the first sentence of this chapter, where Dr. Genčić describes how there were only 26 doctors for 8,000 wounded, with only ten actively working while 16 were assigned to administrative duties, we can infer that there were significant issues with the distribution of doctors in the Serbian military medical service during the First World War. Dr. Genčić justified his decisions by explaining that he assigned military doctors to administrative duties because they were more familiar with military administration, and, in his opinion, there were enough doctors on the frontlines. As for civilian medical needs, he relied on foreign medical aid and doctors for support.[59]

Dr. Lazar Genčić faced significant criticism from his contemporaries for his decisions as the Head of the Health Department of the Supreme Command. However, the challenges faced by Serbian medicine during the early stages of the First World War, combined with systemic issues that had developed over decades, suggest that it is overly simplistic to attribute all shortcomings to a single individual. The war exposed deep-seated structural deficiencies in Serbian medical services that were difficult to address under the extreme pressures of wartime. While Genčić's organizational decisions regarding the distribution of civilian and military doctors have been questioned, the extent to which alternative strategies might have changed

[58] Ilić, *Na vetrometini epidemija: Lazar Genčić,* 34–36.

[59] Ibid.

outcomes remains unclear. Additionally, civilian doctors often went unrecognized for their contributions, with much of the success attributed to the army's medical service.

During the first period of the First World War, Serbia's greatest medical challenge was undoubtedly the typhus and relapsing fever epidemic. This crisis was closely connected to another key aspect of the time – foreign aid. The first cases of typhus were recorded in 1914, shortly after the war began. Initial military successes on the frontlines were quickly followed by outbreaks of the disease. According to British doctor William Hunter, after the first battles, Serbia had 40,000 Austrian POWs, whom he identified as the primary source of the epidemic.[60] This fact was also confirmed by Dr. Genčić.[61]

Unlike cholera during the Balkan Wars, which primarily affected the military, the typhus epidemic during the First World War impacted both the army and the civilian population. This was largely due to the increased movement of people caused by the war, which led to widespread transmission of the disease.

In the early stages of the epidemic, the primary efforts to combat typhus were carried out by Serbian doctors. At the time, there were very few professional bacteriologists in Serbia. Thanks to Dr. Borisavljević, during his mandate as the Head of the Health Department of the Defence Ministry, funding was secured for several doctors to specialize in bacteriology at leading European universities. One of these doctors was Dr. Dragutin Petković (Petkovich), who later represented Serbia on the Inter-Allied Committee in Salonika. Petković was sent to Paris and Berlin, where he studied under the renowned physician Robert Koch, considered one of the founders of modern bacteriology. However, by the time Petković and other doctors

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[60] William Hunter, "The Serbian Epidemics of Typhus and Relapsing Fever in 1915: Their Origin, Course, and Preventive Measures employed for their Arrest," *Proceedings of the Royal Society of Medicine,* no. 13 (1920): 40–41.

[61] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 780.

returned, Borisavljević was no longer in his post, and, despite their specialized training, the bacteriologists were not assigned to the roles for which they had been trained, preventing them from applying their expertise effectively.[62]

There was little the Serbian bacteriologists could do during the cholera and typhus epidemics, as they had not been involved in the fieldwork for years and also lacked the necessary equipment and resources to combat the outbreaks.[63] The shortage of specialized bacteriologists led to massive confusion during the typhus epidemic, as doctors, lacking proper laboratories and practical knowledge, struggled to identify the exact strain of typhus, which was later confirmed as spotted typhus. As a result, Serbian medicine once again became dependent on foreign aid.

Since the beginning of the war, several foreign medical missions from the USA, Russia, the UK, and Belgium, as well as individual foreign doctors, had been present in Serbia. However, as Genčić explained in his chapter, most of these missions were private initiatives organized by various Red Cross societies and other associations, primarily focused on treating the wounded, and thus were not equipped to combat epidemics. The only exception was the Scottish Women's Hospitals for Foreign Service (SWH). Founded in 1914 by Elsie Inglis, a renowned and highly respected doctor in Serbia, the SWH was the only foreign mission that actively engaged in the fight against typhus from the very beginning of the epidemic.[64]

As the epidemic worsened, in early 1915 Serbia was forced to officially request assistance from its Allies, who swiftly responded by sending experts in fields such as bacteriology, epidemiology, and infectious disease control, along with the necessary equipment. The French government dispatched 100 military doctors, including bacteriologists

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[62] Borisavljević, "Vojni sanitet u miru i ratu od 1884 do 1921," 805.

[63] Simić, "Kritički pogled na rad našeg saniteta u prošlosti i sadašnjosti," 796–797.

[64] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 782.

and specialists in combating epidemics. These French doctors were divided into smaller groups and deployed to smaller towns and rural areas to fight the disease.[65]

On March 4, 1915, the British military mission arrived in Serbia, consisting of Colonel William Hunter, an infectious disease specialist and the head of the mission; Major G. E. F. Stammers, an epidemiologist; Captain H. W. C. Topley, a bacteriologist; and 22 officers and medical technicians. Hunter was a distinguished foreign expert with a high rank and extensive wartime experience, recommended by the British government. His status ensured that his proposals were immediately accepted and systematically implemented by the Serbian government and the High Command. Hunter and his team identified hospitals as the primary source of infection, which was easily spread via railway traffic. Shortly afterward, the British team proposed several measures, which were promptly accepted and enforced by the Supreme Command.[66]

Dr. Hunter also created an improvised device made from old barrels for disinfecting clothes and other objects. Its effectiveness and simplicity impressed the Serbian government, which immediately initiated mass production of what became known as "the Serbian Barrel." This device, along with other epidemic control measures proposed by Hunter and his team, and through coordinated, large-scale efforts within the military, civilian population, and prisoner-of-war camps, helped halt the epidemic in less than three months. According to Dr. Božidar Birtašević, a military epidemiologist, there were skeptics, both domestic and foreign, who attributed the rapid containment of the epidemic to the natural onset of the summer season.

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[65] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 783.

[66] Božidar Birtašević, *Vojna Epidemiologija* (Beograd: Vojnoizdavacki i Novinski Centar, 1989), 84–85.

However, this view is convincingly refuted by the fact that, unlike in Serbia, the typhus epidemic continued in Poland for four consecutive years, as well as in Romania and Russia.[67]

When speaking of the numbers, it is difficult to provide an accurate assessment of how many casualties typhus claimed in Serbia. The then Head of the Health Department of the Supreme Command, Dr. Genčić, stated in his chapter that there were over 30,000 typhus-related deaths among Serbian troops.[68] As for civilian casualties, the typhus pandemic claimed more lives than the Austrian army. According to Dr. Hunter, between January and March 1915, there were 500,000 cases of typhus and relapsing fever, with at least 120,000 deaths.[69]

In the autumn of 1915, a general offensive by the Central Powers against the weakened Serbia began, marking the start of the second period of the First World War in Serbia. The offensive forced the Serbian Army into a difficult retreat through Albania toward Greece, during which Serbian medical services collapsed. The army, already thinned and exhausted by battles, hardships, and hunger, faced new mass war-related diseases, such as cholera, which emerged after the recent typhus epidemic. By that point, Serbian doctors were completely powerless against these outbreaks.[70]

By the spring of 1916, 151,820 Serbian soldiers had gathered on the Greek island of Corfu. The sick were moved to nearby islands such as Lazzareto, whose name originates from its historical function as a quarantine station, with most of them placed on Vido Island. In these poor conditions, with makeshift accommodations under large tents, mass deaths occurred due to exhaustion, hunger edema, and dysentery. In the first two months of 1916 alone, around 7,000 soldiers died on Vido Island. Due to a lack of sufficient resources to bury them on land,

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[67] Birtašević, *Vojna Epidemiologija,* 85.

[68] Genčić, "Zašto je došlo do epidemija i pomora u našoj vojsci za vreme ratova 1912-1918?" 782.

[69] Hunter, "The Serbian Epidemics of Typhus and Relapsing Fever in 1915," 39.

[70] Birtašević, *Vojna Epidemiologija,* 88.

the bodies were taken out to sea, in what became known as the "Blue Tomb."[71] This topic was a popular motif in Serbian literature. On the island of Vido, a memorial plaque still stands today, engraved with the following lines:

"Here at the bottom, where the shells fall into the weary sleep

And the moss drops over the dead algae's

Lie the gravesite of the valiant, brother by a brother,

Prometheuse's of hope, apostles of woe."

These lyrics are from the famous ode "Blue Tomb," composed by Milutin Bojić to honour the fallen soldiers. Bojić, a poet who personally endured the exodus from Serbia and the despair of Corfu, wrote the poem to honour their sacrifice.

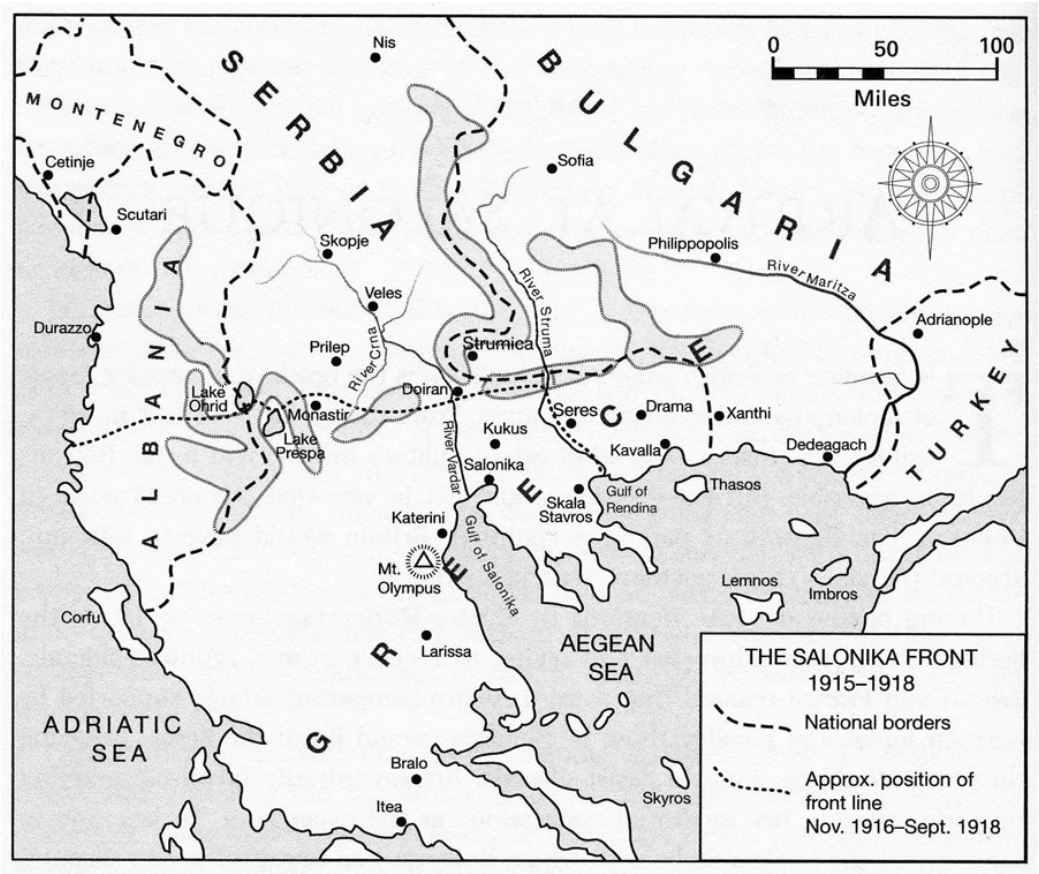

Figure 1. "The Salonika front, 1915-1918." Digital image. Manatū Taonga — Ministry for Culture and Heritage. July 30, 2014. https://nzhistory.govt.nz/media/photo/salonika-front-19151918

[71] Birtašević, *Vojna Epidemiologija,* 88.

The time the Serbian Army spent on Corfu was not only a period of recovery but also of reorganization, including its medical service. After the tragic retreat through Albania to Corfu, Dr. Lazar Genčić was relieved of his duties as the head of the Supreme Command's medical service. In early 1916, under the leadership of French General Jean Frèdèric Lucien Piarron de Montdésir, the Serbian medical service underwent a reorganization. The main change was that Dr. Roman Sondermayer replaced Genčić, who was reassigned as Medical Inspector in the Ministry of Defence, the second-highest position, making the transition less dramatic. Interestingly, Genčić had appointed Sondermayer as Inspector in 1915, and Sondermayer returned the favor in 1917, reflecting mutual respect despite their past disagreements.[72]

After recovering on Corfu and in North Africa, the Serbian Army was transferred to the Salonika front in the summer of 1916, with around 130,000 soldiers.[73] This marked the beginning of the third period of Serbia's First World War history. The biggest challenge for all Allied troops in the region during this time was malaria, which will be our primary focus in the following chapters. This period is also significant for Serbian medical history, as the medical corps, with the help of Serbia's Allies, reemerged after its total collapse and once again played a crucial role in defending its troops from the deadly, invisible enemy. Thanks to its Allies, the Serbian Army's medical service was reorganized and well-equipped with all the necessary supplies and medical facilities in Salonika.

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[72] Ilić, *Na vetrometini epidemija: Lazar Genčić,* 66.

[73] Birtašević, *Vojna Epidemiologija,* 88.

Chapter II: Malaria

An Ancient Foe

"We were sitting at lunch when a shiver ran down my spine, and I felt just as if an unprepared person stepped out of a warm room into the cold, shivering from the chill. My hands were cold... And the sun was blazing, and the earth was trembling from the heat. I looked around with fear, then cautiously muttered that I felt cold."[74] That is how Stevan Jakovljević (Yakovlyevich), the author of the book *Srpska trilogija* (*The Serbian Trilogy)*, vividly captured the memory of a Serbian Army officer on the frontlines of the Salonika front. The book is a collection of personal stories and memoirs from Serbian soldiers who fought in the First World War. The Serbian Army officer's account describes the early stages of a malaria infection. It is no wonder that malaria was a part of the memories for many soldiers, not just on the Salonika front. As James Webb Jr. described it, malaria is the deadliest and the oldest enemy of the mankind.[75] War against malaria has always been an endless battle against invisible foe. The disease is as old as the human race, and it is estimated that malaria kills between 1.1 and 2.7 million people every year.[76] We can only imagine how many casualties this war has claimed throughout history.

Just like in any other war, in order to defeat the enemy, we need to understand it. Until the mid-19th century, it was believed that malaria was caused by miasmas, which spread from swamps and marshes. This is why the term "malaria" comes from the Italian words "mal aria," meaning "foul air."[77] Even in ancient times, people recognized the connection between malaria,

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[74] Stevan Jakovljević, *Srpska trilogija* (Belgrade: G. Kon, 1937), 621.

[75] James L. A. Webb Jr., *Humanity's Burden: A Global History of Malaria* (Cambridge: Cambridge University Press, 2009), 1.

[76] Ibid., 2.

[77] Žarko Ruvidić, *Malarija u vojsci i njeno suzbijanje* (Belgrade: Vojno-sanitetski glasnik, 1938), 6.

mosquitoes, and swampy areas. Marcus Terentius Varro, a contemporary of Gaius Julius Caesar and one of ancient Rome's greatest scholars, warned against living near lush areas. He advocated for the *in loco sublimi* construction method, where residential buildings were elevated. In the early 18th century, Giovanni Maria Lancisi, an Italian physician, epidemiologist, and anatomist, established a link between the presence of mosquitoes and the prevalence of malaria. It was also known that even before European colonization, people in Central America were aware of the danger posed by mosquitoes, and African tribes had synonymous terms for lush vegetation and mosquitoes.[78]

The biggest breakthrough in understanding malaria came in 1880 when French doctor and scientist Alphonse Laveran discovered parasites in the blood of a malaria patient. In 1897, Major Ronald Ross of the Indian Medical Service (IMS) identified the vector responsible for transmitting the malaria parasite to humans. Ross found that the female mosquito of the Anopheles genus was responsible for malaria transmission, injecting the parasite into the blood of both people and certain animals. These discoveries opened up the fascinating possibility of preventing malaria by eradicating mosquitoes, either in their adult or larval stages.[79]

When researching medical history, one inevitable component is always the search for a cure. This is certainly true for malaria. Fortunately, nature provided humans with an ally in the unfair fight against malaria: the cinchona tree. From its bark, an alkaloid drug called quinine is extracted. This medicine has been used since the early nineteenth century, though the bark itself had been used even earlier, dating back at least to the seventeenth century.[80]

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[78] Vladimir Stanojević, *Istorija ratnih zaraza: Od Napoleona do Evropskog rata završno* (Belgrade: Zlatibor, 1924), 116.

[79] Mark Harrison, *The Medical War: British Military Medicine in the First World War* (Toronto: Oxford University Press, 2010), 229.

[80] Leo Slater, *War and Disease: Biomedical Research on Malaria in the Twentieth Century* (New Brunswick, NJ: Rutgers University Press, 2009), 17.

