Journal of Statistics Applications & Probability
An International Journal

http://dx.doi.org/10.18576/jsap/120314

Variables Affecting the Mother's Access to Quality Care during Childbirth using the Neural Networks and Logistic Regression Models

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Received: 2 Feb. 2023, Revised: 12 Apr. 2023, Accepted: 12 May 2023.
Published online: 1 Sep. 2023.

Abstract: Quality pregnancy and birth care is crucial in reducing maternal and child mortality in Egypt, requiring both supply and demand interventions. Using data from the Egypt Demographic Health Survey 2014, a neural networks and logistic regression models were built to determine demographic, social, and economic determinants affecting mother's access to care during childbirth. The study found that mother's working status had a significant impact on access to care, with an inverse relationship. Logistic regression outperformed neural networks in analyzing the relationship between explanatory variables and mother's access to care during childbirth.

Keywords: Demographic Health Survey (DHS), Economic, Social, and demographic factors, Maternal health care during childbirth, Neural networks, Quality of care.

1 Introduction

Every day, 1,500 women lose their lives due to preventable pregnancy and childbirth complications [1]. In 2005, 536,000 women died globally, with the majority of deaths occurring in developing countries [2]. Improving maternal health is one of the eight Millennium Development Goals agreed upon by the international community at the United Nations Summit in 2000; the primary objective of this goal was to reduce maternal mortality ratio by 75% from 1990 to 2015. However, by 2015, the percentage had only decreased by around 5%, necessitating an acceleration of progress to achieve the fifth goal [3].

Maternal mortality rates reveal a significant disparity between developing and developed countries, the likelihood of a woman dying during the maternity period is estimated at around 1 in 75 in developing countries, compared to 1 in 7,300 in developed countries. For example, while the chance of maternal death in Ireland is 1 in 48,000, in Niger, one in seven women die from pregnancy-related complications [4].

About 99% of all maternal deaths in all regions of the world occur in developing countries, with more than half of these deaths occurring in sub-Saharan Africa and one-third in South Asia. The maternal mortality rate in developing countries is 450 deaths per 100,000 live births, while in developed countries the rate is estimated at 9 per 100,000 live births. In total, Except for Afghanistan, all of the sub-Saharan African nations with maternal mortality rates of at least 1,000 per 100,000 live births are Burundi, Cameroon, Chad, the Democratic Republic of the Congo, Guinea-Bissau, Angola, Liberia, Malawi, Niger, Rwanda, Nigeria, Sierra Leone, and Somalia [5].

The causes of maternal mortality at the global level can be classified during pregnancy, childbirth, or in the period following childbirth into direct and indirect causes, of which 80% are due to direct causes. The main factors that cause deaths can also be listed: 13% of all maternal deaths occur due to severe bleeding (primarily postpartum bleeding), various infections, disorders that lead to high blood pressure during pregnancy and difficult delivery, and complications after unsafe abortion. Among the indirect causes behind maternal deaths (20%) are diseases such as malaria, anemia, HIV/AIDS and cardiovascular diseases that make pregnancy more difficult or increase the risk of pregnancy [6].

Given that qualified midwives attended about 60% of deliveries in poor countries in 2006, it may be said that 50 million women who gave birth at home did not receive the assistance of skilled health professionals. A significant disparity in prenatal care coverage exists globally, with antenatal care coverage ranging from 34% in East Africa to 93% in South America. In Peru, 87% of pregnant women received at least one benefit. Four prenatal care visits only 12% of these services are covered in Ethiopia [7].

There are several reasons why women may not benefit from the pregnancy and delivery care services they require. Even if

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trained health professionals are present, there may not be sufficient care services or staff in some remote areas, which will result in subpar care. In other circumstances, pregnant women may lack access to health care facilities for numerous reasons, including lack of transportation, inability to finance transportation, or health care prices. Therefore, to improve maternal health, existing gaps in the capacity and quality of health systems and barriers to access to health services must be identified and filled at the community level [8].

1.1 Research Problem

The primary issue with research is the requirement for obtaining a good level of newborn health, which is closely related to the level of health care provided to the mother during pregnancy and extends to the postpartum period. Where the concern for the mother's health and care is a very important subject, and it has been the subject of global and local scientific concerns, given that the mother is one of the sensitive sets in society, where it is affected by the environmental conditions surrounding it, especially in the most important periods of its life, which are the period of pregnancy, childbirth and after birth. Psychiatric studies indicate that taking care of a woman during her pregnancy gives her a natural and healthy birth and maintains her health. This topic has been of great importance by specialists in the medical, demographic, and social fields, with different treatment patterns in different specializations.

