

Research Paper

The Relationship Between Health System Functions and the Prevalence of Down Syndrome on a Global Scale



Behzad Karami Matin¹ , Ali Kazemi-Karyani¹ , *Shahin Soltani¹ , Shahram Akbari¹ , Shiva Toloui Rakhshan¹ , Marzieh Mohammadi Moghadam²

1. Research Center for Environmental Determinants of Health (RCEDH), Health Institute, Kermanshah University of Medical Sciences, Kermanshah, Iran.
2. Sabzevar University of Medical Sciences, Sabzevar, Iran.



Citation Karami Matin B, Kazemi-Karyani A, Soltani Sh, Akbari Sh, Toloui Rakhshan Sh, Mohammadi Moghadam Sh. [The Relationship Between Health System Functions and the Prevalence of Down Syndrome on a Global Scale (Persian)]. *Archives of Rehabilitation*. 2022; 23(2):186-203. <https://doi.org/10.32598/RJ.23.2.1719.8>

<https://doi.org/10.32598/RJ.23.2.1719.8>



ABSTRACT

Objective Down syndrome or trisomy 21 is one of the most common human chromosomal disorders that affect cognitive functions, communication and behavioral skills. At the macro level, various factors can contribute to the Down syndrome prevalence and mortality. This study aimed to investigate the association of health system functions with Down syndrome prevalence and mortality worldwide.

Materials & Methods The study was a cross-sectional study conducted based on the secondary analysis of existing data in 2019. Data from 202 countries in six different regions (African Region [AFRO], Eastern Mediterranean Region [EMRO], European Region [EURO], South-East Asia Region [SEARO], Western Pacific Region [WPRO], and Pan American Health Organization [PAHO]) were included in the study. Data were extracted from the World Health Organization (WHO), the World Bank and the Institute for Health Metrics and Evaluation databases. The adjusted linear regression analysis was used to examine the association between health system-related factors with prevalence of, and death due to Down syndrome as the outcome variables. In the present study, two functions of health financing (domestic general government health expenditure [GGHE-D] per capita in PPP [purchasing power parity] int\$, domestic private health expenditure [PHE-D] per capita in PPP int\$, external health expenditure [EXT] per capita in PPP int\$) and health system resources (nurse and midwifery personnel, generalist medical practitioners [GMP], specialist medical practitioners [SMP], pharmacists, dentists, physiotherapists) were included in the study as independent variables. We used the Stata software version 14 to analyze

Results Africa and low-income countries had the highest deaths due to Down syndrome. On the other side, Europe and high-income countries had the highest prevalence of Down syndrome worldwide. According to the available data, Iran had a lower prevalence (29.31 vs 38.44 per 100,000 population) and higher deaths (0.34 vs 0.32 per 100,000 population) compared to high-income countries. The 20-year trend of prevalence of, and deaths due to Down syndrome in Iran has always been lower and higher than high-income countries, respectively. Linear regression analysis showed that GGHE-D per capita ($\beta=0.385$, $P<0.001$) and PHE-D per capita ($\beta=0.354$, $P=0.02$) could predict the prevalence of Down syndrome significantly in the study countries. On the other hand, nurse and midwifery personnel ($\beta=-0.607$, $P=0.014$) and number of SMP ($\beta=0.420$, $P=0.025$) were associated with increased deaths from Down syndrome in the included countries.

Conclusion Our findings showed GGHE-D and PHE-D are associated with a higher prevalence of Down syndrome in health systems. On the other hand, health system resources (nurses and SMP) were the main predictors of death due to Down syndrome in the included countries. International organizations and governments need to monitor and improve the equitable access of vulnerable groups to health services in low-income countries. Improving health insurance coverage and equitable distribution of health resources is suggested to reduce deaths due to Down syndrome in Iran.

