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Health Cooperation in light of crises and sanctions in Developing Countries. (Case study in Syria)

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Abstract

The methods, mechanisms, and plans for international health cooperation are still vague. However, many studies have confirmed that political affairs have great impacts on health bodies and organizations. Accordingly, the current study focuses on a special case which is the 13-year Syrian crisis, under the semi-collapse of the health system, foreign sanctions, and the unprecedented high demand for public health services. Hence, the problem can be expressed by the following question: Has health cooperation contributed to achieving social results during the Syrian crisis period under the increasing demand for health services? On the other hand, the study aimed to illustrate the reality of health cooperation (global, macro, micro) in the Syrian government areas, which suffer from external sanctions. Moreover, it aims to study, analyze,

and predict the demand for health services in Syria (Latakia (using artificial intelligence models represented by the Facebook profit model and illustrating the social consequences of health cooperation in these areas. However, the descriptive analytical approach was used and artificial intelligence models were applied to analyze and predict data using Python. Accordingly, the study has an important set of results including: The economic sanctions imposed on the Syrian government during the current war have had a great impact on the economic situation in general, and the health sector in particular leading to a weak health system. Furthermore, the demand for health services in Latakia public hospitals increased significantly because of people displacement, in addition to high levels of poverty. Health cooperation in Syria has not resulted in effective social returns or to be able to encounter growing demand and minimize citizens' burdens. Finally, artificial intelligence models are highly efficient and credible in predicting health demand, which contributes to the development of plans and strategies.

Introduction

In today's rapidly changing healthcare landscape, collaboration has been represented as a key driver in health promotion. Healthcare systems around the world face common challenges, such as aging populations, high healthcare costs, the growing burden of chronic diseases, epidemics, wars…etc. It has become clear that a collaborative approach is necessary to address these issues effectively.

However, health has a dual nature as it is considered an end and a means for economic and social development at the same time. On the other hand, the accelerating increase of population worldwide and the high demand for health services accompanied by stable supply put the health sector at risk. However, there are constant endeavors and efforts made by countries to improve the health situation in many ways, the most important one is cooperation [1]. Many studies indicate that collaboration helps enhance health, the quality of shared information, and knowledge transfer, wherein there are varied measures for such collaboration and its consequences [2; 67]. Qualitatively speaking, collaboration in health leads to advanced and improved innovation, decision-making and relationships. Quantitatively, it helps minimize hospitalization and recovery time, symptom and psychological improvement, improved facilities, easy access to health services, and others [3]. The term health collaboration is defined as "a process in which services, relationships, and elements are interconnected in the health care process" [4].

Healthcare improvement includes not only specialists and providers but also patients. More precisely, this cooperation in making decisions and coordination is known as interpersonal

collaboration [5]. Health cooperation in a health facility is called only micro health cooperation which refers to the relationship between patients and health personnel and cadres in different specialties, and all other services and material providers. On the other hand, some researchers believe that professionals and specialists consider cooperation as a mechanism to improve healthcare because they can exchange opinions, ideas, and services, and this may expand to include funding and planning between various health bodies (hospitals, ministries, health insurance companies, health authorities, etc.) and get better information about patients [6]. This can be called "Macro Health Cooperation", which refers to the health cooperation between various governmental and non-governmental agencies inside the country, or it can be referred to as cooperation within the country's health system. However, the collaboration of all health actors in a country reflects the best way of integration between healthcare and cooperation, the relationship type, and the cooperation feasibility and consequences [7]. Although cooperation between all health bodies within the same country is beneficial, there are many constraints and obstacles in this field, including time, lack of knowledge, routine, corruption, and lack of trust [8]. In fact, the last kind of health cooperation can be referred to as "global health cooperation", which is external health cooperation with the local health system at various components. However, the Covid-19 crisis has illustrated the strengths and weaknesses of the global health system and international health cooperation by testing its resilience [9]. Global health cooperation can be divided into regional health cooperation and international health cooperation.

Over the past two decades, great attention has been paid to the concept of health cooperation in diverse fields. Thus, close cooperation can lead to good results and developed health and social effects, but it is worth noting that regular and repeated calls for more cooperation have not been accompanied by any detailed plans [10]. Many developed countries in Europe have been interested in health cooperation, and have endeavored to conclude several agreements to confront various health crises, as a result of the necessary need and the negative consequences of the Corona pandemic crisis [11]. Health systems seek to achieve varied goals and social returns, which are achieved by improving the population's health indicators well, and meeting the growing health needs for all, leading to the advancement of societies and living condition enhancement [12; 13].

By adopting the concepts of health cooperation, countries seek to achieve many goals, particularly improving access to high-quality health services. So, the achievement of this goal needs local and international health cooperation in many cases. Therefore, healthcare providers can exchange experiences, technologies, and resources to bridge the current gaps in the

healthcare infrastructure between countries around the world. Additionally, health cooperation helps do research and development through the exchange of knowledge and participation in research, which have positive effects on the Global Health system [10]. Health cooperation contributes effectively during the period of crises, disasters and wars, through effort coordination and the exchange of experiences and assistance, which raises the capacity and flexibility of health systems to respond to various crises [9]. However, the demand for health services is one of the most important indicators used by many countries because of its importance in determining the population's needs for health services, and its impact on determining the necessary supply of health services and ensuring it. On the other hand, the demand for healthcare and health services is more complicated than the demand for other goods because healthcare decisions are always puzzling and not easy [14].

The high increase in demand for health services during the crisis period has great impact on the health system response. In this context, studies discussed the effects of the sudden rise in health demand during the Corona pandemic period and the great pressure on hospitals accompanied by the collapse of health systems in some countries. Nevertheless, without global health cooperation (international and regional), health systems in countries, such as Italy, could not face the crisis, which was accompanied by catastrophic social consequences, wherein health cooperation contributed to minimizing [15]. Forecasting the demand for health services plays an important role in estimating the number of services provided to clients in the future. Thus, the more realistic the forecast, the more helpful for the management to provide appropriate financial appropriations that cover patients' needs in hospitals and health centers, in addition to developing plans and policies. On the other hand, the correct forecasting of future demand contributes to illustrate difficulties and challenges and developing strategies necessary for health cooperation in its different forms (micro, macro, regional, and international) [16].