Malaria and Wars

We could describe malaria as vicious in times of peace and deadly in times of war. This disease has acted as an invisible force, influencing the outcomes of numerous wars throughout history. While researching malaria and the Serbian Army on the Salonika front, I was struck by the number of malaria cases during other conflicts as well. When we focus primarily on the political and military aspects of wars, it's easy to overlook the significant impact diseases have had on military operations. To bridge the gap between military and medical history, and to better understand malaria's role on the Salonika front, I believe it would be helpful to briefly explore the numbers and ways in which malaria has affected various conflicts in history.

In many wars throughout history, malaria has caused more casualties than the enemy's weapons. One of the best examples of this was the Anglo-Dutch war in 1809. The English army, numbering 39,219, fought against the Dutch during the height of summer on the island of Walcheren, located just off the Dutch coast. The war began in August and continued until December, the worst months for malaria infections. Within days of arriving on the malaria-infested island, nearly all the British soldiers were hospitalized. Over 26,846 soldiers fell ill with malaria, and 4,175 died within four months. In contrast, only 247 British soldiers were killed by the Dutch. Ultimately, malaria forced the British to abandon the campaign and return home, despite their initial military successes.[81]

When analyzing malaria cases in different wars and conflicts, one can notice that one of the main reasons why it was difficult for the armies to combat the disease was its unpredictability, which was the case on the Salonika front. The issue was that there were no guarantees that certain antimalarial measures will work again, even if they had been proven effective in other locations or previous wars. One of the main points of disagreement among

[81] Stanojević, *Istorija ratnih zaraza,* 117.

experts was the prophylactic efficacy of quinine. In many instances, malaria cases remained high despite regular quinine prophylaxis. On the other hand, there are wars where quinine proved to be an effective preventive measure. The Russo-Turkish War of 1828–1829 is a notable example, where Russian troops that underwent prophylactic quininization were more resistant to malaria than those who did not. Similarly, during the American Civil War, quinine use significantly reduced malaria cases and deaths among soldiers, showcasing its value in both prevention and treatment.[82]

Malaria caused significant problems for the French during their colonization of Algeria and Tunisia. In 1834, the mortality rate in French military hospitals reached nearly 25% of all soldiers. Malaria also forced the French to halt the construction of the Panama Canal, and entire missions in Madagascar were put at risk due to the disease. Similarly, during the Spanish-American War, the Americans considered retreating their troops from Cuba for the same reasons.[83]

Before the Anglo-Ashanti Wars (1873–1874 and 1895–1897), the British meticulously planned their operations, fully aware of the dangers malaria posed. The troops were carefully selected and equipped with water filtering kits. The British army also prepared sanitary infrastructure to combat malaria, including both on-water and on-land hospitals. As a result, malaria cases and casualties were minimal, and the British successfully mitigated the disease's impact on the campaign. In contrast, despite similar detailed preparations, the Italians faced severe challenges during their campaign in Abyssinia. From December 1895 to May 1896, over 3,300 Italian soldiers contracted malaria, which significantly compromised the entire military operation.[84]

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[82] Stanojević, *Istorija ratnih zaraza,* 119-121.

[83] Ruvidić, *Malarija u vojsci i njeno suzbijanje,* 6.

[84] Stanojević, *Istorija ratnih zaraza,* 125-127.

What all wars where malaria had an impact have in common, and what influenced the outcome the most, was the terrain. If the area was filled with swamps and lush vegetation, avoiding the disease was nearly impossible, and no matter the level of preparation, troop infections were inevitable. In such cases, focusing on the effective treatment of infected soldiers became crucial. This is evident from the examples above. The British sanitary infrastructure and medical supplies were key factors in their success against the Ashanti. In Macedonia, the terrain, along with other factors, posed significant challenges for the Serbian and other Allied forces. The region, known for its swamps and lush vegetation, used to be a highly malarious part of the Balkan Peninsula. Malaria was widespread on both sides, and the number of casualties was roughly the same.

Malaria in the Balkans

People from the central Balkan Peninsula have been familiar with malaria since ancient times. In fact, there was a Roman colony near the town of Požega in Serbia called Mala Vietta, or "the evil village," named for the high number of malaria infections. However, in more recent history, most of Serbian territory has been malaria-free.[85]

In the Serbian Army during peacetime, malaria was generally considered a milder disease. In the monthly and annual reports of the military medical service, many cases were diagnosed as *febris intermittens*, or "intermittent fever." According to the 1896 annual report, there were 1,906 cases of malaria among Serbian soldiers, with no fatalities, and only 19 soldiers were temporarily released from service due to malaria. In 1904, the army recorded 2,416 cases, with an incidence rate of 107.4 cases per 1,000 soldiers. That year also saw no

[85] Ruvidić, *Malarija u vojsci i njeno suzbijanje,* 6.

fatalities, and only eight soldiers were discharged. The average treatment duration was four days.[86]

The situation changed rapidly during the First Balkan War (1912–1913), when the Serbian Army faced mass malaria infections for the first time. Malaria severely impacted the Serbian troops stationed on the Albanian coast, with an epidemic breaking out among the soldiers in Lezhë and around the besieged city of Shkodër. The epidemic was primarily caused by poor sanitary and topographical conditions. From Lezhë to Shkodër, the terrain is waterlogged and mostly marshy. In the spring, large portions of it are submerged due to the floods of the Great Drin and the overflow of Lake Shkodër, leading to a significant presence of mosquitoes in the area.[87]

Another source of the epidemic was the unique wartime conditions along this part of the Albanian coast. Large numbers of Turkish, Montenegrin, and Serbian troops were concentrated in the Shkodër area. The sanitary conditions were extremely poor, not only on the frontlines but also among the civilian populations in Lezhë, Shkodër, and the surrounding villages. This was largely due to human and animal remains being left unremoved for extended periods. With a shortage of medical supplies, many infected soldiers went untreated, becoming carriers of malaria and contributing to its spread through mosquitoes. The besieged Turkish garrison in Lezhë was particularly affected. Numbering around 800-900 men, the garrison was captured in November 1912. Shortly after, they began to suffer from dysentery and malaria, and by spring, the diseases had devastated them. According to Dr. Vladimir Stanojević, who participated in these events as a Serbian Army medical officer, malaria took such a severe toll

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[86] Djordje Protić, "Malarija na Solunskom frontu," in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 436.

[87] Stanojević, *Istorija ratnih zaraza,* 129.

on the garrison that the Serbian Supreme Command, out of compassion, ordered the release of these prisoners so they could return home.[88]

Like many armies before them, the Serbian Army, faced with a severe malaria epidemic for the first time, saw their entire military operation in the Shkodër region put at risk. Lacking experience in dealing with malaria on such a scale, the Serbians turned to Turkish doctors among the prisoners of war for advice on managing the disease. According to Stanojević, a Turkish doctor revealed that the Turks had also experienced significant malaria complications among the local population. The epidemic had been so severe that the Turks had sent a special medical mission from Istanbul to investigate. The mission's report indicated that the malaria on the Albanian coast was of a different, more resilient strain, which they referred to as "Albanian malaria." The only solution the mission could suggest was to periodically rotate the troops stationed in Shkodër.[89]

The Balkan Wars impacted the Serbian Army both positively and negatively. Most importantly, they marked the Serbian Army's first encounter with a malaria epidemic, especially during military operations. This becomes even more relevant when we consider that the malaria along the Albanian coastline was a particularly dangerous variation of the disease, similar to that found in Macedonia. This similarity can be attributed to the fact that malaria in Albania and Northern Greece was likely of the same strain or strain combination. The physical distance between Shkodër and Thessaloniki (Salonika) is relatively small—only 320 km (200 miles) by air. Beyond proximity, the two regions share other characteristics, such as climate, terrain, and poor sanitary conditions among the local population.

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[88] Stanojević, *Istorija ratnih zaraza,* 129–130.

[89] Ibid., 130.

On the other hand, although the Balkan Wars provided the Serbian Army and doctors with valuable experience and knowledge about the enemy, they would again meet just a few years later, the wars significantly impacted army's capabilities for the following war. As we discussed in the previous chapter, after the Balkan Wars the Serbian Army experienced significant shortages in both military and medical supply, as well as a severely understaffed medical service.

Salonika Medical Front

During the First World War, thanks to scientific advancements, doctors were able to control infectious diseases on the frontlines for the first time in history. However, this was true for all but one disease—malaria. It remained the only untamable disease, ravaging armies on both sides of the front in Macedonia, the Middle East, and Africa. In this regard, Salonika and the Macedonian front played a crucial role in malaria research, as it was the first war in Europe after the "golden age" of malariology and key scientific discoveries regarding malaria's aetiology and transmission cycle. These discoveries on scientifically sound prophylactic and therapeutic measures had raised great hopes of eradicating this ancient scourge. However, the First World War, particularly the experience in Salonika, shattered that optimism and prompted further epidemiological and scientific studies on malaria. As a result, the Macedonian front became an enormous experimental field for malaria research, especially for evaluating the therapeutic and prophylactic efficacy of quinine.[90]

When analyzing the factors contributing to malaria's prevalence in Salonika, doctors and epidemiologists identified the local topography and population as the two main sources of

[90] Bernardino Fantini, "Malaria and the First World War," in *Die Medizin und Der Erste Weltkrieg,* ed. Wolfgang U. Eckart, and Christoph Gradmann (Pfaffenweiler: Centaurus-Verlagsgesellschaft, 1996), 241.

the disease's spread. Kosta Todorović (Todorovich), regimental doctor of the 13th Infantry Regiment of the Timok Division and one of the pioneers of Serbian epidemiology—after whom Belgrade's Clinic for Infectious and Tropical Diseases is named—described the Moglena (Almopia) region, where part of the Serbian forces were stationed, as one of the most malaria-prone areas on the Salonika front. According to Dr. Todorović, the geological composition of the terrain hindered the natural filtration of surface water due to the prevalence of swamps and small streams. This, in turn, fostered dense vegetation, making the Moglena fields highly fertile, as evidenced by the numerous villages scattered throughout the area. These villages, however, were extremely unhygienic and densely packed, often separated by less than 1–2 kilometers. The climate of the region resembled that of coastal areas, with mild winters and scorching summers. In July and August, temperatures frequently exceeded 50°C. Furthermore, the area is shielded from winds by large mountain ranges to the northwest and east.[91]

The humid terrain, combined with the tropical climate, created perfect conditions for a large mosquito population to thrive in the region. They were most numerous in the summer, especially after heavy rains and storms, which would briefly reduce their population, only for even larger swarms to emerge afterward.[92] A particularly troubling issue was the overwhelming density of Anopheles mosquitoes, the primary transmitters of malaria. Between April and October, it was not uncommon to find over a hundred mosquitoes inside a single tent occupied by just three soldiers.[93]

Malaria morbidity among the local population in the area was exceptionally high. According to Bernardino Fantini, an Italian malariologist, the malarial index within the

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[91] Protić, "Malarija na Solunskom frontu," 440.

[92] Protić, "Malarija na Solunskom frontu," 440.

[93] Fantini, "Malaria and the First World War," 244.

population ranged from 60% to 90%.[94] Dr. Todorović also stressed the significant role the local population played in the spread of the disease, as well as the devastating impact of malaria. He described the inhabitants as "of Slavic origin, with a low level of cultural development, living in the most primitive conditions, and attributing all misfortunes, such as illness and death, to fate." Malaria, known locally as "treska" (the "trembling" fever), was a familiar illness that had plagued them for centuries, affecting everyone. According to Todorović, during the summer months, when malaria was at its peak, many locals could be seen with their heads wrapped, lying beside fountains or streams in an attempt to reduce the high body temperatures experienced during a malarial attack. Their "pale, greenish-yellow complexion" was a characteristic sign of chronic malaria cases in Moglena. He also noted the alarmingly high mortality rate in the area, particularly in certain villages. Foustani, for example, was a small town with approximately 3,000 residents, a high birth rate, but a disproportionately high death rate. In 1917 alone, 300 people died from malaria.[95]

On the frontlines, malaria was the most common and dangerous disease, affecting both allied and enemy forces equally. The severity of the malaria crisis is perhaps best captured in the words of French General Maurice Paul Emmanuel Sarrail, who, upon receiving orders to launch an attack, sent a telegram to the Supreme Allied Commander stating: "I regret to inform you, but my entire army is now in hospitals due to malaria."[96]

Similar situation was with the British forces in the area. Between 1916 and 1918, 162.517 out of 404,207 British soldiers in Macedonia were hospitalized due to malaria

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[94] The malarial index represents the percentage of a population infected with the disease. Fantini, "Malaria and the First World War," 244.

[95] Protić, "Malarija na Solunskom frontu," 440.

[96] Aleksandar Nedok, Branislav Popović, and Veljko Todorović, *Srpski vojni sanitet u Prvom svetskom ratu* (Belgrade: Medija Centar Odbrana, 2014), 291.

infection.[97] For comparison, the number of all other British casualties (killed, wounded, taken prisoner and discharged) was 23.762 soldiers.[98] According to Colonel C. M. Wenyon of the British Army Medical Service, fatality rate from malaria among the British troops was the highest in 1916 (1.01%), and that the lower mortality in 1917 and 1918 (0.37% and 0.31% respectively).[99] On the other hand, malaria morbidity was steadily increasing among the British during the Macedonian campaign. During 1916 one quarter of the British forces was infected, in 1917 one third, and 1918 nearly a half of all the British troops were infected. Here we should note that majority of cases in 1917 and 1918 were reinfections. According to C. H. Treadgold, who examined malaria cases across various British units in Macedonia in 1917, great majority, if not all of the soldiers who contracted malaria, had been infected during 1916.[100]

The Germans also suffered heavy losses by malaria. The disease was most present on the Salonika front. In 1917, 23.240 of the German troops on the Salonika front were hospitalized. Occasionally in certain units up to 70% of soldiers were infected. In contrast, the same year the Germans had only 1280 hospitalized soldiers on the Eastern front. Stanojević, while discussing the German experience with malaria, cited data published by the German physician, microbiologist, and hygienist Professor Dr. Theodor von Wasielewski. In his article on the malaria cases among German forces during the First World War, von Wasielewski noted: "Malaria, despite the enormous efforts made to combat it, nevertheless accounted for twice as

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[97] Bernard J. Brabin, "Malaria's Contribution To World War One – The Unexpected Adversary," Malaria Journal, 16 December 2014, https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-497

[98] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 291.

[99] Bernard J. Brabin, "Malaria's Contribution To World War One – The Unexpected Adversary," Malaria Journal, 16 December 2014, https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-497

[100] Fantini, "Malaria and the First World War," 247.

many cases as the combined total of the three other main wartime infectious diseases: typhus, cholera, and typhoid fever."[101]

A serious issue the Germans faced was the lack of quinine supply, a crucial drug for treating malaria.[102] One of the main reasons for this shortage was the British sabotage of the German quinine factory, Chininefabrik, in Amsterdam in 1917, by pressuring the Dutch to shut it down.[103] This significantly reduced the efficacy of German forces on all malaria-affected fronts. The quinine shortage also played a key role in shaping post-war antimalarial drug research. According to Fantini, it is doubtful if any of the synthetic antimalarials in use today would have been developed if the Germans had not been deprived of quinine during the war. Fearing future dependence on quinine, the Germans began working on their own antimalarial drugs after the war.[104] Consequently, the German pharmaceutical industry made the most significant progress in the antimalarial field during the interwar period.

According to the statistics from the medical Supreme Command of the Allied forces, during the war on the Salonika front, the malaria morbidity rate among the total number of troops reached 65%, with a mortality rate of 1.5%, accounting for 25% of overall deaths. The incidence of acute malaria steadily declined after 1916, while cases of chronic malaria increased in 1917 before eventually decreasing. Notably, the mortality rate for chronic malaria was significantly higher than that of acute cases.[105] The numbers from the French Army further confirmed this trend. In 1916, 39% of all disease-related deaths in the French Army on the

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[101] Stanojević, *Istorija ratnih zaraza,* 142–145.

[102] Fantini, "Malaria and the First World War," 251.

[103] Mark Honigsbaum, *The Fever Trail: in Search of the Cure for Malaria* (New York: Picador: Farrar, Straus & Giroux, 2003), 213.

[104] Fantini, "Malaria and the First World War," 266.

[105] Branislav Popović et al., "Malaria in the Serbian Army on the Salonika Front: A Review of the Outbreak in the Second Half of 1916," *Opšta medicina* 14, no. 1–2 (2008): 39.