Living with pregnancy, childbirth and postpartum differs from one woman to another, depending on her economic, social and demographic circumstances, the stage of pregnancy and childbirth is a natural physiological process that every pregnant woman goes through and is exposed to many dangers and complications, with the great progress in health services, it has become possible to detect these dangers early, and it has become possible to follow up on pregnancy until delivery and beyond, with a good follow-up, also the registration of this percentage of women who receive health care is due to a number of factors and reasons, including: social, economic and demographic, and therefore it requires special attention from those concerned, especially in the field of scientific research, which determines the procedures to be accomplished at various health and social levels [9].

According to data from 2017, 810 women die per day from pregnancy- and childbirth-related avoidable causes, a latest report released by UNFPA and UN partner agencies shows that this figure represents a decrease of around 38 percent from the global maternal mortality rate between 2000 and 2017, The rate of fall is far below globally agreed targets, which is a troubling trend for maternal health, thus these new numbers cannot be praised. As countries see that the rate of reduction can be accelerated, they are now consolidating their efforts toward a new goal of reducing maternal mortality below that rate. The global maternal mortality rate is to be brought down to fewer than 70 per 100,000 live births as part of Sustainable Development Goal 3, with no country's rate exceeding twice the global rate [10].

1.2 Research Questions

Despite the efforts made by the country in the field of reproductive health, by establishing health centers, preparing health programs and conducting demographic health surveys, however, much remains to be done to achieve risk-free motherhood and reduce rates of pregnancy and childbirth-related diseases and maternal mortality rates to their lowest levels, all of these led us to raise questions about the health care of the pregnant mother and the various factors and conditions affecting it [11]. Accordingly, the study questions center on the following main question:

Are demographic, social, and economic factors impacting pregnant mothers' access to quality health care?

A number of the following sub-questions emerge from the previous main question:

i. Does the age of the pregnant mother affect the health follow-up of her pregnancy?
ii. Does the rank of the newborn affect the health follow-up of the pregnant mother?
iii. Does the place of residence of pregnant mothers affect their demand for health follow-up services?
iv. Does the mother's educational level affect the health follow-up of her pregnancy?
v. Does mothers' income affect the health follow-up of their pregnancy?
vi. Does husbands' income affect their pregnant wives' follow-up to their pregnancy?

1.3 Research Assumptions

To answer the questions of the research, the research was based on the formulation of some hypotheses that need to be tested. The most important of these hypotheses are:

i. The age of the mother affects the health follow-up of her pregnancy.
ii. The rank of pregnancy affects the health follow-up of the pregnant mother.

iii. Pregnant mothers' place of residence affects their demand for health follow-up services.

iv. The mother's educational level affects the health follow-up of her pregnancy.

v. Mothers' income affects the health follow-up of their pregnancy.

vi. There is an effect of husbands' income on their pregnant wives' follow-up of their pregnancies.

1.4 The Importance of the Research

The importance of the study appears in that it highlights and shows that caring for pregnant women and providing them with all health services guarantees the mother's physical, mental and social safety, which achieves a reduction in maternal mortality rates during pregnancy, childbirth and the puerperim, reduce neonatal, infant and early childhood mortality, reducing the incidence of disease for both mothers and children, protecting and strengthening the mother's physical, mental and social health, and protecting her from complications at all stages of pregnancy, childbirth and the puerperium. In addition to preventing fatal diseases, especially those that can be prevented by vaccination, and organic illnesses, especially genetic and congenital ones, and assisting in the early detection of the disease and providing diagnostic and therapeutic capabilities in order to reduce complications, suffering, and disability, as well as ensuring the safety of pregnancy and early detection of any deviation from the norm and working to correct it, it is also important to protect children from a variety of other dangers, including those that can be prevented by vaccination, and to protect children from genetic and con.

It also shows the great importance of the research in providing information on the social, economic and demographic factors affecting maternal health care during childbirth in Egypt, which benefit planners and implementers of population policies and programs in devising and enacting effective policies that affect the provision of appropriate health care to the mother during childbirth, which reduces the risks to the mother and the child, which generally helps in improving the health status of the mother and her newborn.