Syria has suffered from an armed conflict for thirteen years leading to severe damage to healthcare infrastructure and affecting badly on the health system. However, this crisis is still affecting the country, reaching a culmination in one of the world's most complex emergencies with large-scale humanitarian needs.

However, the current crisis has directly affected health development indicators with the result that Syria has lost from 10 to 20 years of economic development in general and health development in particular. This was accompanied by the respread of many pandemics (typhoid, hepatitis A, measles, leishmaniasis, polio, tuberculosis, AIDS, and other psychological illnesses). The war in Syria has led to the establishment of sub-health systems in northwestern Syria (including Turkish-controlled areas in northern Syria), northeastern regions under the

Autonomous Administration of North and East Syria, and the remaining two-thirds of the country under the Syrian government control (Syria Public Health Network 2020). These health systems have evolved differently with different leadership and governance structures, differences in funding, and different priorities in providing health care [17]. Moreover, Syria has the highest number of internally displaced persons and refugees in other countries. During the war, at least half of the Syrian population, which was estimated 22 million, has been displaced, 6.7 million are internal refugees, women and children consisted of at least two-thirds of those displaced, and nearly 4.3 million were external refugees. Accordingly, the poverty percentage was 95% in Syria, according to the United Nations report for 2022. Therefore, the need for complex health cooperation has increased, which helps provide health services and reduce the war's social effects on the population, in light of a significant increase in demand for government health services and the high cost of private medical services resulting from inflation, making people unable to buy health and medical services from the private sector [18]. During 13 years of crisis and war, the Syrian health services sector has been significantly influenced. According to the data of the Syrian Ministry of Health at the end of 2022, up to 65% of hospitals have limited or no capacity. Additionally, more than 67% of health centers were damaged, and more than 72% of doctors and specialists in various fields traveled abroad [20; 21; 19].

Understanding the health issues of internally displaced people (IDPs) and the response of the health system, requires a deep understanding of their complex situation. IDPs are unevenly distributed in three key areas controlled by the various conflict parties, each one has developed its health system (UNHCR 2018). The Syrian health sector is unorganized and multi-dependent. In other words, some health facilities are affiliated with the Ministry of Health, others with the Ministry of Education and Scientific Research, and some others with governmental and non-governmental ministries, bodies, or organizations. However, international organizations, associations and bodies have been greatly active in the humanitarian and health field during the crisis. Meanwhile, with the spread of disorganization, the health system has become unstable and the spread of corruption makes achieving positive results of health cooperation difficult [22]. In many cases, the degree of global health response and cooperation has been acceptable during crises around the world (health, environmental, wars) that are accompanied by a high increase in demand for health services. Therefore, health cooperation in its various forms is an important option to face high demand and achieve good social returns, whereas political interventions, sanctions and international relations play a negative role in restricting this

cooperation, such as the Syrian war, the Iraqi war, and the suffering in North Korea and other countries whose policies are contradicted to Western trends.

Consequently, the current research aims to fill the scientific gap related to the limited studies about health cooperation and its social role in the increasing demand for health services during the crisis period in third-world countries that suffer from long wars and increasing economic sanctions. Despite the large number of studies about health cooperation during crises at the global level, there is an urgent need to study the reality of health cooperation and its social effects under the high demand during crises in third-world countries that suffer from economic and political sanctions. Hence, the study problem can be formulated in the following question: Did health cooperation contribute to achieving social results during the Syrian crisis in light of the increasing demand for health services?

Study Objectives

The study aims to:

1) Illustrate the reality of health cooperation (global, macro, micro) in the Syrian government areas, which suffer from external sanctions.

2) Study, analyze and predict the demand for health services in Syria (Latakia) using artificial intelligence models represented by the Facebook profit model.

3) Clarify the social consequences of health cooperation in the Syrian government areas, which suffer from external sanctions.

Study Significance

The importance of the study is based on two basic aspects. Theoretically, the study seeks to analyze a case that has not been adequately focused on by previous studies, which is the study of the health cooperation effects in countries that suffer from complex crises and several sanctions under the increasing demand for services and the high level of poverty. Practically, the study focuses on studying and analyzing the growing demand using artificial intelligence models and clarifying the social implications and effects of health cooperation. Hence, the current study is expected to contribute to supporting health cooperation and avoiding difficulties facing health cooperation in countries that suffer from crises, wars and external sanctions at the same time.

Study Hypotheses

The study adopted several hypotheses, which can be formulated as follows:

First hypothesis: Health cooperation has contributed to achieving high social returns in the light of the high demand for health services during the Syrian crisis.

Second hypothesis: The artificial intelligence model that is used to predict the demand for health services is very efficient and credible.

Study Methodology

The descriptive analytical approach was used. Furthermore, the data mining and collecting depended on different sources to design the table of demand for health services. The data was also analyzed using artificial intelligence models and the PYTHON program. Meanwhile, the study limits encompassed the Syrian government areas, since getting data is possible, in addition to the economic sanctions imposed by the United States, Europe and many other countries on the Syrian government which increased the health system burden and difficulties and significantly limited international health cooperation.