Keywords Down syndrome, Prevalence, Mortality, Health system, Health financing

Received: 20 Aug 2021

Accepted: 19 Oct 2021

Available Online: 01 Jul 2022

* Corresponding Author:

Shahin Soltani, PhD.

Address: Research Center for Environmental Determinants of Health (RCEDH), Health Institute, Kermanshah University of Medical Sciences, Kermanshah, Iran.

Tel: +98 (83) 38281991

E-Mail: shahin.soltani@kums.ac.ir

English Version

D

Introduction

Down Syndrome (DS) or trisomy 21 is one of the most common human chromosomal disorders, described by an English physician, John Langdon Down, in 1866. DS is the first human chromosomal abnormality that was diagnosed due to the presence of an extra chromosome 21. This disorder is the most frequent genetic cause of mental retardation in living infants. DS causes spontaneous abortions and only 20 to 25% of infants will survive after birth [1].

According to the framework of the [World Health Organization \(WHO\)](#), health systems can affect the health status of communities via four functions, including financing, resource production, service delivery, and trusteeship. The function of financing refers to how financial resources are collected, accumulated, and allocated in the health system. This function is one of the main tasks of health systems that make it possible to achieve universal health coverage via financial protection and effective coverage of services. On the other hand, the function of providing resources refers to the production of inputs (human resources, physical resources, such as buildings and equipment, knowledge, etc.) by health systems, which includes different organizations and institutions [2].

Inequalities in health systems in the field of financing are one of the effective factors in the prevalence of contagious and non-contagious diseases in the world, and this issue leads to a significant gap in health outcomes [3, 4]. According to the importance of evidence in the health policy cycle and the role of financing mechanisms and providing resources to prevent and control non-contagious and contagious diseases, we only examined the impact of these functions on the prevalence of mortality caused by DS in this study. Therefore, this study was conducted to investigate the relationship between health system functions and the prevalence of DS and resulting mortality in countries around the world.

Materials and Methods

This cross-sectional study was conducted using secondary analysis of existing data. This study was performed based on the conceptual framework of the [WHO](#) regarding the main functions of health systems. In this context, the four functions of trusteeship, resource production, financing, and service delivery are recognized as the four main functions of health systems that can affect the health status of individuals in a society [5].

In this study, the effect of two functions of financing and resource production, as the inputs of a health system, on the prevalence of DS and resulting mortality in countries around the world was measured. For this purpose, a linear regression test was used to identify the most important determinants of DS prevalence and mortality in world health systems. In this study, the prevalence of DS (per 100,000 people) and its related mortality (per 100,000 people) were included as dependent variables in the model. Also, variables related to the health system were included in the regression model as explanatory variables.

Variables related to health financing (based on purchasing power parity [PPP]) included public health expenditures, private health expenditures, and per capita external health expenditures [6]. Government health expenditures are expenditures incurred by governments and government resources in the health system [7]. Private health expenditures include a portion of current health expenditures that are financed from domestic and foreign sources. Domestic private resources are resources that are funded by households, companies, and nonprofits.

Foreign health expenditures are financial resources that are spent from abroad and foreign aid in the health system. In addition, according to the available data, the variables related to resource production include the number of internal physicians and specialists, the number of physiotherapists, the number of nurses and midwives (per 1000 people), the number of dentists (per 10,000 people), and the number of pharmacists (per 10,000 people). In the present study, the latest data for 2019 were extracted from the databases of the World Bank, the [WHO](#), and the Institute for Health Metrics and Evaluation. Since the data of many countries were not available for some variables in 2019, the latest data available during the last five years (2019-2015) were used.

In this study, data from 202 countries were analyzed. The countries were divided into six geographical regions according to the [WHO](#): European Region (EURO), Pan American Health Organization (PAHO), African Region (AFRO), Eastern Mediterranean Region (EMRO), South-East Asia Region (SEARO), and the Western Pacific Region (WPRO). Accordingly, a total of 46 countries were in Africa, 38 countries were in America, 53 countries were in Europe, 23 countries were in the Eastern Mediterranean, 15 countries were in Southeast Asia, and 27 countries were in the western Pacific. This article is the result of a research project with the code 990902 and the ethics code IR.KUMS.REC.1399.890.