Salonika front were caused by malaria. According to data from *Statistique médicale* published by the French Ministry of Defence in 1922, as cited by Stanojević, the French Army reported a total of 100,503 infections and 1,638 deaths from all diseases combined in 1916.[106] Out of these, 33,193 were malaria infections, with 21,178 acute and 12,015 chronic malaria cases, resulting in 635 deaths–403 acute and 232 chronic cases.[107]

Fortunately, the death rate in 1917 and 1918 dropped significantly. In 1917 there were in total 36,258 malaria infections, majority of which were chronic malaria cases (32,820), while the rest 3,438 cases were acute cases. That year, 235 soldiers died from malaria, with most of the deaths (206) resulting from chronic infections. In 1918, the French Army reported 24,148 malaria infections, with the vast majority (23,050) being chronic cases. This tendency was also reflected in mortality data. Out of 250 malaria-related deaths in 1918, 239 soldiers died from chronic malaria.[108]

Having examined malaria cases among both Allied and German forces, we gain a broader understanding of the challenges posed by the disease on the Salonika front. These insights provide crucial context for analyzing the experiences of the Serbian troops, who faced similar challenges and severe consequences of the epidemic. In the following sections, we will take a closer look at the impact of malaria on the Serbian Army, exploring the scale of the outbreaks, preventive measures, treatment efforts, and their overall effects on the troops 'health and operational capabilities.

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[106] Stanojević, *Istorija ratnih zaraza,* 140.

[107] Ibid., 138

[108] Ibid.

Malaria Among Serbian Troops in Salonika

For the Serbian Army, as for their French and British allies, malaria was the greatest medical challenge on the Salonika front. However, it is important to note that it significantly affected only certain Serbian units. The Šumadija (Shumadiya) and Timok divisions of the Second Army were the most impacted, while the rest of the Serbian forces were largely unaffected. Consequently, Serbian historiography on the subject primarily focuses on these two divisions.

The primary reason the Šumadija and Timok divisions were ravaged by malaria was that they were stationed in highly malarial regions, mainly in the lowlands of Northern Greece, where malaria had historically plagued the local population. Naturally, when foreign armies, including the Serbian forces, entered these areas during the First World War, they faced the same fate as the civilian Greek population.

To comprehensively analyze and fully understand the facts regarding the malaria epidemic among Serbian forces on the Salonika front, it is essential to begin by identifying where the affected divisions were stationed. While most authors mention certain locations in their writings, they rarely provide timelines for when the troops arrived at these places. As a result, pinpointing the exact transit camp locations and establishing a timeline for the movements of the Šumadija and Timok divisions proved quite challenging.

Nevertheless, identifying the locations and timelines of mass malaria outbreaks, antimalarial interventions, and significant events is crucial for analyzing the environmental impact of the malaria epidemic, as well as for fully grasping the broader context of the problem. By examining wartime maps—particularly railroad maps—along with soldiers' memoirs, hospital workload reports, and the locations of specific hospitals, I was able to reconstruct troop movements and establish a clearer timeline of events and locations.

The loading of Serbian troops onto Allied ships began on April 13, 1916. By May 21, a total of 6,025 Serbian officers and 124,090 soldiers had been transported from the island of Corfu—where they had been recovering from exhausting battles against a combined Austro-Hungarian, German and Bulgarian force, and an arduous retreat from Serbia—to Salonika. By May 30, the total number of Serbian troops, including all reinforcements, had reached 144,000.[109]

The autobiography of Tadija Pejović (Tadiya Peyovich), then a reserve second lieutenant in the Šumadija Division, was invaluable for reconstructing the division's movements and locations. In his memoirs, he provided a detailed account of their camp locations as they made their way to the frontlines. According to his writings, the Šumadija Division arrived at the port of Salonika on May 14, 1916, before proceeding to the village of Loutra on the Halkidiki Peninsula, approximately 120 km to the south, where they were stationed from May 15 to June 21.[110]

The Serbian Army Supreme Command was fully aware of the threat posed by malaria and, in response, formed the "Hygiene Commission." From January to May 1916, while the troops were stationed on the island of Corfu, the commission worked to prepare the land for the safe passage of soldiers.[111] In addition, prophylactic quinine was administered in Halkidiki, with a dosage of 0.25 grams in tablet form for 10 days, followed by a 10-day pause. Thanks to these anti-mosquito measures, drainage efforts, and quinine prophylaxis, the Serbian Army recorded only 88 cases of malaria while they were based in Halkidiki.[112]

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[109] Ljubomir Samardžić, "Na Putu Za Otadžbinu, Odlazak Srpske Vojske Sa Krfa," RTS (Radio Television of Serbia), May 22, 2016. https://www.rts.rs/lat/vesti/veliki-rat/srbi-na-krfu/2322766/na-putu-za-otadzbinu-odlazak-srpske-vojske-sa-krfa.html

[110] Tadija Pejović, *Moje uspomene i doživljaji: 1892 - 1919* (Belgrade: BIGZ, 1978), 60–64.

[111] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu*, 292.

[112] Protić, "Malarija na Solunskom frontu," 438.

However, the situation changed rapidly after the troops left Halkidiki. According to Pejović, the Šumadija Division departed from the camp in Loutra, Halkidiki, on the night of June 21–22, 1916, and embarked on a 220 km march toward the Moglena Valley (now Almopia) and the frontline positions. After 34 days, they arrived at the town of Subotsko (modern Aridaía), located in the centre of the Moglena Valley, on July 24.[113]

The first massive malaria outbreak among the Serbian forces began shortly after they passed Salonika, which was located midway along their march, when they arrived at the village of Topchin, now known as Gefyra (Greek: Γέφυρα, meaning 'Bridge'; until 1926 known as Τοψίν/Topsin, Macedonian: Топчиево/Topchievo, Turkish: Topçin) on the left bank of the Vardar River. Located about 20 km northwest of Salonika, this village was known as one of the most malarial places in Vardar Valley. The risk of malaria resulted from the abundance of mosquitoes, including the Anopheles species, which thrived in the dense vegetation along both banks of the Vardar River—an ideal breeding ground for mosquitoes. This led to a high malaria incidence rate among the local population, which, according to French wartime malaria maps (Figure 2), ranged from 50% to 100%.[114]

[113] Pejović, *Moje uspomene i doživljaji,* 64.

[114] Protić, "Malarija na Solunskom frontu," 439.

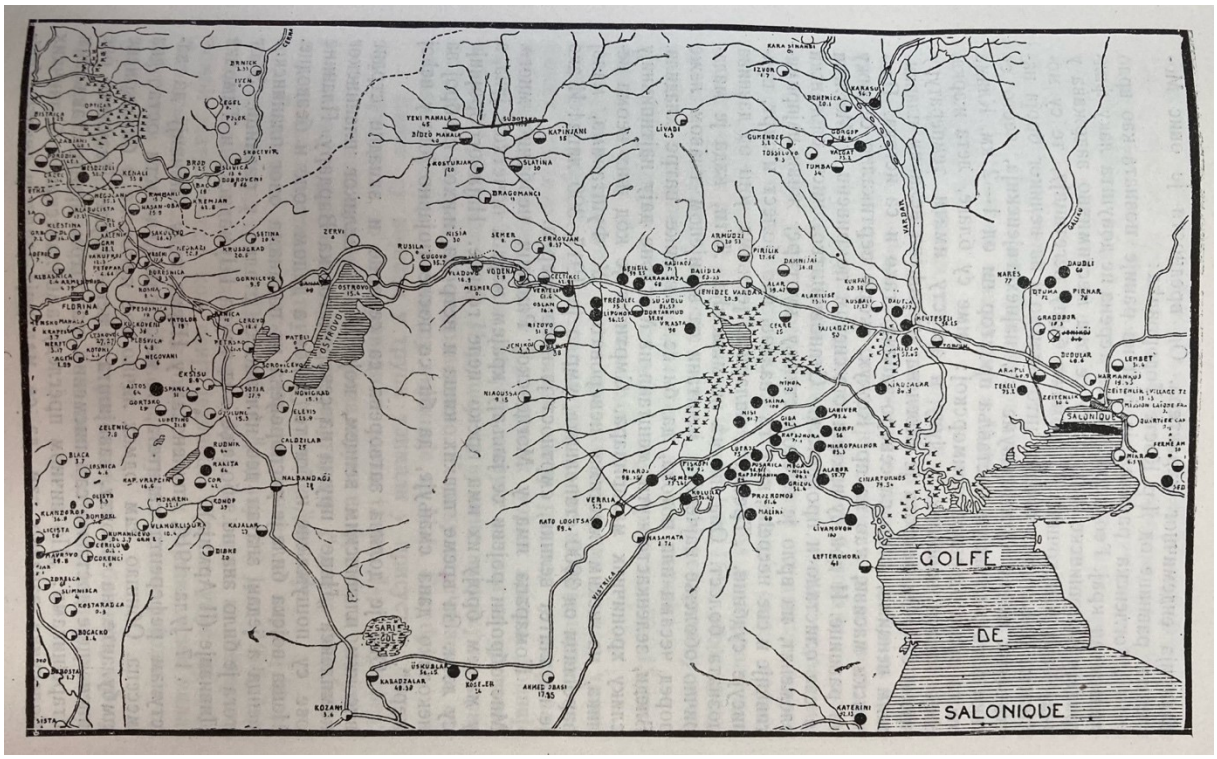

Figure 2. Wartime map of the Salonika front with marked malaria incidence rates. Djordje Protić, "Malarija na Solunskom frontu," 439.

According to Dr. Dobrivoje Ger. Popović, the Medical Officer of the Šumadija Division, his unit arrived in the Topchin area on July 12 and set up camp near the Vardar River.[115] Soon, the units of the Timok Division joined them. It is uncertain how long the troops stayed in the area, as none of the authors specify that information. We can assume they did not remain there for long, since Pejović did not specifically emphasize this location, and we know that the troops arrived in the Moglena Valley by July 24, which, as Todorović's earlier description highlighted, was no different in terms of its malarial conditions.

Additionally, the workload data from the 2nd Field Hospital of the Šumadija Division in Kosturjan (also known by its Slavic name variations, Kostureni or Kosturino) indicate that it was overwhelmed with malaria patients from that division in the second half of July.[116]

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[115] Dobrivoje Ger. Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu," in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 433–434.

[116] Protić, "Malarija na Solunskom frontu," 442.

Kosturjan, now known as Xifiani (referred to by its Greek name variation, Kostourgianni, before 1922), is located just 6 km from Aridaía, where, according to Pejović, the division had arrived on July 24. The hospital's workload timeline and its proximity to Aridaía further increase the likelihood that the troops left the Topchin area shortly after July 12 and arrived at their frontline positions by the time Pejović indicated.

The fact that Topchin was identified by most authors as a key location in the march but not analyzed separately in Serbian historiography suggests that the entire second half of the march, from the Vardar River Valley to the Moglena Valley, was likely viewed as a single medical front, with Topchin as the starting point. This perspective makes sense, as the remaining stretch through the lowland areas of Macedonia—covering approximately 85 kilometers from Topchin to Aridaía (Subotsko)—shared similar environmental and topographical conditions. Furthermore, the physically exhausting march, combined with nighttime exposure to mosquitoes and the lack of protective measures, significantly worsened conditions for infected soldiers and contributed to the spread of endemic malaria in the Moglena Valley as the disease spread along the troops' marching route.

Pejović mentioned an important detail that further highlights the issue of troops' exposure during the march. The Šumadija Division marched mostly at night to avoid the extreme daytime heat, which exposed them to mosquitoes when the insects were most active.[117] Without physical protection, such as mosquito nets, the troops were highly vulnerable to bites. This combination of factors gives us a clear understanding of how these conditions could—and did—lead to devastating consequences, which we will analyze in greater detail in the following section.

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[117] Pejović, *Moje uspomene i doživljaji,* 65.

Given that the risks associated with Topchin and the Vardar River Valley were already well-established and likely known to the Serbian Army's Supreme Command, it raises questions as to why this specific location was chosen as the transit camp for the Šumadija and Timok Divisions. All authors from that period assert that the medical corps was unaware of when and who determined the locations for the transit camps on the left bank of the Vardar, where the units of the Second Army (Šumadija and Timok Divisions) were stationed.[118] Dr. Dobrivoje Ger. Popović, the Medical Officer of the Šumadija Division, blamed the army's medical service, arguing that the Medical Corps had sufficient authority to prevent deployment in such a risky area. He further noted that if strategic and health objectives had been properly aligned, the initial mass infection in Topchin could have been avoided, or at least the risks could have been minimized.[119]

On the other hand, Russian epidemiologist and bacteriologist Niktopolion Chernozubov, who moved to the Kingdom of Serbs, Croats, and Slovenes after the war, criticized the Supreme Command for making this decision without consulting the Medical Corps.[120] Despite these criticisms, the reasons for stationing the Šumadija and Timok divisions in such a high-risk area remain unclear.

This controversial decision continues to perplex medical experts and historians, especially given that, prior to deployment to Salonika, the Serbian Army and its medical services had shown significant progress in implementing preventive measures against infectious diseases, including malaria—a notable improvement after decades of neglect of the Medical Corps. Documents from the Serbian Army archives and accounts by doctors from the

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[118] Popović et al., "Malaria in the Serbian Army on the Salonika Front: A Review of the Outbreak in the Second Half of 1916," 42.

[119] Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu," 433–434.

[120] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 292.

Salonika front reveal that preventive measures were carefully coordinated in the months prior to the troops' deployment. Yet, military authorities unexpectedly failed to involve the Medical Corps at the crucial moment for preventing the epidemic.[121]

This further raises the question: would a malaria epidemic in the Serbian Army have occurred if not for that mistake? The prevailing opinion among modern Serbian historians and medical experts is that an epidemic was inevitable, as avoiding endemic malaria areas on the Salonika front was nearly impossible. After all, Allied troops (French and British) had already been affected. However, the rapid outbreak in the Serbian Second Army in July 1916, particularly within the Šumadija and Timok Divisions, likely could have been mitigated had the troops not been stationed in the Topchin area during their march to the frontline positions.[122]

Aleksandar Nedok, one of the leading experts on the matter, elaborated on the issue, emphasizing that the main challenge was the underdeveloped railway lines in northern Greece, which had been acquired from Turkey in 1912. The inadequacy of the railroads made the rapid transfer of large numbers of soldiers to distant positions extremely difficult. As a result, a long march to the more remote left section of the front became the only viable option. Given these circumstances, it is likely that the risk was taken knowingly due to the lack of alternative solutions.[123]

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[121] Popović et al., "Malaria in the Serbian Army on the Salonika Front: A Review of the Outbreak in the Second Half of 1916," 42.

[122] Ibid.

[123] Aleksandar Nedok, "The Serbian Army Medical Corps in 1917 – 1918," *Vojnosanitetski pregled*, no. 65 (2008): 20.

The Epidemic

As soon as Serbian troops arrived in the Vardar River Valley, a mass malaria outbreak began and continued when the troops arrived at their positions in Moglena. By the end of July, half of the troops had fallen ill. The infection rate remained high until November, when the onset of winter led to a decline in malaria cases. Meanwhile, other Serbian troops stationed in less malarial highland areas experienced significantly fewer infections.[124]

When describing the horror faced by the Serbian troops in the Vardar River Valley, Dr. Popović (Popovich), the medical officer of the Šumadija Division, which was the first to arrive in the area, wrote: "Immediately upon the troops 'arrival, swarms of mosquitoes left horrifying marks on the unprotected soldiers; the bitten areas on their faces, hands, and legs were the size of walnuts. The infection was already widespread." Despite immediately notifying the Head of the Health Department of the Supreme Command, his concerns appeared to fall on deaf ears, and the disease continued to ravage the troops. By 21 July there were 247 new cases of malaria. After Popović's second report, Dr. Sondermayer, then the Head of the Health Department of the Supreme Command, personally visited the troops and remarked: "There is nothing to worry about; your medical officer (Dr. Popović) is just more scared than he should be!"[125]

A few days later, the number of new malaria cases surged to 300 per day, making antimalarial measures urgent. In this critical period, on 17 July 1916, Dr. Djordje Protić was sent to assist as the medical officer for the Šumadija Division. He observed that all forms of malaria were present, including the most severe cases, but tertian and quartan malaria were the most common. Given the severity of the situation and the limited supply of quinine, Dr. Protić implemented a classification system for the soldiers, dividing them into three groups, each with

[124] Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu," 433–434.

[125] Ibid.

corresponding treatment and prevention schedules and doses. The first group consisted of healthy soldiers who had not yet contracted malaria; the second group included soldiers who had recovered from milder cases; and the third group comprised soldiers who had recovered from severe cases. He instructed each regimental doctor to maintain a detailed list of malaria patients. In addition to the treatment measures, the troops were also ordered to carry out sanitation efforts on the terrain where they were stationed in order to help control the spread of the disease.[126]

Starting on 19 July 1916, as part of Protić's malaria prophylaxis plan, soldiers were administered quinine for five days each week, followed by a two-day break. He also recommended adding 10–15 drops of diluted hydrochloric acid (Acidum muriaticum dilutum), mixed with water, to enhance quinine's effectiveness. According to the charts, the quinine prophylaxis was scheduled to last three weeks. In the first week, all three groups of soldiers received a 0.50 g dose of quinine. During the second week, only the third group (those who had recovered from severe malaria) continued receiving a 0.50 g dose, while the first two groups (healthy soldiers and those who had recovered from milder cases) were given 0.25 g doses. In the third week, all three groups received a 0.25 g dose of quinine.[127]

Although quinine could not completely eradicate the malaria parasite, it effectively treated the symptoms, and as a result, the measures introduced by Dr. Protić proved to be effective. The number of troops needing medical care soon began to decrease. From 1 to 15 July, there were 4,404 malaria cases in the Šumadija Division (30% of the division). For the next two weeks, from 16 to 31 July, 3,242 cases were reported (22%). This was followed by

[126] Protić, "Malarija na Solunskom frontu," 440–441.