Study Model:

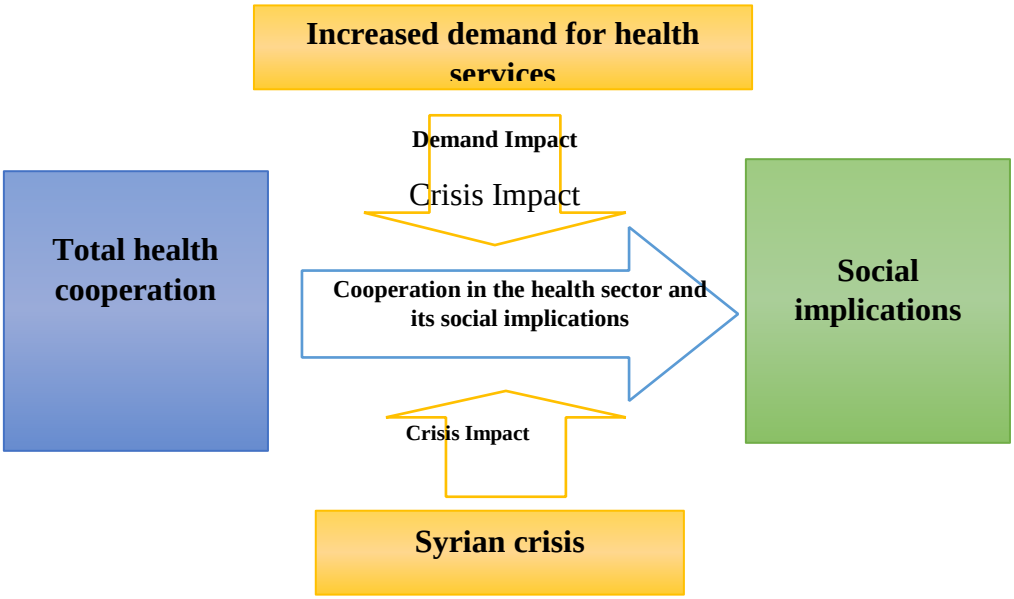


Figure 1 Study Model

Researchers' preparation

Source: own editing, 2024

Literature Review

Global cooperation in health matters is old, with more than 70 years of WHO activity. However, international health cooperation in developing countries and conflict zones has no substantive results, which is often affected by political relations. Cooperation in the health sector is constantly growing nowadays after the sequential challenges, particularly the Coronavirus pandemic. However, this cooperation may be national or international. Recently, cooperation between nations in healthcare has become very popular which includes the movement of experts, patients, and equipment between countries for mutual benefits. Nevertheless, many constraints resulted from the COVID-19 pandemic that badly affected international cooperation during several crises, including information scarcity, the collapse of some health systems, and difficulties in crossing the border [23]. Comprehensive health cooperation, which includes all forms and levels of health cooperation, can be expressed as follows:

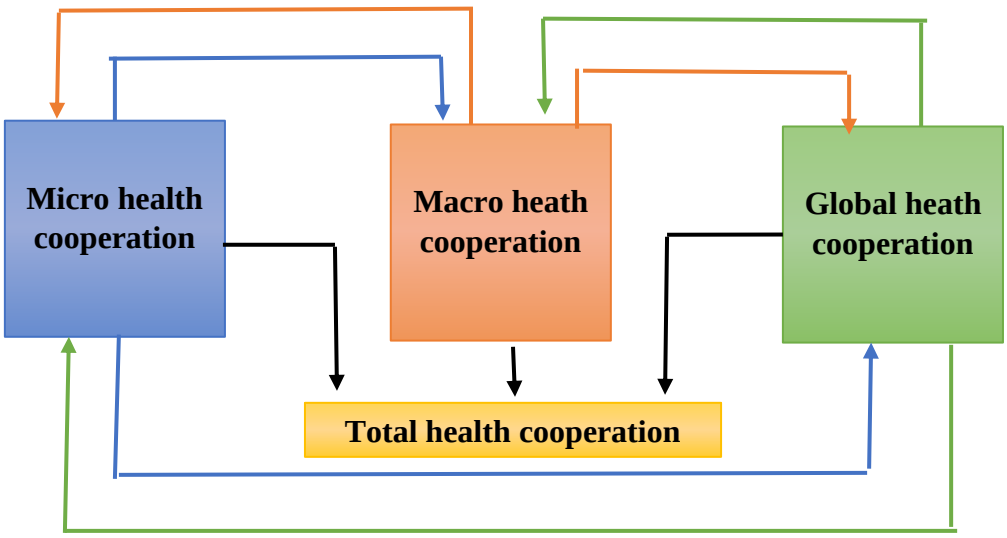


Figure 2: Comprehensive Health Collaboration Network

Researchers' preparation

Source: own editing, 2024

1. Micro health cooperation:

The first micro-network of health cooperation refers to the relationship in the health facility, which is the most important issue for patients. In this context, a great problem emerged during the period of disasters and wars, which is how to treat sick people during the period of natural or health disasters or wars. For example, during the period of the Corona pandemic, there were a lot of difficulties in planning and cooperation, and many hospitals stopped receiving other

cases that were not infected with the virus. So, health cooperation and its mechanisms during periods of crises, disasters and wars should be reconsidered [24]. On the other hand, transparency and equality are an important factor in health cooperation to be effective and efficient, since inequality and corruption have become a bad phenomenon spread in third world countries, which affect citizens' rights to equality and justice in getting health services, and hinder any partial health cooperation [25]. Working in a team significantly improves health cooperation and helps propose innovative solutions for complicated clinical issues, whereas the multidisciplinary team has more overlapping roles, communication and troubleshooting for the sake of patients, as well as achieving high social impact [26]. The COVID-19 crisis has had a significant impact on health cooperation in hospitals, as the interrelation between health authorities, patients and their families has been affected. Additionally, the increasing interest in Corona patients has influenced the ability to provide other health services by hospitals. Consequently, in crises, many constraints and difficulties interrupt cooperation [27].

On the other hand, some studies focused on the role of health cooperation within hospitals in improving health service quality. So, patients' satisfaction is an important indicator of the efficiency of health cooperation and is usually measured by various indicators, such as reliability and response strength [28].

Various crises affect the cooperation network in health facilities. More precisely, the difficulty of supply, high demand, low quality of services and the cancellation of many medical services are a great challenge for hospital management. In this context, a clear problem has emerged embodied in many unskilled and inexperienced hospital managers who are unable to face crises. Therefore, ways for health cooperation within hospitals must be studied and improved to develop future strategies to face various crises [29; 30].

Micro health cooperation plays an essential role in healthcare systems. However, there is no doubt that previous experiences during crises and wars indicated that many health systems around the world are weak in dealing with the sudden rise in demand for health services, and so hospital management's ability must be enhanced by activating the role of cooperation during the crisis.