STATA software v. 14 was used to analyze the data and Excel software was used to draw the charts.

Results

In this study, based on available data, data from 202 countries were analyzed. The African region and low-income countries had the highest rate of mortality caused by DS, and the European region and high-income countries had the highest prevalence of DS. At the national level, Romania and Burkina Faso had the lowest (0.028 per 100,000 people) and the highest (1.263 per 100,000 people) mortality caused by DS, and also Taiwan and Brunei had the lowest (8.326 per 100,000 people) and the highest (97.003 per 100,000 people) prevalence of DS among the countries studied.

According to the available data, the prevalence of DS and its related mortality in Iran in 2019 were about 29.31 and 0.34 per 100,000 people, respectively, which is lower than in the Eastern Mediterranean region. Figures 1 and 2 show the 20-year trend of DS prevalence and mortality caused by it in Iran compared to high-income countries. The 20-year trend of DS in Iran compared to high-income countries from 2000 to 2019 has always been lower, and in contrast, the DS-related mortality rate compared to high-income countries has always been more during the studied years.

Table 1 shows the regression model of the most crucial predictors of DS prevalence in health systems. Per capita public health expenditures ($P < 0.001$, $\beta = 0.385$) and private health expenditures ($P = 0.021$, $\beta = 0.354$) are the most crucial predictors of DS prevalence in world health systems; thus, the increase in per capita public and private health expenditures increases the prevalence of DS directly and significantly.

Also, Table 2 shows the most crucial predictors of DS-related mortality in the world's health systems. In this model, two variables of nurse and midwife ratio ($P = 0.014$, $\beta = -0.607$) and the number of specialist physicians ($P = 0.025$, $\beta = -0.420$) were the strongest predictors of mortality caused by DS in the world health systems.

Discussion

This study was conducted to identify the most crucial predictors of DS prevalence and its related mortality in world health systems. The explanatory variables of this study were selected based on two vital functions of health systems, i.e. financing and resource production. These two functions as inputs of a health system play a vital role in predicting the health status of individuals in a society. The results of the one-way analysis of variance showed that the prevalence of DS in higher-income countries was significantly higher than in lower-income countries. On the other hand, the linear regression model showed that the two variables of per capita public and private health expenditures can directly and significantly predict the prevalence of DS in countries around the world. These results show that people with DS have a higher life expectancy and a higher chance of survival due to higher costs in the welfare and health sectors.

Families in low-income countries have less access to health services and are deprived of access to health care due to financial problems or lack of services [8, 9]. For example, Zahari et al indicated that the prevalence of congenital heart diseases in people with DS is similar in Malaysia and high-income countries, but the survival rate was lower in this country because of the delay in performing required medical surgeries due to limited human and physical resources [10]. In low-income countries, other



Figure 1. Twenty-year trend of down syndrome prevalence in Iran compared to high-income countries