[127] Ibid., 442.

2,389 cases from 1 to 15 August (16%) and 2,793 cases from 16 to 31 August (18%). By the middle of September, the number had again decreased to 2,435 cases (17%).[128]

As in other allied armies on the Macedonian front, malaria was the main burden for medical services. The outbreak in the Šumadija Division was so severe that even the 3rd Field Hospital in Kosturjan, typically focused on surgical interventions, treated 1,159 malaria patients between 8 July and 4 August 1916. After that period, the 2nd Field Hospital of the Šumadija Division, under the command of Dr. Josif Nedok, took over the care of malaria patients. The workload at this hospital was immense. According to official reports, during the entire operation, over 205 days, the hospital treated 6,300 malaria patients and 183 wounded soldiers.[129] One of those patients was Tadija Pejović, who fell ill from malaria on 22 October and spent 15 days in the 2nd Field Hospital.[130]

An analysis of the quinine usage data also reflected the fluctuation in malaria cases. According to Protić's charts, the Šumadija Division used 172 kg of quinine in July, 87 kg in August, and 69.5 kg in the first two weeks of September 1916. The average amount of quinine per soldier was approximately 22 grams from 1 July to 15 September, bringing the total amount used during this period to 328.5 kg.[131]

The quinine consumption analysis also reveals an interesting fact. As we can notice from Portić's statistics, in September 1916, the Šumadija Division used significantly larger amounts of quinine. However, the number of infected soldiers remained consistent with the previous months, which indicates that the quinine was predominantly used for treatment rather than prophylaxis. This assumption is further supported by data from the Health Department of

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[128] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 293.

[129] Protić, "Malarija na Solunskom frontu," 442.

[130] Pejović, *Moje uspomene i doživljaji,* 73.

[131] Protić, "Malarija na Solunskom frontu," 443.

the Supreme Command, showing that in September 1916, the mortality rate was exceptionally high—100 soldiers died—making it the deadliest month for the Serbian Army during the entire Salonika operation.[132]

As for the Timok Division, there seems to be less information available for the year 1916 in comparison to the Šumadija Division. However, according to Protić, the situation in the Timok Division was likely worse than in the Šumadija Division during the summer of 1916. This is highlighted by the fact that the division lost its medical officer Lieutenant Colonel Dr. Milan Dimitrijević (Dimitiyevich) to severe malaria infection that led to his evacuation from the frontlines. In October of the same year, Protić was sent to the Timok Division to temporarily act as a medical officer for a month.[133]

As the regimental doctor of the 13th Infantry Regiment of the Timok Division, Dr. Kosta Todorović provides rare insight into the division's condition during the summer of 1916. According to his account, in August 1916, 1,009 soldiers from his regiment were hospitalized, and a total of 41 kilograms of quinine was consumed.[134]

As we could see from data on the numbers of patients and quinine consumption in the Šumadija Division, malaria was active even after the summer. A significant decrease in the number of malaria cases was recorded only at the end of 1916 and the beginning of 1917, primarily due to the cold winter days and their effect on the malaria parasite's gestation period.

According to the annual report from 21 January 1918 by Dr. Petar Pajić (Payich), the medical officer of the Timok Division, malaria, though in fewer numbers, remained present among the troops throughout the winter. Soldiers continued to suffer from malaria, mostly in its chronic form. New cases also emerged, as houses and dugouts remained infested with

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[132] Protić, "Malarija na Solunskom frontu," 451.

[133] Ibid., 446.

[134] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 294.

mosquitoes capable of transmitting the disease. Consequently, the Timok Division entered 1917 with a significant number of soldiers suffering from chronic, latent malaria, which only needed slightly more favourable conditions to flare up, spread, and evolve into a full-blown epidemic.[135]

From January to March 1917, most malaria cases were sporadic and consisted predominantly of mild tertian infections. However, throughout May and June, the combination of warmer weather and frequent rains led to an increase in the mosquito population, which in turn caused a surge in malaria cases. Despite the rise in numbers, the majority of infections during this period remained mild tertian malaria. In July, severe malaria cases began to appear more frequently, and from late July through August, the situation worsened significantly. The number of infections increased substantially, culminating in more severe and deadly cases.[136]

In September, the number of malaria cases began to decline. However, the decrease in the total number of cases was not proportionate to the reduction in severe cases. Very severe illnesses appeared, often accompanied by jaundice and hemoglobinuria. This decrease in malaria cases became more evident in October and November, just as the rise had been abrupt in July.[137]

It is interesting that the rise in malaria cases often did not occur simultaneously across all regiments. For example, in the Timok Division, the 15th Infantry Regiment recorded the highest number of cases in April, while in July and August, the 13th Infantry Regiment faced the most severe situation. However, in both regiments, the number of cases peaked only in the second half of August. Throughout this period, the situation in the 14th Infantry Regiment was

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[135] Protić, "Malarija na Solunskom frontu," 446.

[136] Ibid., 446–447.

[137] Ibid., 447.

comparatively better, but its peak came later, in the second half of September, and it recorded significantly more malaria cases than the 13th and 15th Regiments in October and November.[138]

In 1918, malaria among the troops of the Serbian Second Army received significantly less attention in Serbian historiography compared to the years 1916 and 1917, with most records limited to numerical data. This was likely because the number of cases and the severity of attacks were notably lower than in previous years. The reason behind this decline by 1918 was in part due to better medical practices, anti-malarial measures, such as oiling, mosquitos and larvae destruction and swamp drainage in and around the frontlines. Furthermore, doctors had better understanding of the uses and limits of quinine as both a prophylaxis and treatment.

The exact number of malaria cases among all Serbian troops in Salonika is difficult to assess. According to the Health Department of the Supreme Command, in 1916 (since July), there were 9,474 malaria patients, in 1917 there were 26,401, and in 1918 (up to 1 October), there were 14,685 cases. However, the report from the Chief of the Medical Corps of the Second Army, covering the period from 1 July to 31 December 1916, states that 27,534 soldiers suffered from malaria, with 13,194 being treated in hospitals.[139]

The most likely reason for the discrepancy in numbers is the fact that while many soldiers were treated within their units, some were sent multiple times to clinics, field hospitals, and general hospitals. Therefore, it is possible that the Second Army Medical Corps included all the malaria relapses in their statistics.

Despite inconsistencies in patient counts, the number of fatal malaria cases remained consistent across all reports. In 1916, which saw the highest number of deaths among Serbian troops, 261 soldiers (2.8%) died from malaria. In 1917, this number dropped to 106 soldiers

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[138] Protić, "Malarija na Solunskom frontu," 447.

[139] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 295.

(0.4%), and by 1918, it had further decreased to 45 soldiers (0.3%). Overall, the general mortality rate from malaria within the Serbian Army at the Salonika front, during the period between 1 July 1916 and 1 September 1918, was 0.87%, with a total of 412 soldiers losing their lives to the disease.[140]

Quinine Prophylaxis

The issue of malaria prophylaxis was the most common point of disagreement among the Allied doctors in Salonika. In 1897, when Maj. Ronald Ross of the IMS (Indian Medical Service) identified the mosquito vector responsible for transmitting the malaria parasite to humans, specifically the female of the Anopheles genus. This groundbreaking discovery presented an alternative approach to malaria prevention. As Professor Harrison, an expert on medical history from Oxford, described, these discoveries opened up the exciting prospect of preventing malaria by destroying mosquitoes, either in their adult or larval forms.[141]

Before the First World War, medical experts in the British Army were engaged in a heated debate over the relative merits of these different methods of malaria prevention. On one side were the vocal advocates of quinine prophylaxis, such as Drs. J. W. W. Stephens and S. R. Christophers, who conducted experiments in 1901-1903 at Mian Mir in the Punjab using methods advocated by Ross. Although they relied on using measures against adult mosquitoes and their larvae, the experiment ultimately failed and, according to Harrison, proved to be a setback for Ross and his supporters. On the other side were doctors who aligned with Dr. Ross and strongly advocated for mosquito destruction as the primary means of malaria prevention.

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[140] Protić, "Malarija na Solunskom frontu," 451–452.

[141] Harrison, *The Medical War,* 229.

Ross himself had angrily resigned from the IMS in 1899 due to the Government of India's refusal to implement his recommendations.[142]

Later, an alternative approach emerged. In 1911, IMS officer C. A. Bentley wrote an influential report on malaria prevention in the city of Bombay, proposing a flexible, non-exclusive strategy. Bentley recommended combining quinine administration with mosquito control measures as circumstances required. This balanced approach leveraged the strengths of both methods, offering a more adaptable and pragmatic solution to combating malaria.[143]

The Macedonian front raised a different question. There, the issue was not whether destroying mosquitoes was effective, but whether it was possible. Furthermore, it was not whether quinine was a good choice, but rather whether there were any substitutes for it. In Salonika, there was no room for debates. The situation was urgent, and both the Serbian and Allied forces had to rely on the limited options available. Quinine was one of the few means available to combat malaria, and the doctors and medical officers had to make the most out of it. Additionally, terrain drainage and other anti-mosquito measures, such as oiling water, digging trenches and destroying larvae, were applied whenever possible. As mentioned earlier, Dr. Djordje Protić, who represented the medical officer of the Šumadija Division and classified soldiers into three groups for quinine administration, also emphasized the importance of terrain drainage. Therefore, we can see that the methods for malaria prevention suggested by C. A. Bentley were in fact implemented.

The efficacy of quinine prophylaxis was an issue of its own. Quinine prophylaxis often produced positive yet insufficient results, as the number of infections and reinfections remained high despite quininization. Nevertheless, in the absence of more effective substitutes, medical

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[142] Harrison, *The Medical War,* 229.

[143] Ibid., 230.

officers focused on adjusting the quinine dose and ensuring its proper distribution among the troops.

The prophylactic use of quinine in the Serbian Army on the Salonika front began soon after taking positions in July 1916. One of the first documented examples of quinine prophylaxis in the Serbian Army was Protić's three-week plan, as discussed in the previous section. Unlike in 1916, the Serbian Army approached malaria in 1917 with significantly greater awareness. That year, the prophylactic use of quinine started as early as March. In the Timok Division, a direct order from the Commander required every soldier to be issued one quinine pastille daily, except on weekends—a regime similar to Protić's earlier plan. However, this order was later lifted, allowing each regimental doctor to establish their own prophylaxis plan.[144]

Dr. Kosta Todorović offers firsthand perspective into the results of quinine prophylaxis in his regiment. His report covers the period from May 15 to September 15, 1917, a critical timeframe for analyzing the development of the malaria epidemic.

According to Todorović's report, numerous malaria cases began to appear in early May, not only among those who had suffered from malaria the previous year but also among soldiers who had never been infected before.[145] To provide a more comprehensive understanding of the epidemic's progression, Todorović included a detailed table outlining dates, case statistics, and quinine usage.

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[144] Protić, "Malarija na Solunskom frontu," 446.

[145] Ibid., 448.

Time Period	Number of Malaria Cases	Quinine Regimen	Quinine Consumption
15 May – 1 June	92	15–27 May: 0.20 g daily 27–31 May: 0.80 g daily	10 kg
1 – 15 June	38	3, 7, 10, 14 June: 0.80 g (Wednesdays and Saturdays)	15 kg
15 – 30 June	111	17, 21, 24, 28 June: 0.8 g (Wednesdays and Saturdays)	10 kg
1 – 15 July	282	1, 4, 8 July: 0.80 g 12–15 July: 0.40 g daily	15 kg
15 – 31 July	340	0.40 g daily	16 kg
1 – 15 August	508	1–13 August: 0.40 g daily 14-15 August: No quinine	11 kg
15 – 31 August	501	15–20 August: No quinine 20 August: 3 g 21 August: 2 g 22 August: 1 g 23–31 August: 0.40 g daily	30 kg
1 – 10 September	200	1 September: 0.40 g 2 September: 3 g 3 September: 2 g 4 September: 1 g 5–10 September: No quinine	15 kg

Table 1. Malaria Cases and Quinine Usage in the 13th Infantry Regiment, Timok Division (May–September 1917).
Source: Djordje Protić, "Malarija na Solunskom frontu" in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 448.

As we can see from the table, although the number of malaria cases significantly decreased in the first half of June—suggesting the success of the preventive quinine regimen (administered twice a week, on Wednesdays and Saturdays, at a dose of 0.80 g)—cases suddenly surged again from June 15 onward, despite the consistent use of quinine at the prescribed dosage.

According to Todorović's report, by June 10, the number of malaria cases was already significant, and even soldiers who had consistently taken quinine twice a week at a dose of 0.80 g fell ill. In an effort to achieve better results, a daily dose of 0.40 g was administered from July 12 to August 12. Despite this adjustment, the number of malaria cases continued to rise. The disease took on an epidemic character and reached its peak between August 12 and 20, coinciding with the regiment running out of quinine.[146]

Todorović argues that a daily prophylactic dose of 0.40 g of quinine, as per earlier guidance, did not bring significant results, as nearly every soldier had contracted malaria. To address the worsening situation, higher therapeutic doses were administered. On August 20, all soldiers received 3 grams of quinine (0.60 g every three hours), followed by 2 grams on August 21 and 1 gram on August 22. After this regimen, the number of malaria cases noticeably decreased, and the improvement lasted until August 30.[147]

When the number of malaria cases began to rise again, another round of higher doses was administered. On September 2, soldiers received 3 grams of quinine, followed by 2 grams on September 3 and 1 gram on September 4.[148]

Todorović's 13th Regiment had a strength of 2,500 soldiers as of June 15, 1917. Between June and September, the regiment recorded 2,600 cases of malaria infections and

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[146] Protić, "Malarija na Solunskom frontu," 448.

[147] Ibid.

[148] Ibid.

reinfections, with 850 soldiers (13%) requiring hospitalization. Dr. Pajić, the medical officer of the Timok Division, noted that the situation in the 13th Regiment could be generalized to all other regiments in the division.[149]

The Šumadija Division faced similar challenges. Throughout 1917, according to Protić, quinine was distributed in the Šumadija Division as a preventive measure against malaria twice weekly (on the 1st and 4th days), initially at a dosage of one gram per day. This was later reduced to 0.60 grams per day, administered as two 0.20-gram tablets at noon and one in the evening. Despite these efforts, this prophylactic dose still proved ineffective.[150]

Speaking of the results of the quinine regimen, Todorović concluded: "Despite the vigorous use of quinine, the results were unsatisfactory." [151] This concluding sentence accurately reflects the situation regarding quinine prophylaxis efforts, not only in the Serbian Army but across all Allied armies. On the one hand, quinine had a noticeable impact on the epidemic, often leading to a significant reduction in the number of cases when administered in sufficient quantities. Furthermore, as seen in Todorović's accounts, the absence of quinine prophylaxis coincided with the peak of the epidemic.

On the other hand, despite the use of quinine and its limited impact on reducing cases, the percentage of infected troops remained high enough to impair the armies 'combat capabilities, sometimes bringing military operations in Salonika to a complete halt.

The British had similar observations. According to W. G. Willoughby and L. Cassidy, who both had been serving in Macedonia, British soldiers were given 5 grains (approximately 0.32 grams) or more of quinine daily at sundown, or 15 to 30 grains (1 to 2 grams) on two consecutive days weekly. However, the prophylactic value of quinine seemed to be incomplete

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[149] Protić, "Malarija na Solunskom frontu," 449.

[150] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 296.

[151] Protić, "Malarija na Solunskom frontu," 449.

and questionable. Even when the dose was increased to 3 grams per day, the results were not conclusive.[152] This is particularly noteworthy, as according to Todorović, the same dose led to significant improvement within his regiment.

Malariologists at the time struggled to understand why quinine was generally ineffective as a preventative measure, with various speculations surrounding its failure. This issue affected all troops stationed on the Salonika front. One of the most common explanations was soldiers' reluctance to take the medicine. Its unpleasant taste, tendency to cause nausea, ringing in the ears, and other negative side effects, as well as widespread rumours that quinine caused sexual impotence, were among the most common reasons why soldiers avoided taking the medicine as prophylaxis.[153]

Speaking of the British Army, S. R. Christophers believed that quinine prophylaxis relied entirely on good discipline and expert supervision, which, in his view, had often been lacking in Salonika.[154] Additionally, according to Harrison, there was even a persistent belief—possibly strongest among older British military personnel—that contracting and succumbing to disease was ignoble. The rumours were fuelled by the idea that men had intentionally contracted malaria by ignoring preventive measures in order to leave Salonika.[155] However, P. G. Shute countered these claims, noting from his personal experience that anti-malarial discipline was generally well-maintained and quinine parades were regularly enforced.[156]

According to Philip-Antoine Breau, who wrote a thesis on malaria among French troops in Salonika, the French Army also regarded quininization as a matter of discipline. They

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[152] Fantini, "Malaria and the First World War," 247–248.