2. Macro health cooperation:

Many studies emphasize the role and importance of local health cooperation in enhancing the provision of health services through interrelation and coordination between the various governmental and non-governmental components of the health system [31]. However, many studies have indicated the role of local health cooperation and its social importance, as

individuals' health is usually affected by many factors, such as education policies, economic and social conditions, health care, social insurance, work environment, living standards... etc. [32]. More precisely, the activities of national governments and the coordination with all non-governmental health and humanitarian authorities have a direct impact on the provision of appropriate health services both quantitively and qualitatively. So, cooperation or partnership between several sectors may be a good way for activity coordination to enhance and improve individuals' health [33]. National and local collaborations have been introduced between all entities to improve health outcomes. Although these experiences are important, the review did not identify any credible evidence that this cooperation improved health. However, evidence for the effectiveness of locally developed partnerships targeting changes in health outcomes and behaviors is needed [34]. Macro (local) health cooperation includes the relationship between different sectors, the coordination of joining local partnerships, the increasing possibility of getting healthcare, the enhancement of disease prevention, and health-enhanced procedures that involve a variety of stakeholders (health insurance, social services, health-related networks, supply chains, patient associations, educational and training bodies, hospitals, health workers, societal associations, patients and their families etc.). Accordingly, the local health cooperation network is very complex [35]. Local health cooperation has an important role in achieving social returns and reducing the burden on citizens, but organization and cooperation is necessary between all parties within the complex local health cooperation network. Thus, the disorganization and chaos make the experience unimportant and the desired benefits unachievable. Therefore, plans and strategies must be developed and roles must be organized to make effective health cooperation with good social results.

3. Global health cooperation:

International cooperation has been greatly focused on solving health problems and addressing various challenges interrupting the provision of health services in general, and during crises in particular [36]. Therefore, many international and regional partnerships were held in many fields for health improvement, including common and mutual work between healthcare and social services, wherein this cooperation could be mandatory or voluntary, according to national policy [38; 37]. Otherwise, different kinds of cooperation and coordination between many healthcare institutions and international and national bodies and organizations. Moreover, these organizations have international and national cooperation. These organizations usually provide organized cooperation between doctors, patients and governments in different countries [39]. The COVID-19 pandemic and the economic tension between the USA and China had a bad

impact on countries that require international cooperation and support. This cooperation may include vaccine distribution and the development of drugs. Accordingly, the results confirmed that international relations significantly affect global health cooperation [40].

However, health security is one of the basic human rights, so this issue has got great attention and concern embodied by cooperation between nations; and this cooperation is crystalized in developing and conflicted countries where this right is absent. Therefore, international health cooperation is embodied in efforts made to face the inequality caused by this pandemic [29]. This led to suspicion and mistrust in international organizations, including the World Health Organization [41]. The global health cooperation system has insufficient contribution to solving the COVID-19 crisis because conflicts and power-related interests of international relations have harmed the work of international organizations, leading to a decline in confidence in international organizations such as the World Health Organization. So, alternatives must be sought, as similar epidemics or crises may occur in the future. At the same time, international health cooperation was limited and inefficient in the Syrian government areas, wherein many countries took part in the sanctions imposed on the Syrian state by the United States.

4. Health services Demand:

Demand for health usually increases during crises, especially medical ones. Moreover, there are many economic determinants for the demand for healthcare services, including the health service cost and the patient's income. Therefore, the demand for health services is influenced by a set of economic and social factors that vary according to the country [42]. There are many factors affecting the demand for health services, which are determined by a set of factors that influence it positively or negatively. However, individuals' demand for health services is related to various other determinants, which are known as social determinants of health. In detail, they are a set of determinants and structural conditions of everyday lifestyle that is responsible for a major part of health disparities between countries and within the same country [43].

These determinants include income level, goods and services, people's living conditions such as the accessibility to health services and health insurance, schools and education, working and leisure conditions, housing, environment, age, number of family members, gender, treatment costs, price of medicines and marital status etc. [44]. The current crisis and war, in addition to the Covid-19 crisis, have a great impact on the increase in health demand for government hospitals. Moreover, there are other factors for this increase including low per capita income, and hyperinflation [45]. International cooperation was badly affected by the COVID-19 pandemic. However, international cooperation such as the European Union is being criticized

for not being able to act properly during the pandemic and meet the high demand for health, as health systems have fully collapsed in countries like Italy [46].

***5. Syrian crisis and economic sanctions*:**

Notably, Syria and the USA's political relations are interrupted by several difficulties. Throughout history, the United States has imposed more than 31 sanctions on Syria, the most influential one was after 2011. At the same time, the European Union, Canada, Japan and other countries imposed many political and economic sanctions represented by breaking off diplomatic relations, economic and financial sanctions on Syrian banks, ministries and companies …etc. Consequently, these sanctions have greatly affected the social aspect, as inflation rates have risen significantly, in addition to great difficulties in buying medical supplies and medicines, raising social effects. Furthermore, this has been accompanied by a minimized role of many international organizations and many countries' fear of providing medical assistance or dealing with the Syrian government during the period of the Corona pandemic or during the devastating earthquake that struck Syria [47; 48; 49; 50; 51; 52; 53; 54].

The practical side

Health Cooperation Under Increased Demand During the Syrian Crisis

Syria has suffered from a long war that extended from 2011 till now and included most of the Syrian governorates, but Latakia is one of the few governorates that was not significantly affected by the war. Accordingly, this led to a large displacement from many governorates to the Latakia governorate since it is safer than others. However, in 2010, Latakia's population was approximately one million (1,054,000) evenly distributed between the countryside and the city, while from 2013 to 2023 the number doubled four times. The governorate includes 26 hospitals, 9 public hospitals, and 17 private hospitals with a bed capacity of 2038 beds, 1670 beds are in public hospitals [55; 20].

Health demand for services in public hospitals

The data in the Syrian Statistical Collection and the data of the Latakia Health Directorate were mined, designed, and aggregated in a time series representing the demand for health services provided in Latakia public hospitals between 2000-2023, for analyzing and predicting them.