1.5 Objectives of the Research

The following sub-objectives are derived from the research's overall purpose of providing policy makers with current and verified information about health care services during childbirth and their role in lowering health risks to the mother and child:

- Identifying the factors that prevent many pregnant mothers from conducting medical follow-up during pregnancy and after childbirth.
- Determining the most crucial personal qualities that allow the mother to give birth in a medical facility.
- Building a statistical model to determine the most important economic, social and demographic determinants that affect the mother's access to health care during childbirth.
- Comparison between some statistical methods and their quality in determining the previous factors.
- Highlighting the importance of health care for pregnant women.
- Knowing the level of care provided to women during pregnancy.
- Identifying the nature of the relationship between social, economic and demographic characteristics and the extent of women's access to health care during pregnancy
- Finally, a study of the most important factors affecting the level of receiving care during pregnancy.

2 Materials and Methods

The 2014 Demographic Health Survey, in its eleventh session, was the primary source of data for the research, which was conducted in-depth; the survey presented the latest data to follow up on the population and health situation in Egypt. The survey data was collected by questioning 28175 of selected households, 15848 women who gave birth during the previous five years out of 21,762 ever married women in the age group of 15-49 years, who were asked about pregnancy care, care during childbirth and postpartum care [12].

2.1 Description of the Study Sample

In order to update significant health and demographic indicators that were computed and gathered in the prior population survey series, the Demographic Health Survey – Egypt 2014 included a survey of previously married women in the reproductive age group of 15–49 years. These variables included those related to reproduction, family planning, infant and

child mortality, immunization rates, coverage of prenatal care, nutrition, and the degree of anemia. Indicators about domestic violence, the prevalence of female genital mutilation, and social services for children were also included in the 2014 survey design.

In the survey, 21,903 qualifying women were chosen for interviews out of a total of 21,903 eligible women, and 21,762 women completed the individual form, resulting in a response rate of 99.4%. In all geographic regions, the household response rate was 97%, and the response rate of qualified women exceeded 98% [13].

With a total of 11391 women, the study used the relative distribution of women aged 15 to 49 who gave birth to a live child in the five years prior to the survey, the service provider during pregnancy to the last child, the percentage of obtaining any pregnancy care, and regular care from a trained service provider. This study's analysis is a secondary examination of the survey's unprocessed data [14].

Table No. (1) shows the double frequency and proportional distribution of the study sample between the age of the woman during the reproductive life period, which ranges from 15 to 49 years of age, and between the place of residence in the governorates of Lower Egypt (rural and urban) in addition to the Frontier governorates, the rural and urban governorates of Upper Egypt

Table (1): The frequency and proportional double distribution between each of the mother's age during the reproductive life period, and between the places of residence (the governorates of Lower Egypt, the governorates of Upper Egypt, and the Frontier governorates)

			Age in 5-year Groups							Total
			15-19	20-24	25-29	30-34	35-39	40-44	45-49	
Residence	Urban Governorates	Count	27	352	853	614	325	88	19	2278
		% of Total	0.2%	2.2%	5.4%	3.9%	2.1%	0.6%	0.1%	14.4%
	Urban Lower Egypt	Count	21	246	604	424	196	74	7	1572
		% of Total	0.1%	1.6%	3.8%	2.7%	1.2%	0.5%	0.0%	9.9%
	Rural Lower Egypt	Count	118	1053	1594	943	392	132	19	4251
		% of Total	0.7%	6.6%	10.1%	6.0%	2.5%	0.8%	0.1%	26.8%
	Urban Upper Egypt	Count	21	358	606	494	267	116	11	1873
		% of Total	0.1%	2.3%	3.8%	3.1%	1.7%	0.7%	0.1%	11.8%
	Rural Upper Egypt	Count	157	1226	1661	1051	538	152	27	4812
		% of Total	1.0%	7.7%	10.5%	6.6%	3.4%	1.0%	0.2%	30.4%
	Frontier Governorates	Count	34	229	372	242	125	50	10	1062
		% of Total	0.2%	1.4%	2.3%	1.5%	0.8%	0.3%	0.1%	6.7%
Total		Count	378	3464	5690	3768	1843	612	93	15848
		% of Total	2.4%	21.9%	35.9%	23.8%	11.6%	3.9%	0.6%	100.0%

It was found from the previous table that the data were counted for 15,848 women from the 2014 Demographic Health Survey, and the proportion of women for the study sample from Rural Upper Egypt reached 30.4%, while the percentage of women for the study sample from the Rural Lower Egypt was 26.8%, and the percentage of women who came to Urban Upper Egypt was 11.8%. Among the urban governorates in general, 14.4%, and Urban Lower Egypt by 9.9%, and as for the Frontier governorates, the percentage of women in the sample was 6.7%.