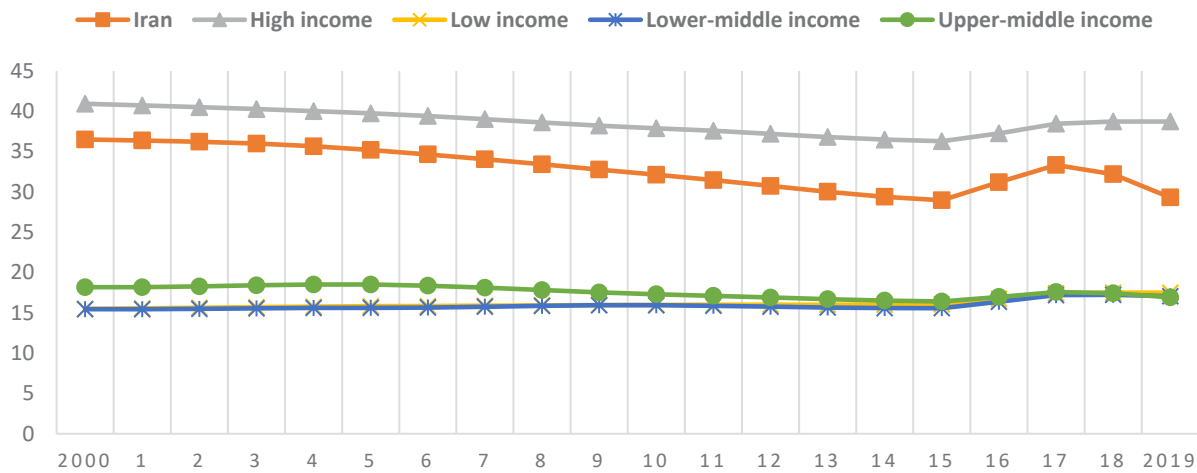


Figure 2. Twenty-year trend of mortality caused by down syndrome in Iran compared to high-income countries Archives of Rehabilitation

risk factors, such as the prevalence of contagious diseases, poor quality of life, malnutrition, and poor environmental and social conditions can play a role in reducing the survival of children with DS [11-14]. Public health problems, insufficient health services, and their unfair distribution have seriously challenged the universal health coverage in these countries [15-17]. On the other hand, people with DS in these countries by increasing age and exacerbating health issues have less chance to increase life expectancy [18]. People with DS need special health services and care to have a long and high-quality life and benefiting from this type of care is associated with several challenges in low-income countries.

The findings of this study showed that the ratio of nurses and midwives and the number of specialist physicians in countries can inversely and significantly predict the mortality rate caused by DS. This finding could indicate that in countries where the resources of the health system (such as human resources, physical resources, equipment, medical devices, etc.) are not sufficient for the population covered, the possibility of using services is limited. For example, Dekumbent showed that a severe shortage of human resources and medical equipment is observed in sub-Saharan Africa, with one neurologist for every three million people and one magnetic resonance imaging (MRI) machine for every 25 million people [15]. In another study conducted in the United States, the leading causes of death in people with DS were congenital heart defects, leuke-

Table 1. Regression model of the most crucial determinants of down syndrome prevalence in world health systems

Variables	Standard Coefficients (β)	Standard Error	P
Constant	-	4.522	0.001
Pharmacists	-0.387	0.533	0.470
General Practitioners	0.006	<0.001	0.951
Specialists	-0.075	<0.001	0.619
Dentists	0.227	0.578	0.121
Nurses and Midwives	-0.144	0.798	0.481
Physiotherapists	-0.002	<0.001	0.988
Per Capita Health Public Expenditures	0.385	0.002	<0.001*
Per Capita Health Private Expenditures	0.354	0.006	0.021*
Per Capita Health Foreign Expenditures	-0.027	0.072	0.776

*The coefficients are significant at the level of 0.05.

Table 2. Regression model of the most crucial predictors of down syndrome-related mortality in world health systems

Variables	Standard Coefficients (β)	Standard Error	P
Constant		0.063	0.001
Pharmacists	-0.068	0.011	0.726
General practitioners	-0.020	0.000	0.883
Specialists	-0.420	0.000	0.025*
Dentists	-0.225	0.010	0.153
Nurses and midwives	-0.607	0.014	0.014*
Physiotherapists	0.363	0.000	0.984
Per capita health public expenditures	0.439	0.000	0.067
Per capita health private expenditures	0.122	0.000	0.569
Per Capita Health Foreign Expenditures	-0.005	0.001	0.970

*The coefficients are significant at the level of 0.05.

Archives of
Rehabilitation

mia, respiratory diseases, congenital malformations, and vascular diseases, which are non-contagious and costly diseases in health systems and these types of diseases impose significant costs on families and health systems [19].