Table 1: Demand for public health services in Latakia from 2000 to 2023

Diet	Demand for health services
2000	1127893
2001	1173498
2002	1223489
2003	1273342
2004	1311314
2005	1352282
2006	1323434
2007	1429776
2008	1401838
2009	1449479
2010	1378795
2011	1343672
2012	1771912
2013	2011132
2014	2453345
2015	2234500
2016	2657125
2017	3150442
2018	3162412
2019	3457814
2020	4215102
2021	3846715
2022	3451545
2023	3461524

Source: own editing, 2024

According to the previous table (table 1.), a proportionate increase in demand for public health services between 2000-2011, and this increase began to rise significantly between 2012-2021, and then decreased slightly between 2021-2023.

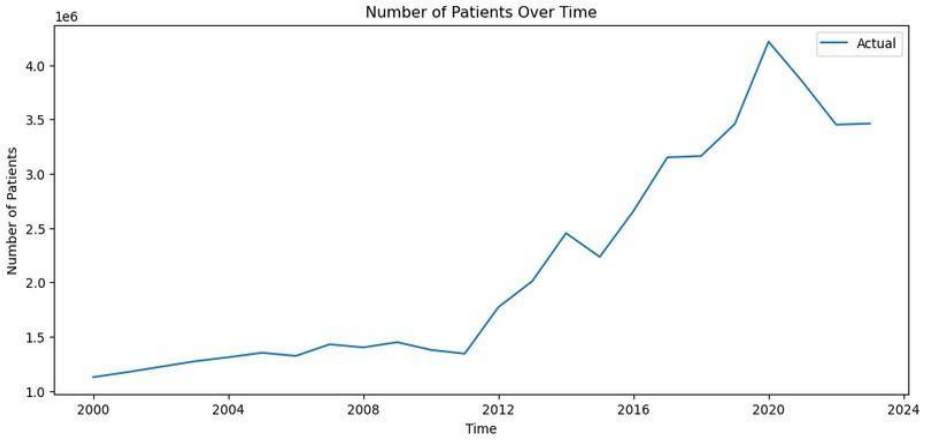


Figure 3: High health demand in Latakia.

The previous figure (Figure 3.) indicates a significant increase in health demand between the years 2000-2021, due to several reasons, the most important one is the increasing displacement from other governorates under military operations, particularly from Aleppo to Latakia, where the population quadrupled from 1,050,000 to 4,320,000 leading to a significant increase in the demand for hospitals. Additionally, this was accompanied by a high level of poverty, increasing the demand for public services more than the private sector. The increasing demand for health between 2019-2021 is due to the Corona pandemic crisis, whereas this demand decreased slightly in 2021-2023 due to the control of the COVID-19 pandemic, in addition to the return of some displaced people to their cities.

Actually, this great demand has increased the economic and social burden on the Syrian state, which suffers from sanctions and economic problems. Therefore, the need for health cooperation has become urgent, as the crisis and the high demand for public services have affected the state's ability to provide free treatment for all under this limited ability. This, in turn, increased the negative social effects and many diseases spread, where many patients, especially cancer patients, suffered from the lack of public and personal capabilities to provide chemical doses. Thus, the government resorted to pricing many services in public hospitals, rising citizens' burden who were unable to be treated outside those hospitals.

On the other hand, the consequences are several and great including a low number of experienced doctors who traveled abroad, the low quality of health services provided in public hospitals, the spread of corruption and nepotism, and the inability to access health services.

Accordingly, the role of health cooperation under high demand during the Syrian crisis and its social effects and consequences are as follows:

Micro health cooperation in Syria and Social impact

The high demand and the decreased number of health staff have significantly affected relation networks and cooperation in public hospitals, which have limited capacity and low financial capabilities, in addition to the difficulty of supply, high costs, the fuel crisis, and old medical equipment. Despite the efforts made by hospital management, the quality of services has declined significantly [56]. At the same time, the beneficiaries' satisfaction with the services has declined, with the result that medical errors increased due to lack of experience and good diagnosis, as well as corruption and nepotism in arranging and ordering patients' rights to medication, and the breakdown of devices and lack of maintenance. There has been no effective health cooperation in hospitals, despite many medical staff being kind to patients, but this empathy is insufficient to have healthy cooperation without proper planning and organization. On the other hand, the high health demand led to low-quality services, and the government gradually resorted to pricing many services, wherein the great pressure awakened the medical staff's response. Moreover, this led to low levels of reliability, tangibility, and safety as well, and what made the matter worse was the spread of the coronavirus pandemic and the isolation of large sections of hospitals, leading to a large number of individuals who were unable to be treated and hospitalized. Therefore, partial health cooperation was bad because of several factors mentioned above. With the growing future demand, things are expected to get worse, so appropriate plans and strategies must be developed to enhance the level of cooperation.

All previous factors have a negative impact on citizens' social affairs, generating a feeling of the inability to have public or private medication under current circumstances. Consequently, lots of people resort to pharmacies to buy medicines with no medical test. Thus, a new phenomenon has emerged which is the pharmacist who plays the role of a doctor by prescribing medicines and examining patients with neither experience nor specialization.

Macro health cooperation in Syria and Social impact

The Syrian health system is unorganized and has a lot of nepotism. During the crisis, health and humanitarian charities and associations have increased, which have been accused of corruption [57]. However, the results of macro health cooperation were no better than the partial one, the free treatment was limited and the level of poverty was high. All these made the health system have a limited ability to meet the high demand for services, and the state was unable to provide medication. Meanwhile, insurance companies tried to evade their obligations, and governmental services were unaffordable for people. Additionally, the associations' assistance was restricted to cover only a very small part of the citizens' needs [58]. In fact, the war has had

bad effects on the health system in Syria, having it restricted, in addition to the weak and inexperienced public health cadres in managing the crisis, with the absent role of the Ministry of Health and related unions. Furthermore, the rapid spread of corruption and exploitation made the situation worse, and this in turn led to the increase of social suffering and a significant decrease in social health indicators as well as the spread of diseases and epidemics again.