At the level of age groups during the reproductive life period, the 25-29 age group came first with a rate of 35.9%, followed by the 30-34 age group with 23.8%, then the 20-24 age group with 21.9%, then the 35-39 age group with 11.6 %. While the percentages decrease as the age of the woman increases, the age group 40-44 has increased by 3.9%, the age group 15-19 has increased by 2.4%, and finally the age group 45-49 has increased by 0.6%.

In general, the proportion of women from rural areas was 59.6%, while the proportion of women from urban areas was 40.4%, as shown in the following table (2):

Table (2): The frequency and proportional double distribution between the mother's age during the reproductive life period, and the place of residence (urban, rural)

			Age in 5-year Groups							Total
			15-19	20-24	25-29	30-34	35-39	40-44	45-49	
Residence	Urban	Count	86	1100	2290	1700	870	312	41	6399
		% of Total	0.5%	6.9%	14.4%	10.7%	5.5%	2.0%	0.3%	40.4%
	Rural	Count	292	2364	3400	2068	973	300	52	9449
		% of Total	1.8%	14.9%	21.5%	13.0%	6.1%	1.9%	0.3%	59.6%
Total		Count	378	3464	5690	3768	1843	612	93	15848
		% of Total	2.4%	21.9%	35.9%	23.8%	11.6%	3.9%	0.6%	100.0%

The following table (3) shows the frequency and proportional double distribution of each of the place of residence in the governorates of Lower Egypt (rural and urban) and the governorates of Upper Egypt (rural and urban) as well as the Frontier governorates on the one hand, and on the other hand, the level of prenatal care that the mother receives . At a 99% level of confidence, the findings revealed a statistically significant relationship between the two variables, where the value of Pearson Chi-Square was 426.999 with a coefficient of contingency of 0.162, the relative distribution also showed that 25.6% of women from Rural Upper Egypt received health care during pregnancy, and 25.1% of the women from Rural Lower Egypt, while 10.6% of the women from Urban Upper Egypt received health care during pregnancy, and that percentage reached 9.5% for women in Urban Lower Egypt, while for the Frontier governorates, 5.5% of women received health care during pregnancy.

Table (3): Frequent and double proportional distribution between both places of residence (the governorates of Lower Egypt, the governorates of Upper Egypt, the Frontier governorates), and the extent to which the mother receives health care during pregnancy

			Health Care During Pregnancy		Total
			No	Yes	
Place of Residence	Urban Governorates	Count	103	2175	2278
		% of Total	0.6%	13.7%	14.4%
	Urban Lower Egypt	Count	69	1503	1572
		% of Total	0.4%	9.5%	9.9%
	Rural Lower Egypt	Count	279	3972	4251
		% of Total	1.8%	25.1%	26.8%
	Urban Upper Egypt	Count	200	1673	1873
		% of Total	1.3%	10.6%	11.8%
	Rural Upper Egypt	Count	752	4060	4812
		% of Total	4.7%	25.6%	30.4%
	Frontier Governorates	Count	189	873	1062
		% of Total	1.2%	5.5%	6.7%
Total		Count	1592	14256	15848
		% of Total	10.0%	90.0%	100.0%
Pearson Chi-Square	426.999[a]	Contingency Coefficient	0.162	P_value	0.000

The following table (4) shows the frequency and proportional double distribution of both place of residence (rural - urban) and receiving health care during pregnancy .The findings revealed a statistically significant correlation between the two variables with a 99% degree of confidence, where the value of Pearson Chi-Square was 95.875 with a coefficient of contingency 0.078, the relative distribution also showed that 52.5% of rural women in the research sample received health care during pregnancy, while 37.5% of urban women in the study sample received health care during pregnancy, and 37.5% of urban Lower Egypt women.