[153] Harrison, *The Medical War,* 229.

[154] Ibid., 237.

[155] Ibid., 236.

[156] Ibid., 237.

struggled to enforce mandatory quinine prophylaxis as soldiers often lied about their quinine intake or refused to take it for various reasons: a lack of knowledge about malaria, mistrust of the unfamiliar medicine, the bitter taste of quinine, or simple negligence. When the French Army tested its men for quinine levels, it was found that, despite strict measures, only 30% of men in some regiments tested positive—far too low for quinine prophylaxis to be effective.[157]

The Serbian Army faced similar challenges in enforcing quinine prophylaxis regimens. In September 1917, while examining a group of soldiers from the Timok Division, Todorović found that 49 soldiers had accurately followed the prescribed dosage regimen, whereas 30 soldiers either failed to follow the instructions correctly or consumed doses of quinine smaller than prescribed.[158]

Speaking of the reasons why some soldiers did not take quinine regularly, it should be noted that this was not always merely a matter of negligence. Dr. Dobrivoje Ger. Popović, the medical officer of the Šumadija Division, highlighted several contributing factors, including the division of troops into numerous smaller units and the constant movement of certain units. To address these challenges, he created illustrations emphasizing the importance of quinine prophylaxis and other preventive measures. However, the Health Department of the Supreme Command did not proceed with printing them.[159]

Except for insufficient prophylactic quininization of the troops, experts believed that there were other and more important reasons for the poor results of prophylaxis. For example, Dr. Ross, even though he was a great opponent of the prophylactic quinine use, speculated that the men might have been given their dose of quinine too early in the afternoon with the result

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[157] Philip-Antoine Breau, "French Soldiers' Experiences of Malaria on the Macedonian Front (1916-1918)" (master's thesis, Memorial University of Newfoundland, 2022), 33.

[158] Protić, "Malarija na Solunskom frontu," 449.

[159] Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu," 435.

that when the mosquitoes became active several hours later, the blood was free from quinine leaving the parasite in its sporozoite stage unaffected.[160]

Serbian doctor Djordje Protić believed that the failure to achieve complete success in malaria prophylaxis was due to local nature of the disease itself. He collaborated with Dr. Hirschfeld on this issue, conducting a series of blood sample analyses from infected soldiers that experimentally confirmed their suspicions. The results indicated that a form of malaria, described as being similar to types typically found in tropical regions, prevailed among the patients, even though tertian malaria had been more common initially. In a report to the Head of the Health Department of the Supreme Command on 21 September 1916 Dr. Hirschfeld noted: "…clinically it is evident that this is not ordinary *malaria tertiana* or *malaria quartana*, but a form of tropical malaria (*malaria tropica maligna*), which is now found in the majority of cases in Macedonia."[161]

Protić and Hirschfeld's observations were accurate, as the severity of malaria was most likely fuelled by *Plasmodium falciparum*, a strain common in tropical regions and likely introduced to Macedonia by British troops, some of whom had served in India.[162] A key characteristic of the *malaria tropica maligna*, as Protić and Hirschfeld referred to it, was the development of *Plasmodium* parasites that were highly resistant to quinine. The primary reason for this quinine resistance was the simultaneous infection of many soldiers in Macedonia with different types of *Plasmodium*, which created favourable conditions for superinfection.[163]

Alexander Goodall, a British doctor and lecturer on Clinical Medicine at the University of Edinburgh, who also served as a Temporary Major with the Royal Army Medical Corps

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[160] Harrison, *The Medical War,* 233.

[161] Protić, "Malarija na Solunskom frontu," 446.

[162] Harrison, *The Medical War,* 231.

[163] Nedok, Popović, and Todorović, *Serbian Military Medical Corps in the First World War,* 296.

(RAMC), was responsible for treating 20,000 malaria cases, including those of British and Serbian soldiers stationed in Macedonia during the First World War. Goodall observed that typical malaria attacks were rarely seen in this region. He noted that mosquitoes were not only numerous but also heavily infected, leading to frequent multiple infections in humans. Consequently, patients often received fresh doses of the parasite's toxins daily or even twice a day, resulting in remittent or continuous fevers being as common as the typical intermittent fever. Goodall also emphasized the fact that the localization of toxins in infected blood cells, particularly in cases of malignant tertian malaria caused by multiple or localized infections, produced symptoms that affected different bodily systems.[164]

Superinfection was also confirmed by French studies. During P. Rabaul's experiment in Marseille, where many malarious soldiers returning from the Salonika front were hospitalized, microscopic blood analyses demonstrated that more than 50% of infected soldiers had a double infection with *P. falciparum* and *P. vivax*. Additionally, 19% were infected with *P. falciparum* alone, and 30% with the less dangerous *P. vivax*.[165]

Dr. Protić attempted to address this issue by advocating for the "regular use of quinine in high doses to ensure sufficient levels of it in the body at all times." Nevertheless, even the regimen of taking quinine twice a week (on the 1st and 4th day) in doses of 1 gram at once, followed by 0.60 grams daily in the daily rhythm of 0 + 2 + 1 pastille (to maintain higher quinine levels in the blood overnight), did not significantly reduce the number of cases.[166]

As we could see from the Serbian Army medical officers 'reports on malaria, even in the units where quinine was prophylactically distributed regularly and under medical supervision, the results were almost negligible. The most likely explanation for the insufficient

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[164] Alexander Goodall, "Malaria in Macedonia," *Edinburgh Medical Journal* 22, no. 3 (1919): 158.

[165] Fantini, "Malaria and the First World War," 261.

[166] Nedok, Popović, and Todorović, *rpski vojni sanitet u Prvom svetskom ratu,* 296.

results of quinine prophylaxis lies in the combination of the unique characteristics of Macedonian malaria and the region's favourable environmental conditions, which allowed the disease to thrive. Therefore, it is fair to conclude that blaming the failed malaria prophylaxis on the troops and poor discipline seemed unjustified.

As Treadgold clearly summarized, there were two distinct scientific and clinical problems. Firstly, had any notable proportion of the Macedonian forces been saved through the administration of prophylactic quinine, and if so, what proportion? Secondly, was the overall effect of such measures favorable or not? He believed that these conditions had never been thoroughly investigated using scientific methods, leaving significant gaps in the knowledge and understanding of the issue.[167] Given the lack of comprehensive scientific data at the time, Treadgold's conclusion seems the most reasonable.

Fighting Malaria on the Macedonian Front

Although expert opinions at the time regarding quinine prophylaxis were polarized, the consensus began to shift from 1917. Insufficient results from prophylactic quinine administration gradually led to a greater emphasis on physical protection against mosquitoes and the destruction of larvae. Even prominent supporters of quinine prophylaxis, such as the Italian malariologist Angelo Celli, acknowledged that the effects of quinine prophylaxis were almost negligible when compared to mosquito control measures.[168]

Out of all Allied forces in Salonika the British Army seemed to be the most proactive in terms of malaria prevention. Since 1916 the British put greater emphasis on mechanical protection and anti-mosquito efforts. However, it did not go without challenges. The main

[167] Fantini, "Malaria and the First World War," 264.

[168] Ibid.

problem was that antilarval fight was difficult, and even with comprehensive efforts, it was impossible to completely eliminate mosquitoes and their larvae from the areas occupied by troops. Additionally, mosquito nets proved very impractical in the campaign conditions. They were difficult to maintain, challenging to distribute individually to soldiers, and even harder to ensure proper usage. Because of that, according to W. G. Willoughby and L. Cassidy, although eliminating the breeding sites of mosquitos should be the priority, quinine prophylaxis was still necessary. As a result, in 1917, the British Army increased quinine administration and enhanced supervision.[169]

In 1917, since the issue with mosquito nets persisted, the British resorted to alternative solutions, deciding to withdraw most of the troops to the foothills during the summer and intensify quininization to mitigate the malaria epidemic. However, according to W. H. Sutcliffe, all efforts were ultimately in vain, as the damage had already been done.[170]

As for mosquito control, the British launched a massive drainage operation in the Struma Valley, one of the most malarial areas around Salonika. The operation began in earnest in 1917, and by the end of the war, much of this land was under cultivation, and malaria admissions in the area were reported to be negligible. Still, according to Harrison, such improvements came too late in the war and were too localized to have any appreciable effect on malaria admissions.[171]

The French Army after suffering massive casualties due to malaria in March 1917 established a special "Mission for antimalarial prophylaxis in Macedonia." The mission consisted of 4 managers, 20 medical officers, 100 quinine distributors, 400 sanitary agents, and some administrative staff. The mission was responsible for a wide range of antimalarial

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[169] Fantini, "Malaria and the First World War," 247–248.

[170] Ibid., 248.

[171] Harrison, *The Medical War,* 239.

measures, such as epidemiological analysis, selection of cantonment, quinisation, control of the quinine consumption by urine analysis, troops' individual mosquito protection, anti-anophelic campaign and special propaganda campaigns, including coloured posters, aimed at raising the troops' awareness of the importance of antimalarial measures. As a result, among the French troops in Macedonia malaria considerably improved in 1917, as we could see from the malaria statistics.[172]

At the end of 1917, the Serbian Supreme Command formed a special commission to study the issue of malaria, marking a delayed but significant step in following suit with their Allies.[173] This initiative reflects a growing recognition of the importance of malaria prophylaxis within the Serbian military medical service. Unlike the British and French armies, however, the Serbian Army continued to rely primarily on quinine as its main antimalarial measure, using a total of 11,000 kg of quinine in pastilles, 200 kg in powder, and 407,000 quinine ampoules.[174]

Other preventive measures, such as the use of mosquito nets, were introduced only in 1918, once conditions allowed for their implementation in field hospitals, clinics, and rear facilities. While these measures achieved some success, they likely would have been more effective if adopted earlier.[175] Although there is limited information on the reasons for this delay, it is reasonable to attribute it to supply challenges.

Efforts to control mosquito populations through drainage, drying, and oiling were undertaken during 1917 and 1918 but proved challenging to implement over large areas. Nevertheless, smaller ponds were filled in, and waterlogged areas were cultivated wherever

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[172] Fantini, "Malaria and the First World War," 250.

[173] Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu," 435.

[174] Stanojević, *Istorija ratnih zaraza*, 137.

[175] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 296.

possible, showcasing the Serbian Army's attempts to combat malaria despite logistical and resource constraints.[176]

Before moving on to the next chapter, it is important to emphasize a key aspect of the Allied antimalarial medical efforts. In Salonika, the Allied armies benefited significantly from access to well-equipped hospitals provided by their Greek hosts. These facilities played a pivotal role in combating malaria in Macedonia, particularly in the treatment of infected soldiers. Not only could they accommodate a large number of patients, but many were also equipped with fully functional laboratories. This allowed Allied scientists to conduct critical analyses and experiments, deepening their understanding of the disease's local characteristics and improving their response strategies.

While the significance of hospitals in Salonika is not often highlighted by authors—likely because they were regarded as standard facilities—these institutions were particularly valuable, not only for antimalarial efforts but for addressing all medical challenges in Macedonia. This was especially true for the Serbian Army, which received its first hospital in Salonika in 1917, thanks to the French Army. In March 1917, the French decided to hand over one of their medical complexes, along with all its premises, equipment, and installations. The hospital was then renamed the "Reserve Hospital of Crown Prince Alexander," becoming the main medical institution for the Serbian Army in Macedonia, and in the following chapter, we will analyze how this hospital contributed to the Serbian antimalarial efforts on the front.[177]

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[176] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 296.

[177] Ibid., 129.

Chapter III: The Treatment

In Salonika, both the Allied and enemy forces found themselves in the same trap. As Dr. Ger. Popovic accurately described, "the first opportunity to prevent the infection was missed."[178] However, the real question is whether there was ever any opportunity at all. According to Bernard J. Brabin, a Professor at the Liverpool School of Tropical Medicine, efforts to clear mosquito breeding sites were insufficient, partly because at the time it was not yet known that mosquitoes could spread beyond about 500 meters from their breeding sites.[179] Additionally, the abundance of malaria cases among the local population, combined with the war—which brought an unusually large agglomeration of new, fresh, and highly susceptible soldiers—made it truly impossible to prevent the spread of the disease. Therefore, all the medical officers and doctors could do was focus on treating malaria cases, which was by no means an easy task.

Among all the challenges, there were three main difficulties the doctors faced when treating malaria. The first issue was the high number of infections and soldiers needing treatment. The second was the very nature of Macedonian malaria. Last but not least, were the limited means for fighting it, as quinine was the only effective medicine at the time.

Since this chapter is devoted to the treatment of malaria, it is crucial to understand the basics of its pathogenesis, classification, structure, and life cycle, as well as the basic terminology that will be often used in this chapter.

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[178] Dobrivoje Ger. Popović, "Malarija u Šumadijskoj diviziji na Solunskom frontu," in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 435.

[179] Bernard J. Brabin, "Malaria's Contribution To World War One – The Unexpected Adversary," Malaria Journal, 16 December 2014, https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-497

Malaria is caused by protozoa (microorganisms) called *Plasmodium*. There are four types of *Plasmodium* that affect humans: *Plasmodium falciparum* (the most dangerous one), *P. vivax* (the most common worldwide but generally not fatal), *P. malariae*, and *P. ovale*. In Macedonia the first three were the most common. To properly understand how malaria was treated on the Salonika front, we need to know how Plasmodia reproduces and evolves once they reach the human body.

As we know, the infection begins once a person has been bitten by a female anopheline mosquito that carries immature cells - sporozoites. Once in human blood, sporozoites travel to the liver. When the blood carrying sporozoites reaches the liver, specialized white blood cells called Kupffer cells filter foreign sporozoites from the blood. However, malaria has evolved to successfully escape Kupffer cells, allowing sporozoites to move into the liver cells. There the sporozoites start schizogony, the process of asexual reproduction. During schizogony, the sporozoite divides and fills the liver cells with identical smaller copies of itself. Those copies are called merozoites. That is why an enlarged liver is common in malaria patients. Eventually, the liver cells rupture and release the merozoites into the bloodstream. Once they reach the bloodstream, the merozoites attack red blood cells where they start either asexual or sexual reproduction.[180]

Inside the red blood cell, the merozoite will repeat the same reproduction process as in the liver cells until the red blood cell breaks, releasing more merozoites that will find and attack new red blood cells. This second asexual replication cycle, depending on the species, produces up to 32 merozoites over the course of 24–72 hours. Through repeated rounds of invasion and growth, the parasite establishes acute and, eventually, chronic infections. While some species,

[180] John F. Fisher, "The Life Cycle of Malaria," MED Mastery, last modified 29 April 2021, https://www.medmastery.com/guides/malaria-clinical-guide/life-cycle-malaria

such as *P. vivax*, are restricted to immature red blood cells (reticulocytes), which make up a small fraction of circulating red blood cells and thus limit total parasitemia, P. falciparum are not restricted and can infect many more red blood cells, leading to much more severe infections. That is why *P. falciparum* is considered the most dangerous and deadliest form of malaria.[181]

However, not all merozoites go through the reproduction process inside red blood cells. Instead, some of them become gametocytes - the sexual structures that remain in the blood until a mosquito bites. When a bite happens, the mosquito will ingest the gametocytes. Inside the mosquito the female and male gametocytes form a kinetic egg called an ookinete. The egg eventually becomes an oocyst that releases sporozoites as it matures. When the mosquito bites someone again, it will transfer those sporozoites to them, and the new cycle begins.[182]

When it comes to the clinical manifestations of the disease, which is important for understanding the treatment, the most characteristic symptom of malaria is fever. Its manifestation includes chills, headache, myalgias, nausea, and vomiting, and sometimes diarrhea, abdominal pain, and cough as well. As the disease progresses, some individuals may develop typical malaria paroxysms, with episodes of malaria attacks combined with periods when there are no symptoms at all. The malaria paroxysm happens in three stages that we need to understand as they were an important part of experiments conducted to improve the treatment. The first is the cold stage. This stage lasts between 15 to 60 minutes and is characterized by trembling and a feeling of being cold. The next stage is a hot one that lasts for two to six hours and is characterized by flushed, dry skin, fever that can occasionally exceed

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[181] Kannan Venugopal et al., "Plasmodium Asexual Growth and Sexual Development In The Haematopoietic Niche of The Host," NIH National Library of Medicine, 9 January 2020, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7223625/

[182] John F. Fisher, "The Life Cycle of Malaria," MED Mastery, last modified 29 April 2021, https://www.medmastery.com/guides/malaria-clinical-guide/life-cycle-malaria

41°C, headaches, nausea, and vomiting. Lastly, there is the sweating stage, which lasts for 2 to 4 hours and during which the fever rapidly ends.[183]

In all forms of malaria, the periodic febrile response is caused by the bursting of mature schizonts. In *P. vivax* and *P. ovale* malaria, a schizont brood matures every 48 hours, resulting in tertian fever ("tertian malaria"), whereas fever occurs every 72 hours in P. malariae ("quartan malaria"). The fever in falciparum malaria may occur every 48 hours, although it is frequently unpredictable, with no discernible pattern. These typical fever patterns are rarely seen early in the stages of the disease, however the lack of periodic, synchronized fevers does not rule out the diagnosis of malaria.[184]

As mentioned in the previous chapter, various reports mentioned Macedonian malaria as a different and more dangerous form of the disease. One of the main challenges in dealing with it was its unusual symptoms and behavior, which made detection particularly difficult. Typically, febrile malaria seizures provided valuable indicators for diagnosing the disease. However, in Macedonia, malaria could manifest symptoms resembling those of various internal diseases or even conditions such as psychosis or gangrene, often leading to confusion and misdiagnoses. This difficulty was compounded by the frequent co-occurrence of malaria with other diseases on the Macedonian front, further complicating accurate diagnosis. Consequently, delays in starting appropriate treatment significantly increased the risk of fatal outcomes for patients.