Global health cooperation in Syria and Social impact

As mentioned above, the United States, European countries and many other countries have imposed economic and political sanctions on the Syrian government, which affected the economic situation, and the relationship between the Syrian government and other countries, organizations and agencies around the world. Here, two cases can be distinguished:

- **Regional health cooperation:** The Syrian government has not received any kind of health cooperation from the regional and neighboring countries, except in 2023 when an earthquake hit the country, where countries such as Jordan, Iraq and the UAE offered limited aid for the government. Nevertheless, during the crisis period, only Iran provided some health cooperation through some of its health centers and hospitals in Syria which have limited capabilities.
- **International health cooperation:** The World Health Organization's work was limited and restricted in Syria, in addition to the inability of the Red Crescent Organization to provide health services or meet the health demand through its centers, except for a few numbers of individuals. At the same time, other organizations such as Doctors Without Borders or others were not active in Syria, and even Syria's allies such as China or Russia have no health cooperation with the Syrian government, except during the coronavirus pandemic period, they tend to provide limited quantities of vaccine.

In the same vein, the overstrung political relations affected the global health cooperation (regional, international) in Syria, as any significant change in the ability of the health system was not noticed, but the collapse was clear and growing day by day. Although health cooperation in asylum countries including Lebanon, Turkey, and Jordan was better, where many health organizations, agencies and projects supported by Western countries were active, the reality was different in the Syrian government areas.

Some social health indicators deteriorated during the period of the Syrian crisis, which indicates weak health cooperation (micro, macro, global) as shown in the following table:

Table 2: The Change of Social Health Indicators during the Syrian Crisis

Indicator	Life expectancy at birth in years		Under-five mortality rate for 1,000 live births		Under-five mortality rate for 1,000 live births		Population for each bed in the hospital		Tuberculosis		Polio	
Year	2010	2023	2010	2023	2010	2023	2010	2023	2010	2019	2010	2018
Number	72	58	17	462	151	1147	484	1939	0	1785	0	1487

Source: own editing, 2024

According to the previous table (table 2.), the following can be seen:

1. The hospital capacity decreased. Based on statistics from 2010, the inhabitants' number per bed was 484, while in 2023 the number became 1939.
2. A significant decrease in medical staff from 669 citizens per doctor in 2010 to 8,028 in 2023.
3. The under-five mortality rate rose from 17 per 10,000 live births to 462.
4. The under-five mortality rate rose from 17 per 10,000 live births to 462.
5. The respread of some epidemics in Syria after it was free of them, such as tuberculosis, cholera, polio, hepatitis ... etc.

In fact, the significant decline in health systems' social indicators is evidence of the inefficiency of the various forms of health cooperation during the 13-year Syrian crisis.
Accordingly, the first hypothesis, states that health cooperation has not contributed to achieving high social returns under the high demand for health services during the Syrian crisis. However, the results confirmed that health cooperation was weak in Syria during the crisis and the demand was high, which did not reduce the social burden on citizens.

Facebook prophet model

A lot of studies have been conducted on forecasting the demand and supply of health services using Artificial Intelligence (AI) models recently. However, studies confirmed the importance of multiple artificial intelligence models (ARIMA-LSTM-Fuzzy logic- Facebook prophet model) in forecasting, because of their impact on developing health strategies and plans and activating different types of health cooperation [56; 57; 58].The "**prophet**" model is an open-

source tool that predicts time series. This model can deal with short-term time series in addition to seasonal patterns and long-term trends. Furthermore, the "Prophet" model relies on an additional model that can accommodate nonlinear changes in data, making it suitable for practical applications such as weather forecasting, stock prices, and medical data. The model also provides tools for dealing with missing data and odd values, as well as its ability to provide accurate estimates even if data is limited [59].

Facebook Prophet operates in three main phases. First, the preprocessing phase consists of data cleaning and preparation. The tool automatically deals with missing values, oddities, and odd values. Therefore, users can focus on understanding the time series, rather than performing these tasks manually. Then, modeling takes into account trend and seasonality to estimate the components related to each time note. So, preprocessing data is necessary to minimize this impact. However, the Python library can provide accurate forecasts. In the healthcare sector, the tool can be used to predict time series of medical data. This includes, for example, hospital admissions, medical consultations and infection rates.

This model is expressed by the following equation [60]:

$$y(t) = g(t) + s(t) + h(t) + \varepsilon t$$

The model is expressed by the following flowchart (figure 4.): [61]

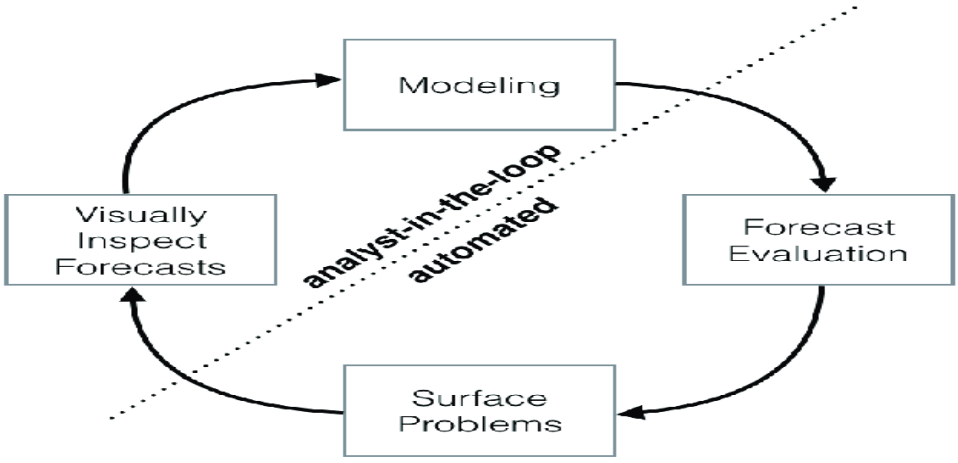


Figure 4: Prophet model implementation flowchart

Analysis of the model credibility and accuracy

The selected model must be highly credible and accurate by using many measures. Although there are several measures, only two measures were used in the study, which are:

1) MAPE Scale: Mean Average Percentage Error (MAPE) scale is used to assess model accuracy. MAPE is calculated by taking the differences' average absolute values between the actual values and the expected ones. More precisely, the average absolute percentage error measures the average error volume caused by a model, or the extent of expectation deviation from the average. Moreover, the MAPE value should not exceed 20%, so the lower it is, the more accurate and credible the model is. It is expressed by the following equation [62]:

$$\text{MAPE} = \frac{1}{n} \sum_{i=1}^{n} \left| \frac{Y_i - F_i}{Y_i} \right| \times 100$$

2) RMSE scale: RMSE stands for Root Mean Square Error. It is another commonly-used measure to evaluate the performance of the machine learning model, particularly in regression tasks. RMSE is derived from MSE and shares the same concept of measuring the average difference between expected and actual values. So, when the scale value is less than 1, this indicates that the model selection is credible and accurate and the training process is adequate [63].

$$\text{RMSE} = \sqrt{MSE}$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} \|y(i) - \hat{y}(i)\|^2}{N}},$$

To calculate RMSE, we calculate the residual (the difference between prediction and fact) for each data point, calculate the residual criterion for each data point, calculate the residual average and calculate the square root of that mean. RMSE is typically used in supervised learning applications, where RMSE is used and needs real measurements at each expected data point [14]:

After data entry for Python, the two measures' results were as follows:

Table 3: Facebook prophet's error metrics values

Error Metric	PROPHET
MAPE	4.67%
RMSI	0.870

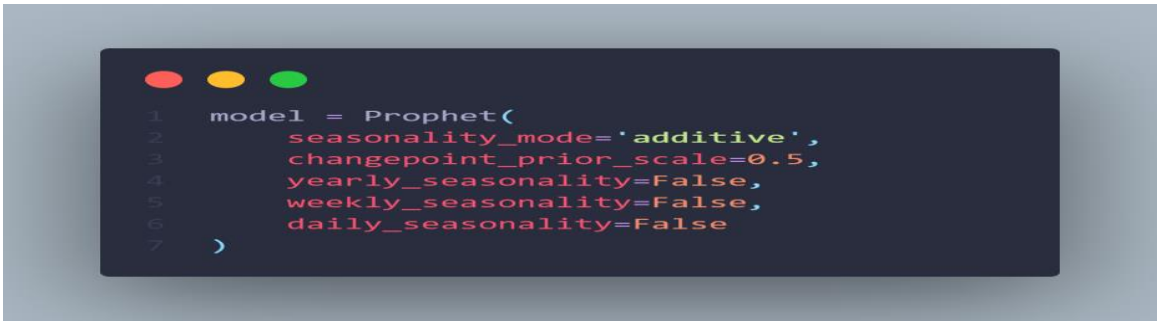
Source: own editing, 2024

Accordingly, it is clear that the chosen model was highly accurate and credible in predicting short time series because the values of the MAPE and RMSE scales were good.

Comparison between the actual data and the predicted one

After the model credibility was confirmed by artificial intelligence measures, the efficiency was also confirmed by comparing the known values and the predicted ones through predicting the data values of the health demand for the years (2020-2021-2022-2023) and comparing them with the predicted values to show the model's efficiency degree and the rates of data convergence.

All the data was taken with no division into training and testing data, because the time series is short and consists of only 23 years. In addition, the data contains no apparent seasonal pattern, and it takes a clear upward trend. However, these adjustments were applied to the basic model to get optimal results, as shown in the following programming code.



An additive seasonal pattern was used, where any seasonal trend was added by summation. Then all yearly, monthly and daily seasonal cases were disabled because the data does not contain any seasonal fluctuations. After that, the model sensitivity was increased to 0.5 to rise its sensitivity to sudden large changes.

The results of the model application were as follows (table 4.):

Table 4: Prophet Model Prediction Results

	Efficiency ratio %	Number of patients	Prophet predict		
			yhat	yhat_lower	yhat_upper
2020	83.31	4215102	3511986	3256286	3742996
2021	93.67	3846715	3603598	3348172	3869319
2022	96.91	3451545	3344960	3446492	3431475
2023	96.96	3461524	3356322	3516586	4035047

yhat: *expected value of patients' number by the Prophet model*

yhat_lower: *the minimum expected range (lower confidence interval).*

yhat_upper: *the maximum expected range (upper confidence interval).*

Source: own editing, 2024

The achieved efficiency rate was high in the first year, 2020, reaching to 83.31. Then, it began to rise in the three years up to 93%, reaching to 96.96% in the last year, which is a very high percentage indicating high efficiency of model application.

The Profit model is predicted as a domain between upper and bottom values.

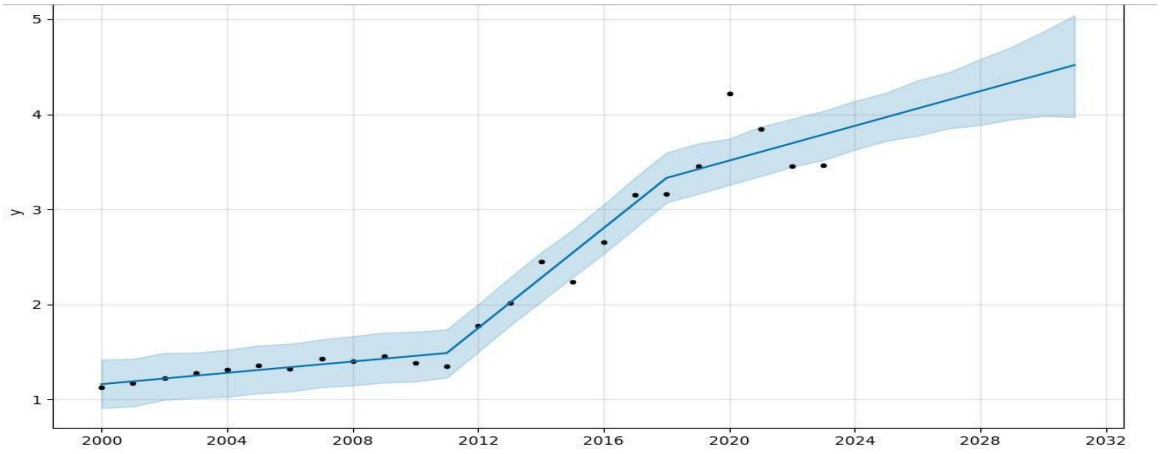


Figure 5: Original data, prediction domain, and predicted values using Prophet

Where the black dots refer to the real values, the shaded field is the expectation range between the maximum and minimum limit, and the blue line is the expected values (figure 5.).