Table (4): Frequency and double proportional distribution between both places of residence (urban, rural), and the extent to which the mother receives health care during pregnancy

			Health Care During Pregnancy		Total
			No	Yes	
Residence	Urban	Count	461	5938	6399
		% of Total	2.9%	37.5%	40.4%
	Rural	Count	1131	8318	9449
		% of Total	7.1%	52.5%	59.6%
Total		Count	1592	14256	15848
		% of Total	10.0%	90.0%	100.0%

Pearson Chi-Square	95.875	Contingency Coefficient	0.078	P_value	0.000

Table (5) also shows the frequency and proportional double distribution of each of the mother's educational status and receiving health care during pregnancy, where the results showed a statistically significant relationship at a confidence level of 99% between the two variables, where the value of Pearson Chi-Square was 749.838 with a coefficient of contingency of 0.213, then, access to health care during pregnancy is related to the level of education that the women have attained, the relative distribution also showed that 53.3% of the women who obtained secondary education in the research sample had received health care during pregnancy, while 16.2% of the women who obtained a higher education than the secondary stage had received health care during pregnancy.

Table (5): Frequency and double proportional distribution between both the mother's educational status and the extent of receiving health care during pregnancy

			Health Care During Pregnancy		Total
			No	Yes	
Educational Status	No education	Count	594	2110	2704
		% of Total	3.7%	13.3%	17.1%
	Primary	Count	224	1121	1345
		% of Total	1.4%	7.1%	8.5%
	Secondary	Count	739	8452	9191
		% of Total	4.7%	53.3%	58.0%
	Higher	Count	35	2573	2608
		% of Total	0.2%	16.2%	16.5%
Total		Count	1592	14256	15848
		% of Total	10.0%	90.0%	100.0%
Pearson Chi-Square	749.838	Contingency Coefficient	0.213	P_value	0.000

The following table (6) shows the frequency and proportional double distribution of both the wealth index and receiving health care during pregnancy. At a 99% level of confidence in the findings, the two variables were found to be statistically significantly correlated, where the value of Pearson Chi-Square reached 539,014 with a coefficient of contingency 0.181, and then access to health care during pregnancy is related to the economic level of the family .The relative distribution showed that 20.6% of the women with the highest economic level in the research sample had received health care during pregnancy, while 19.3% of women with a high economic level had access to health care during pregnancy, also, 18.9% of families with a medium economic level had access to health care during pregnancy, up to 15.3% of families with a very low economic level had received health care during pregnancy.

Table (6): Frequency and double proportional distribution between the wealth index and the extent of receiving health care during pregnancy

			Health Care During Pregnancy		Total
			No	Yes	
Wealth Index	Poorest	Count	541	2424	2965
		% of Total	3.4%	15.3%	18.7%
	Poorer	Count	447	2532	2979
		% of Total	2.8%	16.0%	18.8%
	Middle	Count	293	2989	3282
		% of Total	1.8%	18.9%	20.7%
	Richer	Count	212	3052	3264
		% of Total	1.3%	19.3%	20.6%
	Richest	Count	99	3259	3358
		% of Total	0.6%	20.6%	21.2%
Total		Count	1592	14256	15848
		% of Total	10.0%	90.0%	100.0%
Pearson Chi-Square	539.014	Contingency Coefficient	0.181	P_value	0.000

The following table (7) shows the frequency and double proportional distribution of both the working status of the mother and the receipt of health care during pregnancy, the results showed a statistically significant relationship at a confidence level of 99% between the two variables, where the value of Pearson Chi-Square was 43.197 with a contingency coefficient of 0.052, and therefore access to health care during pregnancy is related to the mother's practical status. The relative distribution showed that 78.2% of the women who did not work in the research sample had received health care during pregnancy, while 11.7% of the working women had received health care during pregnancy.

Table (7): Frequency and double proportional distribution between the practical case and the extent of receiving health care during pregnancy

			Health Care During Pregnancy		Total
			No	Yes	
working Status of the Mother	No	Count	1476	12400	13876
		% of Total	9.3%	78.2%	87.6%
	Yes	Count	116	1856	1972
		% of Total	0.7%	11.7%	12.4%
Total		Count	1592	14256	15848
		% of Total	10.0%	90.0%	100.0%
Pearson Chi-Square	43.197	Contingency Coefficient	0.052	P_value	0.000

2.2 Research Methodology

To achieve the main research objectives, the effect of all explanatory variables (demographic, social, economic) on the mother's access to adequate care during childbirth will be studied (No/Yes), therefore, two different statistical methods will be used, namely the logistic regression method, which is a key model utilized in the creation of the discrimination and division function, In addition to the neural network method, through which a highly efficient mathematical model can be built to predict the dependent variable (access to health care during childbirth) in terms of all explanatory variables, as follows:

2.2.1 Logistic Regression Model

Linear regression is defined as the study of the effect of a group of explanatory variables on a dependent variable that takes quantitative values, where the model that links the variables can be formulated as follows:

$$y = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + ... + \hat{\beta}_i x_i + E \qquad (1)$$

It is known in regression that the right side of these models takes values between $(\infty+, \infty-)$, but when the dependent variable y has a binary rating, the linear regression is not appropriate in this case because $E(y/x) = P(y=1) = p$, As a result, the right side's value is constrained between the two values, making the model inapplicable from the perspective of regression. By applying the proper mathematical transformation to the dependent variable y, this issue can be resolved, and then the ratio $(p/1+p)$ is a positive amount between $(1,0)$, And when the previous ratio is multiplied by its natural logarithm, the answer is:

$$\log(p/1-p) = \hat{\beta}_0 + \hat{\beta}_1 x_i \qquad (2)$$

This model is called the “logistical regression model" and the function resulting from taking the logarithm of both sides is called the “logit transformation” [15]. The resulting logistic function is a continuous function that takes values between zero and one .Also, the value of the dependent variable y approaches zero as the right side of the logistic function approaches from (∞), while it approaches one integer as the right side approaches $(\infty-)$, it is a symmetrical function when the right side of this function is equal to zero, and the ratio (p/q) is called the "Odds Ratio" or success priority. In short, the logistic regression model is simply a logarithmic transformation of linear regression [16]. Logistic regression is superior to the other regression methods in that its estimates are acceptable because it overcomes other regression problems such as the instability of variances in addition to the problem of non-dependency of errors for the standard normal distribution. The following table (8) shows the most important explanatory variables included in the logistic regression model that affect the extent to which the mother receives care during childbirth.

Table (8): The explanatory variables included in logistic regression model

Variable	Code	Measurement
Place of Residence	V024	(Urban Governorates - Urban Lower Egypt - Rural Lower Egypt – Urban Upper Egypt - Rural Upper Egypt - Frontier Governorates)
Residence	V025	(Rural – Urban)
Wealth Index	V190	(Richest - Richer -Middle - Poorer – Poorest)
Mother's Age	V212	(Less than 15 years, 15-19 years , 20-24 years, 25-29 years, 30-34 years, 35-39 years, 40-45 years)
Working Status for Mother	V714	0 → does not work for a financial return 1 → work for a financial return
Working Status for Father	V705	0 → does not work 1 → work
Mother Educational Status	V106	0 → Never went to school 1 → Elementary school not completed 2 → Completed primary/some secondary school 3 → Completed high school or higher
Father Educational Status	V701	0 → Never went to school 1 → Elementary school not completed 2 → Completed primary/some secondary school 3 → Completed high school or higher
Kinship	S806	0 → Not exist 1 → Exist
Drinking Water Source	V113	0 → Unimproved 1 → Improver
The Type of Toilet Facility	V116	0 → Unimproved 1 → Improver
Waste Disposal	V465	0 → Not Good 1 → Good

2.2.1.1 Model Quality Measures

As shown in the following table (9), which represents one of the outputs of the "logistic regression analysis", through which the number of explanatory variables that affect the dependent variable "the mother's access to health care during childbirth" is shown, which was obtained and its results extracted by the method of "stepwise regression", and the fifth model was relied upon, as the chi-square value was (1451.986) with degrees of freedom (14) with a significance of (0.000), which is less than the level of significance 1%, then, with a 99% level of confidence, we reject the null hypothesis and accept the alternative hypothesis regarding the model's significance, which indicates the quality of the model's fit as a whole.

Table (9): The logistic regression model's capacity for explanation is measured by the χ^2 test (Goodness of fit test)

	χ^2	Degree of Freedom	Significance	The Correct Division Ratio
Model 5	1451.986	14	0.000	80.5%

The results also showed that the coefficient of determination was 0.805, which indicates that the independent variables in the model contributed to explaining 80.5% of the changes that may occur in the mother's access to health care during childbirth, which is also a criterion for judging the quality of the model.