Alexander Goodall, a British doctor, described in his accounts one of his cases that illustrated the diagnostic difficulties faced by doctors in Salonika. The patient, a 34-year-old Serbian private treated in Macedonia in early December of 1918, exhibited symptoms of a

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[183] James M. Crutcher and Stephen L. Hoffman, "Malaria," NIH National Library of Medicine, 1996, https://www.ncbi.nlm.nih.gov/books/NBK8584/

[184] Ibid.

respiratory infection and was unresponsive to questions. Suspecting a concurrent malaria infection, Goodall reluctantly decided to administer quinine injections due to concerns about the patient's feeble pulse and lung condition. The treatment resulted in gradual improvement, as the patient regained consciousness and was able to swallow. However, despite the initial success, the patient passed away a few days later. [185]

As Goodall described, the greatest challenge with this case was determining the cause of the patient's condition. Was it malaria, influenza, or both? He concluded that the private "certainly had malaria and probably influenza as well." [186] The autopsy findings revealed an enlarged fibrous spleen—another common malaria symptom and a clear indicator of the disease—as well as double lobar pneumonia. According to Goodall, this case also highlighted the serious implications of a pneumonic complication, which increased the patient's sensitivity to quinine and made the treatment significantly more complex. [187]

According to the Serbian Army medical reports, malaria on the Salonika front was also very difficult to detect even under microscope. "Quite often, in 20-40% of severe cases, we could not find schizonts or any other forms of *Plasmodium* in the blood of malaria patients. On the other hand, though less frequently, we observed cases where completely normal schizonts and other forms were found in the blood, while the patient showed no external signs of the disease."[188] When we consider this fact along with the frequent co-occurrence of malaria with other diseases on the Macedonian front, it becomes evident how multifaceted the challenges were for doctors in their fight against malaria.

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[185] Alexander Goodall, "Malaria in Macedonia," *Edinburgh Medical Journal* 22, no. 3 (1919): 166–167.

[186] Ibid., 167.

[187] Ibid.

[188] Ljubomir D. Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," in *Istorija našeg vojnog saniteta: Naše ratno iskustvo* (Belgrade: Zlatibor, 1925), 456.

As for malaria treatment, quinine was the only drug available at the time. Despite its questionable prophylactic efficacy, quinine proved to be generally effective for treating malaria cases. However, as we already now, Macedonian malaria was more resilient, due to the deadly *Plasmodium vivax* and *Plasmodium falciparum* cocktail.[189] This particularly dangerous form of malaria challenged quinine's therapeutic efficacy in Salonika.

The underperformance of quinine therapy in Macedonia inevitably sparked debates within the scientific community of the time. Two of the most significant discussions took place on February 15 and March 15, 1918, during meetings of the Society of Tropical Medicine. Among the speakers was the renowned Ronald Ross, who presented findings from his research on malaria treatment conducted across four hospitals: Aldershot, London, Oxford, and Epsom. These hospitals treated a total of 2,640 cases, the vast majority being malaria patients from the Salonika front who had been infected in 1916 and were experiencing relapses, with only a few of new infections.[190]

When discussing the therapeutic efficacy of quinine, it is important to distinguish between its effect on the acute phase of malaria infection and its ability to prevent relapses. Ross 'research demonstrated quinine's effectiveness in treating acute phase. However, it also underscored the challenges of using quinine to completely sterilize cases and prevent relapses. Furthermore, the therapy success appeared to depend directly on the dosage.[191]

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[189] Mark Harrison, *The Medical War: British Military Medicine in the First World War* (Toronto: Oxford University Press, 2010), 231.

[190] Bernardino Fantini, "Malaria and the First World War," in *Die Medizin und Der Erste Weltkrieg,* ed. Wolfgang U. Eckart, and Christoph Gradmann (Pfaffenweiler: Centaurus-Verlagsgesellschaft, 1996), 259–260.

[191] Ibid.

According to Ross, 63% of medical officers who participated in the research favoured a daily dose of 30 grains of quinine.[192] On the Salonika front, this dosage—30 grains (approximately 2 grams) per day, and sometimes as much as 40 grains (2.5 grams)—with a usual treatment duration of 1 to 4 weeks, was commonly used for treating malaria.[193] Regarding "anti-relapse prophylaxis," the majority recommended fixed doses of quinine to be administered for periods of up to three and a half months. A year later, in April 1919, Ross concluded that administering 60 to 90 grains of quinine weekly would result in infrequent relapses.[194]

Although quinine was regarded as effective for treating the clinical attacks in most malarial infections, significant disagreement existed regarding its ability to prevent relapses. This debate created a maze of contradictions. Although Ross' approach, which recommended a three-month quinine treatment following the acute phase, was accepted by the War Office and formally endorsed in the Provisional Instructions for malaria treatment, it was not universally embraced. One key point of disagreement was that, in many cases, quinine therapy needed to be extended beyond three months.[195] For example, C. H. Treadgold opposed Ross on this matter, arguing that the disadvantages of quinine prophylaxis outweighed its benefits.[196] He went so far as to claim that quinine was not only ineffective but potentially harmful, as it suppressed the clinical manifestation of the disease, thereby prolonging the latent period and increasing the risk of multiple infections.[197]

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[192] Fantini, "Malaria and the First World War," 259–260.

[193] Harrison, *The Medical War,* 232.

[194] Fantini, "Malaria and the First World War," 259–260.

[195] Ibid., 263.

[196] Harrison, *The Medical Wa,* 232.

[197] Fantini, "Malaria and the First World War," 263.

There was also the fact that most expert opinions and literature on the subject lacked clinical experimental confirmation, and, according to Fantini, no definitive conclusion on this issue could be reached without a system of clinical control.[198] Therefore, this controversy regarding quinine, as French expert R. Gutmann accurately summarized, came down to two possibilities: either it was not "the" specific cure for malaria, or the treatment was not utilized in such a way to get the best from it.[199]

With hundreds of thousands of soldiers in Macedonia, many of whom had never contracted malaria and therefore had no developed immunity, medical officers on the Salonika front were challenged by the powerful and stealthy form of malaria thriving in its ideal natural habitat. While efforts to destroy mosquitoes, their larvae, and breeding grounds were undoubtedly critical, this discussion focuses on the challenges faced after an infection had occurred. With only one medicine available, the doctors focused on readjusting the dose and form of quinine to find the most effective treatment against the vicious Macedonian malaria and ensuring it was administered regularly to the infected soldiers.

Serbian Army Treatment

In the beginning of the Salonika operation, the Serbian Army mostly relied on the same dosage being used by the British army. Initially, the doses rarely exceeded 2 grams of quinine per day. Ideally, quinine was given to patients 6 hours before the anticipated malaria febrile attack. This six-hour timeframe, when taken orally, was enough time for quinine to enter the bloodstream. However, one of the main issues Serbian doctors encountered was the difficulty in predicting when exactly an attack would occur. Part of the problem was that there were too

[198] Fantini, "Malaria and the First World War," 262–263.

[199] Ibid., 259.

many patients and too few doctors available. Most of the patients were brought in when the attack was already near the end or in the midst of an attack that could last for several days. The next attack almost always caught the doctors by surprise or deceived them, lacking any characteristic malaria symptoms but still having the potential for a fatal outcome.[200] In such cases, the doctors had to administer quinine into the patient's bloodstream as soon as possible, and the fastest way to do that was through injections. There were two types of quinine injections used: intravenous and intramuscular.

Although there were different theories and opinions regarding which type of injection was better, most doctors seemed to favour intravenous injections, mainly because of their immediate effect and significantly less painful consequences for the patients. The downsides of those injections were its limited availability, more difficult administration, and potentially dangerous side effects, including a fatal outcome for the patient due to a sudden increase of quinine in their bloodstream. Toxic levels of quinine are referred to as cinchonism. However, according to the official report of the 2nd Field Hospital of the Šumadija Division under the command of Dr. Stefan Nedok from August to November 1916, they administered 2090 intravenous injections and achieved magnificent results without a single negative side effect.[201] Another doctor and one of the first Serbian malariologists who also served on the Salonika front, Dr. Tomislav Jovanović, praised the efficacy of intravenous injections. In his report he said: "I can assert that many people were saved from certain death by intravenous injections. There were cases where individuals who had been in a comatose state for 24-48 hours instantly regained consciousness and recovered after an intravenous injection."[202] On contrary, if an

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[200] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 458.

[201] Djordje Protić, "Malarija na Solunskom frontu," in *History of Serbian Military Medicine; Our Wartime Medical Experience* (Belgrade: Zlatibor, 1925), 442–444.

[202] Ibid., 444.

intravenous injection with pure quinine was given to a conscious patient, in most cases they would immediately collapse. Dr. Ludwik Hirszfeld, who himself contracted malaria, described how he experimented on himself with a single high intravenous dose of 2.5 g of quinine: "As soon as the needle was in the vein, I felt a strange smell of camphor and then fainted."[203] However, Dr. Jovanovic was able to solve that problem by diluting quinine with distilled water or a saline solution. That way he also minimized the risks of dangerous side effects while maintaining almost the same levels of efficacy.[204]

On the other hand, intramuscular quinine injections were easier to administer in field conditions, as they did not require locating a vein or specialized equipment, such as fine needles for direct entry into the bloodstream. Hence, they could be administered by medical personnel with basic training. They were also more readily available because they were easier and cheaper to produce, as their manufacturing required less precision, sterility, and specialized equipment compared to intravenous injections. This made them quicker and more practical to manufacture and distribute.

With intramuscular injections, there was also much less risk of dangerous negative side effects, but they were also much more painful for the patient and would often cause an abscess to appear at the injection spot. One great advantage of this kind of injection over the intravenous one, unfortunately for the patients, was that intramuscular injections were more suitable for long-term malaria treatment. In contrast, due to their immediate powerful effect, intravenous injections were best used for emergency cases.[205]

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[203] Aleksandar Nedok, Branislav Popović, and Veljko Todorović, *Srpski vojni sanitet u Prvom svetskom ratu* (Belgrade: Medija Centar Odbrana, 2014), 297.

[204] Protić, "Malarija na Solunskom frontu," 444.

[205] Ibid.

During their first year of fighting malaria on the Salonika front, Serbian doctors, like their Allied colleagues, tried different quinine combinations and doses to achieve optimal results in treating their patients. By 1917, malaria therapy in the Serbian Army involved administering up to 2 grams of quinine to patients, mostly in pastille form and, though less commonly, through intramuscular injections. Injections were usually given during attacks or immediately before them, and afterwards, quinine was typically administered as pastilles at a dose of 1.50 grams daily, following various plans, for up to a month. Additionally, injections of cacodylate were also administered. The patient typically stayed in the hospital for about a month, after which they were either sent back to their units or to a convalescent camp in Africa or France.[206]

Quinine Experiments

This treatment was similar among all the Allied armies in Salonika and deemed effective, although there was room for improvement. At least, that is what Serbian doctor Ljubomir D. Stojanović (Stoyanovich)—one of the most respected Serbian doctors in Macedonia and an expert in malaria treatment—believed. In the second half of 1917, the Medical Corps of the Supreme Command of the Serbian Army assigned him as the head of the Department of Internal Medicine at the Reserve Hospital of Crown Prince Alexander, the first Serbian permanent hospital in Salonika. After the war, he contributed a chapter titled "Therapy of Malaria in the Serbian Army on the Macedonian Front" to Stanojević's book *History of Serbian Military Medicine,* where he thoroughly described the steps and experiments that led him and his team to develop their own malaria therapy.[207]

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[206] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 459.

[207] Ibid.

When he took the post at the hospital, the situation with malaria was urgent, as the majority of the hospital's patients were malaria cases. Therefore, Stojanović's first priority was to focus on their treatment.

Although Dr. Stojanović considered other possible medications that could potentially work better against malaria, the "good old quinine" again proved itself as the most effective weapon at the time against the vicious disease.[208] After reaffirming quinine's superiority, he focused on finding optimal ways to introduce it into the malarial organism in sufficient quantities without causing great discomfort for the patient.

As he described, the medical staff had been administering intramuscular quinine injections unsystematically, without any criteria or clear protocol. Additionally, the patients were reluctant to undergo intramuscular therapy due to its painful and lasting side effects. However, the main issue he encountered with intramuscular injections was that constant malaria relapses were common after the treatment. One of Stojanović's old malaria patients, besides the muscle stiffness he had from the injections, continued to have regular relapses for years after the war. Another patient of his, a Serbian Army major who received over 120 injections in various Allied hospitals, still experienced relapses every six months. A similar situation occurred with a medical officer who had been Stojanović's patient. He also experienced regular relapses and had a large abscess that contained a lot of quinine residue. All those factors led Dr. Stojanović to distrust the intramuscular injection method itself and to start looking for better treatment methods.[209]

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[208] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 460.

[209] Ibid., 459.

His first assumption was that quinine administered through the stomach—the old and well-proven method—would give the best results. Therefore, he began using it in various forms suitable for oral use, such as powder, pastilles, solution (liquid), and others.[210]

Macedonian malaria's resistance to quinine led the doctors in Salonika to suspect that it might be a chronic disease, like syphilis or dysentery. Consequently, they believed that its therapy should be aligned with the therapy for those diseases, at least in terms of dose and duration. According to his reports, Stojanović also agreed with this assumption and directed his research accordingly. He aimed to keep quinine constantly present in the patient's body. That way, when an attack occurred, quinine would already be there to target the schizonts and other less resistant forms of *Plasmodium*. Moreover, he believed that by consistent quinine treatment, he could eventually eliminate even the most resistant forms of *Plasmodium*. In essence, his goal was to treat malaria patients with quinine to achieve complete eradication of the parasite from their bodies, similar to the approach taken with syphilitic patients.[211]

As we can see already, Stojanović, like Ross, was clearly in favour of quinine therapy and believed, as Gutmann suggested, that it could be optimized to give better results. However, this probably required the use of higher doses of quinine. The problem was that quinine was suspected to be caustic and toxic. When administered in large doses and over extended periods, it could cause various adverse effects, including deafness, amaurosis, vomiting, diarrhea, hemorrhages (particularly hematuria), and other complications. To address these concerns, Stojanović decided to clinically test quinine's efficacy and evaluate patients 'tolerance to it. As he described, this required resolving four crucial questions:

1. What is the most suitable form of quinine and the method for its administration?

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[210] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 460.

[211] Ibid.

2. What is the maximum effective dose of quinine, both individual and daily?
3. How long can quinine be safely administered?
4. How much time is required to sterilize a malarial patient's body from *Plasmodium* with quinine?[212]

To get the answer to the first question, Stojanović relied on the fact that quinine is quickly eliminated from the body through urine, and its presence can be detected even in the smallest quantities using Tanret's reagent. This reagent, traditionally used to detect protein in urine, was repurposed by French and other Allied doctors on the Macedonian front—and likely elsewhere—to monitor whether soldiers were regularly taking quinine as a prophylactic measure against malaria.[213] Tanret's reagent precipitates protein and quinine in the form of a white sediment. The only difference is that the quinine sediment dissolves in alcohol, while the protein sediment does not. This fact led Dr. Stojanović to to explore the possibility of titrating the eliminated quinine in urine, he could roughly determine the rate of absorption, and the amount of quinine absorbed at a given moment, as well as the total amount of quinine that passed through the body, or rather through the bloodstream.[214]

Although the experiments revealed many uncertainties and raised numerous questions, the circumstances simply did not allow for comprehensive research to address them all. As Stojanović observed: "Unfortunately, I was not able to investigate everything or verify what others working on the same problem had achieved. After all, the goal was not to seek absolute truth but rather a relative one, which is often sufficient for clinical purposes."[215] He primarily

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[212] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 460.