Providing sources in the health system is one of the main functions of health systems that can also play a role in increasing the survival of people with DS. In low-income countries, resource constraints are severely challenged due to income constraints. For example, in high-income countries, per capita health expenditures are estimated at an average of about \$ 3,100, while this figure is about \$ 37 in sub-Saharan Africa. In this area of Africa, the health budget of a country with ten million people is equivalent to a health center in developed countries that serves a population of 100,000 people [15].

According to the estimates of the Institute for Health Assessment, the prevalence of DS in Iran is lower compared to high-income countries; however, it has a higher mortality rate. The high mortality rate in Iran can indicate the lower quantity and quality of services in the Iranian health care system. Although Iran's situation in the field of health resources is better compared to some countries in the region, the access of people with DS to these services is limited due to poor financial resources and inadequate geographical, physical, and cultural access. The lack of appropriate price coverage in health insurance and different service packages in these insurances have caused the cost of specialized services, care, and rehabilitation for many families to be high and they are not able to pay these costs [20, 21].

In this regard, Taqadosi et al. in Kashan indicated that people with mental disabilities face various psychological, communication, and self-care problems, such as urinary and fecal incontinence, and many families are deprived of access to required services due to lack of family and financial and social support [22]. Other studies in Iran have shown that people with DS possibly suffer from oral diseases, obesity, psychological problems, nutritional disorders, skeletal abnormalities, congenital heart disease, communication problems, injuries, etc. compared to the general population [23-27].

Therefore, according to the need of people with DS for health services compared to the general population, these people should receive their health services in proportion to their need to have a high-quality life and increase the chance of survival in society. The Iranian health system should pay more attention to the special needs of vulnerable groups, such as people with DS, and provide them with fair access to health services. Increasing life expectancy and reducing DS-related mortality not only are achieved via the provision of health services but also requires the creation of different support systems in the welfare, social, and educational field and including various institutions and organizations.

Conclusion

The findings of the present study indicated that high-income countries (such as those in the European region) and low-income countries have the highest prevalence of DS and the highest mortality rate, respectively. Regression analysis showed that health financing in countries can directly and significantly predict the prevalence of DS in countries around the world. In contrast, two variables of nurses and midwives and the number of physicians specializing in a health system can inversely and significantly predict the mortality rate caused by DS. Iran had a lower prevalence and higher mortality rate compared to high-income countries. The 20-year trend of mortality caused by DS in Iran has been declining but is still higher than in high-income countries. International organizations and governments should monitor the equitable access of vulnerable groups to health services in low-income countries and put the necessary measures on their agenda to increase the quality of life of these people. Also, health policymakers in Iran can take action to increase life expectancy and reduce deaths caused by DS compared to high-income countries by improving health insurance coverage and equitable distribution of health resources and services.

Limitations

This study was conducted using the latest data available in databases until 2019. Since the data for this year was not available for some countries, it was decided to use data from previous years. Various factors may play a role in predicting the prevalence and mortality of DS, but in this study, only some influencing factors related to inputs of health systems were included in the analytical model based on the framework of the WHO and available data.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the ethics committee of [Kermanshah University of Medical Sciences \(KUMS\)](#) (IR.KUMS.REC.1399.890)

Funding

The present study was funded by the [Kermanshah University of Medical Sciences \(KUMS\)](#).

Authors' contributions

Conceptualization and supervision: Behzad KaramiMatin and Shahin Soltani; Methodology: Ali Kazemi-Karyani and Shahin Soltani; Investigation, writing-original draft, and writing-review & editing: All authors; Data collection: Marzieh Mohammadi Moghadam and Shiva Tolouei Rakhshan; Data analysis: Ali Kazemi-Karyani and Shahin Soltani; Funding acquisition and resources: Shahin Soltani and Behzad Karami Matin.

Conflict of interest

The authors declared no conflict of interest.