2.2.1.2 The Logistic Regression Model's Efficient Division

The logistic regression model's effective division is shown in the following table (10), and it is evident from this that the 14585 items have been divided correctly, with a percentage of almost 100% of those whose response was to obtain health care during childbirth, also, there is one item that was correctly divided, as it was expected that the mother would not have obtained health care during childbirth, and indeed the mother did not receive health care. It was also found that there were 1261 items that were expected to receive health care, but health care was not obtained during childbirth which is a wrong classification. The total efficient division ratio of the model was 92.0% of the sample size, which is a very high percentage, which indicates that the logistic regression model has classified health care cases during childbirth well.

Table (10): The Logistic Regression Model's Efficient Division

Observed		Expected		The Correct Division Ratio
		Obtaining Care during Childbirth		
		No	Yes	
Obtaining care during childbirth	No	1	1261	0.1
	Yes	1	14585	100.0
Total ratio				%92.0

2.2.1.3 The Logistic Regression Model Parameters

The Wald's test for the parameters of the logistic regression model, its significance, and the odds ratio are shown in the table below (11) along with its results.

Table (11): The Logistic Regression Model's Parameters and Their Importance

VAR Code	Estimation	S.td Error	Wald Test	D.f	Sig.	Odds Ratio
Place of Residence			95.175	5	0.000	
Urban governorates	0.455	0.260	3.055	1	0.080	1.577
Urban Lower Egypt	0.306	0.182	2.827	1	0.093	1.358
Rural Lower Egypt	-0.227	0.190	1.440	1	0.230	0.797
Urban Upper Egypt	-0.393	0.176	5.000	1	0.025	0.675
Rural Upper Egypt	-0.647	0.190	11.569	1	0.001	0.524
Working Status for Mother			241.585	3	0.000	
Never went to school	0.706	0.104	46.122	1	0.000	2.025
Elementary	0.983	0.070	196.798	1	0.000	2.672
Middle school and pre-secondary	2.008	0.218	85.217	1	0.000	7.448
Wealth Index			122.287	4	0.000	
very poor	0.095	0.075	1.599	1	0.206	1.100
poor	0.487	0.092	27.983	1	0.000	1.628
Moderate	1.038	0.133	61.146	1	0.000	2.822
Rich	2.181	0.237	84.798	1	0.000	8.857
The Age of the Mother at the First Birth	0.088	0.009	87.359	1	0.000	1.092
The Mother is not Working	-0.289	0.107	7.311	1	0.007	0.749
Constant	-0.415	0.258	2.591	1	0.107	0.660

According to the previous table, two explanatory variables left the model, leaving 14 to remain, and their significance was not determined. The following are the most significant variables, whose significance was determined:

Place of Residence:

From the previous table no. (11), it is evident that there is a positive effect of the place of residence on the mother's possibility of obtaining health care during childbirth, where the probability of obtaining health care during childbirth in urban governorates increases at a confidence level of 90%, with a rate of 57.7%, with the highest odds ratio (upper odds) reaching 1.577, while it increased by 35.8% in the urban lower Egypt, with a lower odds ratio of 1.358 at a confidence level of 90%, while the mother's probability of obtaining health care during childbirth decreases in urban upper Egypt by 32.5% and in rural Lower upper by 47.6%.

Mother Educational Status:

It is also clear from the previous table no. (11) that there is a statistically significant effect at the 99% confidence level of the mother's educational status on the mother's probability of obtaining health care during childbirth, where the chances of a mother obtaining health care for those who have completed primary school increase at a level of confidence of 99% and by up to 2.5% with the lowest odds ratio (lower odds) of 2.025, while the mother's probability of obtaining health care increases for those who have completed middle school and some secondary schools, with an increase of 67.2%, with a odds ratio of 2.672, which is equivalent to one and a quarter times compared to those who completed primary school. The results also showed an increase in the chances that the mother will obtain health care for those who have completed secondary school or higher, at a level of confidence of 99%, at a rate of 44.8%, with an odds ratio (upper odds) of 7.448, this is more than three times that of those who completed elementary school, and more than two and a half times that of those who completed middle school and some secondary schools.

Wealth Index:

It is also clear from the previous table that there is a statistically significant effect at the 99% confidence level of the economic level on the mother's probability of obtaining health care during childbirth, where the chances of a mother

obtaining health care for poor mothers increase by up to 10% with the lowest odds ratio (lower odds) of 1.100, but it is not statistically significant, while the mother's probability of obtaining health care increases in middle families, with an increase of 62.8%, with a relatively greater odds ratio of 1.628, which is equivalent to one and a half times compared to poor families. The results also showed an increase in the chances that the rich mother will obtain health care at a level of confidence of 99% and by up to 82.2% with an odds ratio (upper odds) of 2.822, which is more than two and a half times compared to poor families.