[213] H. E. Archer, David Weitzman, and Hedy L. Kay, "Control of Quinidine Dosage," *British Heart Journal* 17, no. 4 (1955): 534.

[214] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 460–461.

[215] Ibid., 461.

aimed to understand why sometimes quinine, especially when taken for a long time and in large amounts, suddenly stops being excreted through urine for no apparent reason, only to reappear later. Additionally, he needed to determine which of the three common methods—oral, subcutaneous, or intramuscular—was the most suitable for administering quinine. For the oral method, he aimed to find out which form of quinine was the most effective: solution, powder, or pastilles.

Interestingly enough, although other Serbian doctors on the front praised the effectiveness of intravenous injections, Dr. Stojanović held a different opinion. After the initial experiments, he completely ruled out intravenous quinine injections as impractical. According to him, they were no better than other methods of quinine administration and were dangerous due to the risk of quinine shock, even when the quinine was highly diluted, and their administration technique was not simple. From a purely theoretical standpoint, intravenous injections would be ideal for treating malaria, as quinine was introduced directly into the bloodstream, where the *Plasmodium* parasites are located, ensuring quick and immediate action, and potentially stopping the attack at its onset. However, in practice, as Dr. Stojanović described, the quinine administered this way did not meet expectations for long-term treatment, and therefore, he focused on other forms of quinine injections, such as subcutaneous injections.[216]

The Serbian Army commonly used quinine packed in ampoules, which was concentrated and quite caustic.[217] To address this, Dr. Stojanović diluted it 10 to 20 times with a saline solution for subcutaneous injections. As for the quinine formulation, he used tartaric acid, which is less irritating to the stomach lining than the mineral acids that were commonly

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[216] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 461.

[217] An ampoule (also spelled ampul or ampule) is a small, sealed glass vial designed to store substances, typically liquids or solids.

used. To ease stomach reactions, particularly when administering liquid quinine, he gave his patients Vichy water alongside the medication.[218]

Once they had sorted out the most suitable forms of quinine, Dr. Stojanović and his team were ready to start with the experiments. They took five patients of approximately the same constitution and simultaneously administered equal amounts of quinine to them in the following ways: the first received 1 gram in liquid mixture, the second 1 gram intramuscularly, the third 1 gram in pastilles, the fourth 1 gram in powder, and the fifth received 1 gram subcutaneously diluted with a saline solution. Then they examined the urine using Tanret's reagent for all of them after 15, 30, and 45 minutes, and then every hour up to 48 hours. A white, cloudy precipitate indicated the presence of quinine in the urine. The examinations were conducted on equal quantities of urine at the same time, adding an equal number of drops of Tanret's reagent. In this way, by comparing the amount of precipitate, or the intensity of the reaction, they were able to determine the quantities of excreted quinine at given moments. They conducted these experiments with the aforementioned five methods of quinine administration and with quantities of 0.25, 0.50, and 1 gram of quinine.[219]

According to the results quinine appeared first in the urine when taken orally in liquid form. It remained present in the highest concentration in the blood for the entire duration and was eliminated the slowest through the urine. Among the other forms of quinine administration, subcutaneous injection with physiological solution came second, followed by pastilles, then powder, and lastly, intramuscular injection–confirming Stojanović's earlier suspicions.[220]

After the initial and somewhat satisfactory experiments, the next thing Dr. Stojanović and his team wanted to determine the process of absorption and elimination of quinine more

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[218] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 461.

[219] Ibid., 462.

[220] Ibid.

precisely through titration, which required measuring the excreted quinine. For this purpose, they again used Tanret's reagent, as they were able to determine how many drops of the reagent were needed to precipitate a certain amount of quinine. They achieved this by taking 10 test tubes, each containing 10 cm^3 of distilled water, and adding 1 cm^3 of a one-percent quinine solution to each test tube. Thus, each test tube contained 0.01 grams of quinine. Then, they added one drop of reagent to the first test tube, two drops to the second, three drops to the third, and so on, until the tenth test tube contained 10 drops of Tanret's reagent. After allowing the quinine to precipitate in all the tubes, they centrifuged them, added one more drop of reagent to each tube, centrifuged them again, and continued this process until they noticed that Tanret's reagent no longer caused any reaction (precipitation), which occurred after adding the 21st drop. From this, they calculated that to precipitate all the quinine from a solution containing 0.01 grams of quinine, 20 drops of Tanret's reagent were needed. This means that one drop precipitates 0.0005 grams of quinine.[221]

They conducted the same experiment in 10 other test tubes, in which they used the same quantities of pure urine instead of distilled water and added 0.01 grams of quinine. The results were exactly the same. In these experiments, the size of the Tanret's reagent drops was such that 20 drops equaled 1 cm^3 in volume.[222]

After precisely determining the process of absorption and elimination of quinine from the body, Dr. Stojanović's team aimed to test how different forms and doses of quinine affected the patients' bodies. They conducted this experiment with three groups of five patients of approximately the same constitution and age, administering 1 gram of quinine in various forms to the first group, 0.50 grams to the second group, and 0.25 grams to the third group. After 15,

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[221] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu,"462.

[222] Ibid., 463.

30, and 45 minutes, and then every hour up to 48 hours, they titrated the patients 'urine with the reagent. They took 10 cm³ of urine from each sample and added Tanret's reagent drop by drop, always centrifuging and adding more reagent until they precisely determined the number of drops needed to precipitate all the quinine from each urine sample. In this way, they accurately calculated the exact amounts of excreted quinine in 10 cm³ of urine at given moments (knowing that one drop of reagent precipitates 0.0005 grams of quinine), allowing them to observe how the absorption and elimination of quinine progressed.[223]

The results of these experiments fully confirmed the previously mentioned results, i.e., that quinine taken orally in liquid form is absorbed the fastest and eliminated the slowest, followed by subcutaneous injection with physiological solution. The same testing method also showed that of the total amount of quinine taken in solution, 50-60% was excreted through urine, while for pastilles, powder, and intramuscular injection, 40-50% was excreted.[224]

Results and Answers

Summarizing the results he and his team obtained from all the experiments, Dr. Stojanović pointed out several interesting facts that led him to the answers to the four questions he aimed to solve.

The main observation they made, which answered their first question regarding the best form of quinine, was that when quinine was introduced into the body in the same quantity but in different forms and by different methods, it behaved very differently in every aspect.

In terms of absorption, they noticed, quinine was absorbed the fastest and appears in the urine when administered subcutaneously or orally. Following in absorption speed were quinine

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[223] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 463.

[224] Ibid.

in powder and pastilles taken orally, and lastly, quinine administered intramuscularly. However, this difference is not significant, at most 20 minutes between the two extremes.

The saturation of the body, or more precisely the blood plasma, with quinine occurs gradually. However, the difference here is much greater: with the solution and subcutaneous injection, it occurs after two hours, while with intramuscular injection, it takes up to four hours; with powder and pastilles, it falls between these extremes. The level of saturation is also highest after the solution and subcutaneous injection, and lowest after the intramuscular injection and pastilles.[225]

The duration of saturation is also longest after the solution and subcutaneous injection, lasting approximately eight hours, and shortest after the powder and pastilles, lasting up to four hours. The experiments showed that elimination of quinine through urine also occurs gradually and in the same order, but much slower than absorption. With one gram of quinine, elimination lasts up to 50 hours and at the shortest 38 to 40 hours. Elimination takes the longest after administration via solution and intramuscular injection, and the shortest after taking pastilles.[226]

With the same dose of quinine, the most of it passes through the blood after the solution and subcutaneous injection, and the least after the intramuscular injection. Although they were not able to determine the exact amount, it seemed that after the subcutaneous injection and solution, almost all most quinine passed through the blood.[227]

Regarding the second question about the maximum effective dose of quinine, Dr. Stojanović concluded that the answer was 1 gram per dose and 3 grams per day. In exceptional circumstances, they would administer 2 grams per dose and 5 grams per day. However, this could only be done for a short period, as such high doses of quinine quickly led to intolerance

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[225] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 463.

[226] Ibid., 464.

[227] Ibid.

and further absorption. With 1 gram of quinine in liquid solution, they found that after 6 hours, the concentration in the blood plasma was approximately 1:25000. Experimentally confirmed, this concentration of quinine was sufficient to first immobilize *Plasmodium* and then gradually dissolve them.[228]

As for the duration of safe quinine administration, the third question, according to Dr. Stojanović, with a maximum dose of 3 grams per day, quinine treatment could be extended for six weeks without causing discomfort to the patient, provided it was administered orally. Subcutaneous injections were not suitable for such a long period due to the pain and other discomforts they caused to soldiers. After this period, if further quinine administration was necessary, the dose had to be reduced to allow the body to adapt and then be prepared again to receive higher doses. Therefore, in such cases, the dosages needed to be gradually reduced.[229]

When speaking of the fourth question—how much time is needed to fully sterilize the body with quinine—Dr. Stojanović described it as more challenging to provide a precise answer. There were several reasons for this, but the main was they were unable to observe their patients for an extended period. However, as he explained, "from the extensive experience we gained in the Salonika hospital, I believe that three months of strict quinine treatment is sufficient to sterilize the body in the vast majority of cases. Of course, this applies to chronic cases; for fresh cases, less time is sufficient."[230] Although he did not specify the exact dose, it is reasonable to assume that this refers to the aforementioned daily dose of up to 3 grams. It is also unclear from his writings whether this length of treatment was ever administered to Serbian soldiers after the war.

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[228] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 464.

[229] Ibid.

[230] Ibid.

The issue of quinine sterilization raised another question among the doctors on the Salonika front regarding how quinine affects *Plasmodium*. And, apparently, the opinions differed a lot. While some asserted that *Plasmodium* degenerated under the influence of quinine, others argue that the same degenerative changes occurred in *Plasmodium* after an attack even in individuals who had never taken quinine. A third group believed that quinine merely aided the body's natural defence process in creating antibodies, as quinine's effect on *Plasmodium* outside the body is entirely different. Nevertheless, Dr. Stojanović held a more pragmatic opinion. He focused on the fact that regardless of these differing opinions, the main fact was that quinine affected *Plasmodium*, as under its influence, malarial attacks subsided, along with many other conditions caused by *Plasmodium*. Furthermore, under the influence of quinine, the number of infected red blood cells decreased, and this was a well-established fact at the time.[231]

Contemporary perspectives align with the idea that quinine does not destroy *Plasmodium* but instead masks the symptoms of malaria, providing symptomatic relief without eradicating the parasite from the body. Essentially, this means that quinine suppresses the clinical manifestations of malaria but leaves patients vulnerable to relapses or reinfections. In retrospect, this view aligns closely with Treadgold's critical view, as he argued that quinine's effect was limited to alleviating symptoms while potentially prolonging the latent period and increasing the risk of multiple infections.

Another point of disagreement among the doctors and scientists in Salonika was whether quinine affected all forms of *Plasmodium* equally. The vast majority believed that quinine only affected the young *Plasmodium* forms and not the mature ones or the gametes. Therefore, according to them, quinine should be administered only during an attack or, if the timing of the attack was known, shortly before it. In case of gametes, they believed that the

[231] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 465.

treatment should stop until they rejuvenate and then treat them like the other forms. Based on their numerous experiments with quinine in various forms administered to patients experiencing attacks of different characteristics, Dr. Stojanović and his team concluded that quinine did not significantly alleviate the intensity or duration of an attack. On the contrary, often times, according to them, it seemed that quinine only worsened already severe symptoms. They applied this practice to malaria attacks of moderate intensity, while for severe cases, administering quinine was necessary. However, whenever possible, they would let the attack run its course, treating only the symptoms—mainly by administering medications to support and maintain heart function during the fever-induced stress—and later use the attack as a benchmark for quinine treatment.[232]

As for gametes, Dr. Stojanović and his team considered them to be transient forms and only temporarily resistant to quinine, therefore he believed that if they continued with the quinine treatment long enough and in sufficient doses, they could either destroy the gametes or at least help the body eliminate them and prevent their spread in the bloodstream. Therefore, their goal was to keep quinine constantly present in the blood, rather than introducing it only after the young *Plasmodium* forms have spread through the bloodstream, as they believed it would make the treatment more effective.[233]

The doctors in Salonika believed that if quinine treatment was prolonged enough to allow several cycles of gamete regeneration to occur in the presence of quinine, the number of gametes might decrease with each regeneration until they eventually disappeared entirely. It was a common opinion that gametes could be entirely eliminated from the body by the fourth regeneration cycle in the presence of quinine, which would take around 2 to 3 months. Although

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[232] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 465.

[233] Ibid.

the opinions differed regarding should quinine be given only during gametes regeneration or consistently, Stojanović's team adopted the latter approach.[234]

Dr. Stojanović often drew a clear analogy between the treatment approaches for malaria and syphilis. He found similarities between the two treatments and believed that some approaches to treating syphilis could be beneficial if applied to malaria treatment as well. Therefore, he treated his malaria patients similarly to how a syphilologist treated their syphilis patients. He first needed to witness a malaria attack, just as a syphilologist needs to see an ulcer. If that was not possible, he requested a microscopic examination, similar to how a syphilologist required a Wassermann test before starting treatment. His goal was to sterilize the body from the disease, just as with syphilis patients, without waiting for new signs of infection to appear. "We all know what antisyphilitic sterilization of the body means. I think antimalarial sterilization should be understood in the same way, except that it is much milder in every respect."[235]

Dr. Stojanović's deemed experiments successful, as he and his team were able to acquire information they needed to maximize quinine efficacy in malaria therapy for the Serbian Army. The most valuable findings they obtained from the experiments were regarding quinine's most effective form, dosage, and the total time needed to complete the therapy. They determined that quinine is most effective when taken orally in liquid form, with a daily dose of 3 grams, administered as 1 gram every eight hours. With this therapy, they predicted it would take at least 2-3 months to completely cure their patients of malaria.[236]

It is also noteworthy that, according to Dr. Stojanović, throughout all the experiments and tests, there were no severe cases of quinine intolerance or idiosyncrasy that would prevent

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[234] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 466.

[235] Ibid.

[236] Ibid.

further use of the medicine.[237] This observation is somewhat surprising, given the high doses of quinine used, which might have been expected to cause more frequent adverse reactions. Nevertheless, the only negative side effects they encountered were gastrointestinal, which they successfully treated with Vichy water. Rare cases of mild idiosyncrasy to quinine were treated with small doses of quinine, calcium chloride, and ergotine. In his opinion, there were no contraindications regarding quinine, and the medicine was successfully used for treating all kinds of malaria cases.[238]

The Therapy

Once Dr. Stojanović had all the necessary information about quinine and its effect on the disease, he created what we can describe as standard operating procedures that he and his team successfully applied to any kind of malaria infection, regardless of its severity. His quinine therapy, involving 1 gram administered three times a day, appeared to be effective in most cases and was reportedly adjusted on a case-by-case basis for particularly challenging instances.

One of the main rules they imposed was that quinine was never given to the patient during the febrile attack. However, they made exceptions to this rule for malaria patients:

- whose attack had lasted several days and threatened to continue or lead to fatal outcome;
- with severe complications;
- with a high number of *Plasmodium* in their blood;
- with pernicious attacks, except those with an algid character.[239]

The therapy for these patients was adjusted and they received quinine even during the attack, usually in the form of subcutaneous injections, typically twice, sometimes three times a day,

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[237] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 466.

[238] Ibid.

[239] Ibid., 467.

with doses ranging from 1.20 to 1.50 grams per dose, until the attack ended. In these situations, the patient's heart was at greater risk, therefore the doctors would also give the patient 1-2 grams of adrenalin along with quinine to help the heart endure the attack.[240]

Although dangerous, the attacks were crucial for the doctors to determine the severity of the situation and the appropriate therapy. As we already know, malaria in Macedonia was difficult to detect. Therefore, Dr. Stojanović emphasized the importance of either directly witnessing the attack or relying on laboratory results for an accurate diagnosis before beginning quinine therapy. In that regard, his approach to malaria aligned with the methods doctors used for managing syphilis diagnosis and treatment at the time.[241]

Once malaria was precisely diagnosed and confirmed the quinine therapy could begin. For the vast majority of cases, treatment typically began with a daily dose of 3 grams. As mentioned, the quinine was in liquid solution with 1:30 tartaric acid and was administered exclusively by designated medical officers to prevent any deceit by the patients, similarly to anti-malaria brigades in the British Army. Quinine was given 1 gram per dose every 8 hours, usually after meals, to ensure better tolerance. In cases of gastrointestinal intolerance, patients were given 200 grams of Vichy water along with quinine. In case of relapse attack of same intensity during quinine treatment, they usually increased the dose to 4, and rarely up to 5 grams per day, for no more than 1 or 2 days, before returning to 3 grams. If the attack persisted, they, in most cases, paused the quinine treatment until the attack ended. However, even in cases like that Stojanović was optimistic and confident. "Mild or altered attacks during quinine treatment only encouraged us to continue, as they indicated that the quinine was affecting even gametes, the mature forms of *Plasmodium*."[242]

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[240] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 467.