Accordingly, the second hypothesis, which states: The artificial intelligence model applying in forecasting the demand for health services is highly efficient and credible, as the previous values proved that the selection of the artificial intelligence model (Prophet) was proper in predicting the demand for health services.

Predicting future health demand

After confirming the model's validity and credibility, the future health demand in Syria was predicted for five years, and the results were as follows (table 5.):

Table 5: Health Demand Forecasting to 2028

Year	Forecast		
	PROPHRT		
	yhat	yhat_lower	yhat_upper
2024	3969047	3719022	4226142
2025	4060409	3772919	4356063
2026	4151771	3851445	4442951
2027	4243133	3885677	4580722
2028	4334746	3945283	4709333

Source: own editing, 2024

According to the previous tables, the value of YHAT is the predicted values of the demand for health services, and the predicted demand between the years 2023-2028 increased by 20.15%. Therefore, it is necessary to plan well and develop appropriate strategies to meet the high demand for health services, as well as rely on the concepts and mechanisms of health cooperation in order to achieve appropriate health social indicators.

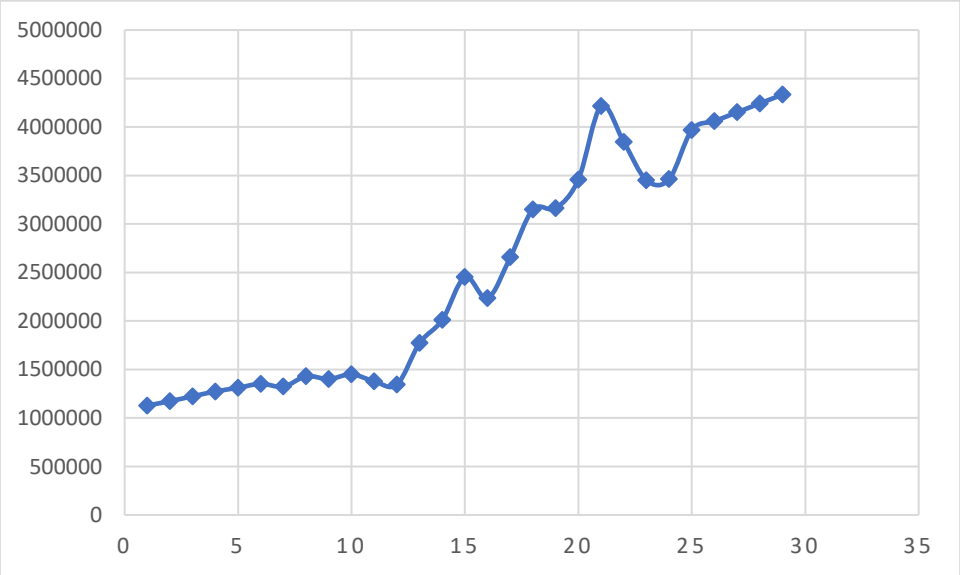


Figure 6: Forecasting future demand using Prophet

The demand for health services provided in public hospitals is expected to increase significantly (figure 6.). However, because of the permanent bad economic situation, there is an urgent need for effective international and national health cooperation, since the negative social effects are high and people are unable to afford medication cost.

Study Findings

After conducting data analysis and discussing the health situation in Syria, the study has the following results:

1) The economic sanctions imposed on the Syrian government during the current war have great impacts on the economic situation in general, and on the health sector in particular, which led to weak health system.

2) The demand for health services provided in Latakia public hospitals has significantly increased due to displacement, in addition to high rates of poverty.

3) Hospital managers are unexperienced and unskilled, accompanied with corruption and nepotism. So, this led to the lack of effective partial health cooperation.

4) The various parts of the Syrian health system are unorganized, accompanied with the country's weak capabilities, which has led to the absence of effective total health cooperation in Syria.

5) Global health cooperation (regional and international) was restricted and ineffective during the Syrian crisis, due to the American pressure on countries.

6) The Syrian crisis and the high demand for government health services led to negative social effects that were illustrated by a set of indicators, wherein different forms of health cooperation were unable to change the difficult social reality.

7) Artificial intelligence models are highly efficient and credible in forecasting health demand, which contributes to the development of future plans and strategies further.

Recommendations

1. Enhancing hospital managers' abilities and skills for optimal exploitation of resources and avoiding waste and nepotism, and the activation of the partial health cooperation network. So, this can be done through training.

2. Redesigning the Syrian health system, by organizing the work of all governmental and non-governmental agencies, and making consultations with external experts who are able of designing an effective holistic cooperation network that contributes to reducing corruption and providing accepted health services.

3. Focus should be done on resolving political disagreements and health needs, so it is necessary to make pressure on governments through health organizations and bodies.
4. Relying on the results of forecasting the demand for health services in developing future health plans and strategies.

Conclusion

Despite health cooperation is important and has positive results in many global situations, disasters and crises, until now the vision is still unclear in its final form since there is effective health cooperation worldwide. However, the matter went beyond since many researchers confirmed the need for alternative health systems to the World Health Organization that is subject to major powers' influence. In this context, the Syrian crisis and the earlies crises in many countries such as Iraq, the northern Korea and others demonstrated the negative political role in establishing effective and international health cooperation system. On the other hand, most countries suffering from crises have significantly increased the health demand for public services, resulting in the complete collapse of health systems. Therefore, it is necessary to focus on the role and importance of an effective model of international health cooperation, wherein the proposed model can be considered a stepping stone that needs to be developed since it concentrates on three main pillars of health cooperation. Finally, the efficiency and effectiveness of health systems are measured by the achieved social health indicators, as health systems that are unable to activate the concepts of health cooperation for various reasons will lead to negative health effects that can be minimized by applying health cooperation if implemented properly.

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