[241] Ibid.

[242] Ibid.

Quinine treatment with a daily dose of 3 grams usually lasted for four, sometimes six weeks. If no attacks occurred during this period, the dose was then reduced to 2 grams per day, taken as one gram in the morning and one in the evening. This was the second stage of the therapy and it lasted for another month. If no attacks occurred during this second period, the dose was further reduced to 1 gram per day. In addition to quinine during this month, patients also received Decoctum Corticis Chinae to drink and cacodylate injections.[243]

We should note that during the whole treatment process the patients were taken care of. The meals were good and regular as well as the hygiene.[244] Also, the hospital imposed strict anti-mosquito measures to reduce the risks of malaria reinfection. Therefore, the premises with malaria patients were well protected with mosquito nets.[245]

At the end of their treatment, the soldiers were given cold showers to test if they would trigger a relapse attack. If the attack did not occur, the patients were considered recovered and sent to convalescent camps in France or Northern Africa to continue their recovery or complete their treatment, particularly for complications. All the recovered patients were instructed that in the event of a relapse, even a mild attack, or the appearance of any suspicious signs of malaria, to immediately begin quinine treatment again. On the other hand, if the cold shower did cause a relapse, the patients were subjected to another quinine or combined therapy, usually with the addition of another medicine, such as novarsenobenzol.[246]

These were the standard procedures that, based on the results of numerous tests and experiments, Dr. Stojanović applied for most of malaria cases in the Serbian Army. Of course, in special cases, such as liver infection or when the person was infected with some other disease

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[243] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 467.

[244] Ibid., 468.

[245] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 296.

[246] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 468.

as well, the therapy was adjusted ad hoc. The only exception was in cases of malaria and amoebic dysentery, as quinine was very lethal to amoebas.[247]

When discussing the results of the therapy, Dr. Stojanović acknowledged that his conclusions were based on personal observations and experiences. He described the therapy as successful and highlighted the two key outcomes to support this assessment.

His first observation was that the majority of patients in his department at the Serbian hospital in Salonika did not experience malaria attacks, unlike patients in other departments where his therapy was either not adopted or improperly applied. Even when an attack did recur, he noted that its severity and intensity had diminished significantly compared to the initial episode and continued to decrease until it eventually disappeared. Regarding the recurrence of the disease after treatment, Stojanović reported, based on patient feedback, that even after three months, significant symptoms had not reappeared.[248]

His second observation, which he described as the greatest success of his therapy, was that there were no fatal cases of malaria in his department at the Salonika hospital.[249] This statement seems plausible, as we know from the previous chapter that in 1918 the morbidity rate among Serbian troops was just 0.3%, corresponding to 45 malaria-related deaths.[250] Therefore, although we cannot claim with certainty the exact extent of Stojanović's contribution to this decline, the low number of deaths still highlights the potential impact of his team's efforts in enhancing understanding of the disease and the uses and limitations of quinine, lending credibility to his claim about the success of his therapy in his department.

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[247] Stojanović, "Terapija malarije u srpskoj vojsci na makedonskom ratištu," 468.

[248] Ibid.

[249] Ibid., 469.

[250] Protić, "Malarija na Solunskom frontu," 451–452.

Another way to assess the efficacy of Stojanović's therapy is by comparing it to the doses used by British doctors. According to Ross, doctors at the Connaught Hospital in Aldershot successfully prevented malaria relapses with a relapse rate of just 10.2%.[251] The British approach typically involved administering daily doses of 30–40 grains (approximately 2–2.5 grams of quinine) over a 4-week period to treat relapses from Macedonian malaria.[252] However, Alexander Goodall, a British doctor who treated malaria cases in Macedonia, prescribed slightly higher doses of 45–60 grains (approximately 2.9–3.9 grams) of quinine per day, administered orally. [253] In comparison, Stojanović's therapy used a similar daily dose of 3 grams (46 grains) but over an extended period of 4–6 weeks. Given the British success with both lower or comparable doses, it is plausible to infer that the dose and duration of Stojanović's therapy would have been effective in preventing relapses. While direct comparative data from Stojanović's patients is unavailable, this parallel suggests that his regimen offered a promising approach to combating malaria relapses.

Modern Serbian historiography largely recognizes Stojanović's contributions, particularly his therapy—consisting of a 3-gram daily dose of liquid quinine taken orally over 4 to 6 weeks—as the primary malaria treatment. However, contemporary medical experts have expressed concerns regarding certain aspects of Stojanović's approach, particularly his stance that quinine should never be administered during a febrile attack except in extreme situations.[254]

This stance remains debatable from multiple perspectives, although it raises questions about whether the administration of quinine during an attack may have intensified the severity of malaria episodes, even in its most severe forms. Serbian contemporary medical experts, such

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[251] Fantini, "Malaria and the First World War," 263.

[252] Harrison, *The Medical War,* 231.

[253] Goodall, "Malaria in Macedonia," 163.

[254] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 298–299.

as Mikić, Popović, Čekanac, Djuričić, Zeljković, and Vidanović, argue that delaying treatment for mild and moderately severe forms of malaria was unjustified, and suggest that the issue of exacerbating attacks, even in severe cases, should have been mitigated with supportive therapy. Moreover, modern research explains the exacerbation of malaria attacks during quinine treatment as a result of increased release of pro-inflammatory mediators from cells stimulated by the breakdown products of malaria parasites destroyed by quinine.[255]

Despite these concerns, Stojanović's therapy was endorsed by all Serbian doctors on the frontlines, first adopted at the Reserve Hospital of Crown Prince Alexander and later standardized across the Serbian military.[256]

[255] Dragan Mikić et al., "Communicable Diseases and Their Prevention and Treatment Effected by the Serbian Army Medical Corps on the Salonika Front in 1917–1918," *Vojnosanitetski pregled* 65, Supplement (2008): 64.

[256] Nedok, Popović, and Todorović, *Srpski vojni sanitet u Prvom svetskom ratu,* 298–299.

Conclusion

As in many wars and battles throughout history, the Macedonian front was another theatre where malaria severely impacted military operations. The region's environment, with its ideal mosquito habitats and an abundance of malaria-transmitting Anopheles species, reinforced by the arrival of additional malaria-carrying species, created perfect conditions for the disease to devastate troops on all sides. Despite the hardships, the Salonika front stands out in history as a remarkable example of Allied cooperation in the fight against a common, invisible enemy.

After a thorough analysis of the available data, we have reached the stage to present the final thoughts and conclusions. Given that this thesis focuses on the efforts of the Serbian Army Medical Corps to combat malaria on the Salonika front, we should begin by discussing the key conclusions drawn from the first chapter, which examined the state of the Medical Corps prior to and during the war.

As we already know, during the pre-war and early stages of the First World War, the Medical Corps was severely understaffed, poorly organized, and focused mainly on surgery. However, following the retreat after the combined Austrian-German-Bulgarian offensive, the Serbian Army underwent a comprehensive recovery and reorganization with the support of the Allies, particularly the French. This included significant improvements to its medical services as well. The Medical Corps benefited from changes in leadership, resupply efforts, and collaboration with Allied medical teams, as British and French armies in Salonika assisted with the patient care, allowing Serbian doctors to focus on frontline duties.

One of the most significant outcomes of the Medical Corps reorganization was the broader recognition of the importance of other branches of medicine, especially epidemiology. The catastrophic spotted typhus epidemic during the early stages of the war clearly

demonstrated the urgent need for effective disease prevention and control, highlighting the critical role of infectious disease management for maintaining troop readiness. As a result, the Medical Corps began placing greater emphasis on addressing infectious diseases, significantly enhancing its capacity to combat epidemics like malaria.

The most notable change, however, was the improved status of medical officers within the Army. Their tireless efforts during the early stages of the war were finally acknowledged, granting them greater authority and a formal role in planning military operations. This shift not only improved their ability to address diseases but also highlighted their indispensable contributions to the war effort.

This leads us to the question of the role the Salonika front and malaria played in shaping the reorganization of the Serbian Army's medical services. To answer this, it is crucial to distinguish between their respective influences, as the main driving force behind the reorganization was not malaria itself but rather the fact that the Serbian Medical Corps, following the retreat, was essentially nonexistent. Therefore, Salonika front played a crucial role in the reorganization by bringing the Serbian Army into close collaboration with the British and French armies, whose support and expertise were integral to rebuilding the Medical Corps.

Malaria, while not the main catalyst for the reorganization, became the first significant test for the revitalized medical service. This naturally leads to the question of how the Serbian Army Medical Corps performed in this critical test. The answer to this question also provides insights into the key research questions, namely: How did malaria impact the Serbian Army on the Salonika front? What antimalarial strategies were employed, and how effective were they? And what was the Serbian Army's approach to malaria treatment?

As for the malaria's impact on the troops in Macedonia, it had a devastating and uniform effect on all armies stationed in the area, bringing military operations to a near standstill for two years. Malaria essentially transformed the Macedonian front into a "medical front," as the

primary focus shifted from combat to controlling the disease and minimizing its toll on troop readiness. With the successful control of malaria, along with the deteriorating internal situation within the Bulgarian, German, and Austro-Hungarian forces, the Allies, including the Serbian Army, were able to engage in more effective military campaigns in the region in 1918.

Speaking of malaria's impact on Serbian forces in Salonika, it should be emphasized that not all divisions experienced its impact equally. Within the Serbian Army, the Šumadija and Timok Divisions of the Second Serbian Army were particularly impacted, whereas the divisions of the First and Third Serbian Armies were comparatively less affected. An analysis of the factors behind this discrepancy reveals that the primary distinction lay in their deployment locations.

During their march to the frontline positions, the Šumadija and Timok Divisions were temporarily stationed near Topchin (nowadays Gefyra), where the transition camps were located, before proceeding to their final destination—the Moglena Valley. Both Topchin and Moglena Valley were lowland regions and traditionally considered highly malarial, making an epidemic inevitable. In contrast, the rest of the Serbian troops were stationed in areas less conducive to the spread of malaria, significantly reducing their exposure to the disease.

The complications with choosing the camp locations faced by the Serbian Medical Corps highlight the importance of effective coordination between military leadership and medical services. Although the Army and Medical Corps underwent significant structural reorganization prior to arriving in Salonika, this decision likely reflects the lingering attitudes of some commanders who were accustomed to prioritizing immediate operational goals over long-term health considerations.

A positive example of a more balanced approach was the Egyptian Expeditionary Force in Palestine, where General Edmund Allenby effectively combined medical recommendations with strategic decisions, allowing the British forces to implement disease prevention measures

more effectively. This integrated approach minimized the impact of malaria and maintained troop readiness, emphasizing the importance of aligning military planning with medical expertise.

The decision to locate the transition camps in the Topchin area was widely criticized by medical officers at the time, as it was regarded as a starting point for mass infection. Yet, the real question in Macedonia was whether it was always possible to avoid malaria. Modern Serbian experts on the subject continue to agree with the premise that these camps were the origin of the epidemic and a strategic mistake. However, they are cautious in asserting that avoiding the area would have entirely prevented the outbreak on the Moglena Valley frontlines, as that region was equally malarial. Therefore, even though it is reasonable to assume that the intensity of the epidemic among the Šumadija and Timok Divisions might have been lower had they avoided Topchin, it is highly unlikely that mass malaria infections in Moglena could have been entirely avoided.

The discussion on the possibility of preventing mass infection in Macedonia brings us to the second research question regarding antimalarial measures. To address this question effectively, it is important to first examine the broader medical debate of the time, as it significantly influenced antimalarial efforts on the Salonika front. In 1897, British medical doctor Ronald Ross identified *Anopheles* mosquitoes as the vector transmitting the malaria parasite to humans, a groundbreaking discovery for which he received the Nobel Prize for Physiology or Medicine in 1902. This revelation opened up the possibility of preventing malaria by targeting mosquitoes, challenging the traditional reliance on quinine prophylaxis. However, it also sparked a heated debate within the medical community. While one faction supported Ross's approach of mosquito destruction, others continued to favour quinine as the primary method of combating malaria.

In Macedonia, initially all armies, including the Serbian Army, relied on quinine as the main prophylaxis against malaria. By 1918, however, Allied forces, particularly the British, had shifted their focus toward mosquito destruction and physical protection measures, such as netting, oiling, mosquito and larvae destruction, and swamp drainage, as these strategies were increasingly regarded as more effective than exclusive reliance on quinine. As for the Serbian Army, while it deployed some of these measures wherever possible, Serbian doctors continued to primarily rely on quinine prophylaxis.

When it comes to the results, reports from Protić and Todorović suggest that while quinine did contribute to a reduction in malaria cases, its efficacy was insufficient to be deemed fully effective, as the percentage of infected troops remained high enough to impair the Army's combat capabilities. This was a common issue across all armies in the region, as persistent high infection rates emphasized the limitations of quinine's prophylactic efficacy.

On the other hand, preventing malaria through mosquito destruction on the Macedonian front proved to be an extremely challenging task. The region's environment—characterized by abundant vegetation and extensive water bodies, which fostered a high density of mosquitoes—created ideal conditions for the disease to persist. Personal protection measures, such as individual and tent nets, were also deemed impractical, as ensuring stable supplies of these items was logistically challenging, and their proper deployment and maintenance proved difficult under field conditions. Additionally, the local population, serving as a primary reservoir of infection, further complicated efforts to control the disease effectively. These factors made it nearly impossible to fully implement mosquito destruction measures, limiting their overall impact.

The data suggest that anti-mosquito measures yielded better results than quinine prophylaxis, as even with regular quinine administration, mortality rates remained high. However, the importance of quinine should not be underestimated. Without its use, as evident

in the case of the XIII Infantry Regiment of the Timok Division in the summer of 1917, the number of malaria cases appeared to skyrocket, underscoring its critical role in mitigating the disease's impact. Another issue, as Harrison described, was that the improvements achieved through mosquito destruction in Macedonia came too late in the war and were too localized to have any significant impact on the epidemic.[257] Therefore, the only viable option was to move the troops to less malarial areas, typically in the highland regions, as British General Milnes did in May 1917.[258] Yet, relocating troops to areas less susceptible to malaria was not always feasible, making the combination of quinine prophylaxis and anti-mosquito measures, though imperfect, the optimal solution—one that all armies in Macedonia sought to implement.

Since malaria infections were inevitable across much of the Salonika front, the need for effective treatment became critical. Traditionally, quinine was the gold standard for treating malaria, but in Macedonia, it appeared less effective. This sparked debates within medical communities about its therapeutic efficacy, with many attributing its underperformance to the unique characteristics of "Macedonian malaria," a term used to describe the local strain of the disease and its unusual resilience to quinine.

Research revealed that the key to this resilience was superinfection, where patients were often infected with multiple malaria strains simultaneously. Macedonian malaria was typically a combination of *Plasmodium falciparum* (the most dangerous strain) and *Plasmodium vivax* (the most common strain worldwide but generally not fatal). This deadly *Plasmodium* cocktail made treatment significantly more challenging.

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[257] Mark Harrison, *The Medical War: British Military Medicine in the First World War* (Toronto: Oxford University Press, 2010), 239.

[258] Bernardino Fantini, "Malaria and the First World War," in *Die Medizin und Der Erste Weltkrieg,* Wolfgang U. Eckart and Christoph Gradmann (eds), Die Medizin und Der Erste Weltkrieg (Centaurus-Verlagsgesellschaft: Pfaffenweiler, 1996), 248.

Despite debates over quinine's therapeutic efficacy, there were still no viable substitutes. Consequently, doctors in Salonika had no choice but to adjust the dosage and duration of quinine therapy to improve its effectiveness. Dr. Ljubomir D. Stojanović, the head of the Department of Internal Medicine at the Serbian hospital in Salonika, and his team conducted a series of experiments to determine the optimal form and dosage of quinine. Their research indicated that the most effective regimen involved administering quinine in liquid solution at a daily dose of 3 grams, divided into 1-gram doses given every 8 hours for up to three months, with a gradual reduction in dosage. Although this dosage was higher than the standard doses used by other Allied armies, the Serbian Army found it effective and adopted it as the standard for treating its troops in Salonika.

The novelty this research introduces to the historiography of medical history of the First World War is based on the contextualization of the Serbian Army Medical Corps 'efforts to control and treat malaria within the broader framework of Allied antimalarial strategies. It also stands out from other contemporary works on the topic, which either provide analyses of specific aspects or offer overly general overviews of the Serbian experience with malaria. By providing a detailed and well-contextualized analysis, this study aims to bridge these gaps, highlighting the challenges and approaches that defined the Serbian Army's response to one of the most persistent health crises of both the Macedonian campaign and the First World War.

With that being said, the greatest challenge in writing this research was the limited availability of sources and information on the topic. Therefore, potential directions for further research would involve a thorough analysis of Serbian military archives in search of new, unpublished data, with particular focus on malaria treatment, as Stojanović's accounts raise intriguing questions and deserve closer examination.

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