The Age of the Mother at the First Birth:

It is also clear from the table that there is a statistically significant effect at the 99% confidence level of the mother's age at the birth of the first child on the mother's probability of obtaining health care during childbirth , where the chances of a mother obtaining health care increased by 9.2%, with an odds ratio (lower odds) of 1.092.

Mother Working Status:

It is also clear from the table that there is a statistically significant effect at a level of confidence of 99% for the working status of the mother on health care during childbirth, as the chances of the mother obtaining health care are increased for non-working women by 25.1%, with an odds ratio (lower odds) of 0.749.

This is the equation of the regression model that represents the relationship between the dependent variable represented in the mother's access to health care during childbirth, and the previous explanatory variables are:

$$\log(p/1-p) = -0.415 + 0.455^{*}V\ 024(1) + 0.306^{*}V\ 024(2) - 0.227^{*}V\ 024(3) + ... + 0.088V^{*}212(1) \quad (3)$$

We accept the hypothesis that there is a statistically significant effect of the economic, social, and demographic variables under study on the mother's chances of receiving health care during childbirth based on the previous findings of the statistical hypothesis tests, which clearly show that the explanatory variables have an impact on the mother's likelihood of receiving healthcare.

2.2.1.4 Model Strength Test

We utilize the Receiver Operating Characteristic (ROC) curve to examine the robustness of the suggested model; the area under the curve was 83.3, which is a very high significant percentage. This shows that the logistic regression model supports the existence of statistically significant economic, social, and demographic factors on the likelihood that a mother will receive medical care during childbirth. This is evident through the twelve explanatory variables that entered the model with an efficient division of 92%; additional factors not measured by the model (errors) also explain 8%.

The region under the rock curve is depicted in Table (12) and Figure (1) below. From this area, classification can be used to gauge the model's sensitivity.

Table (12): Region beneath the Rock Curve

Area	S.td Error	Significance	95% Confidence Interval	
			Lower Limit	Upper Limit
0.833	0.004	0.000	0.914	0.943

According to the preceding table, the area under the rock curve had a 95% confidence level and a confidence interval of 0.914 to 0.943, and it was roughly 0.833. This percentage is regarded as being extremely high and significant because the test's significance level was 0.000. When the area under the curve is different from 0.5, we refer to rejecting the null hypothesis and accepting the alternative hypothesis.

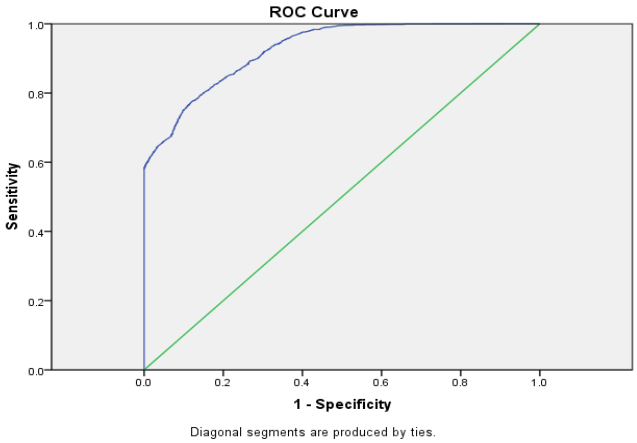

Fig. (1): The Logistic Model Sensitivity's Area under the Rock Curve

As seen in the preceding image (1), the logistic regression is more significant and more accurately classified than random since it has an area under the rock curve of 0.833.

2.2.2 Neural Network Models

2.2.2.1 The Concept of a Neural Network

The artificial neural network is a data processing model based mainly on the innovative structure of the data processing system, it consists of a large number of processing elements closely related together (packages) that work in unison to solve specific problems. Neural networks, like humans, learn by example and training. They are intended for specific applications such as pattern estimation or data classification through the learning process.

As a result, neural networks are computational methods created to mimic how the human mind executes a particular activity, through massive parallel processing dispersed among simple processing units. These units, known as neurons or nodes (Nodes, Neurons), are computational components that have a distinctive sensitivity; they contain experimental and practical information so that, by modifying the weights, the user can access it [17].

2.2.2.2 Properties of Neural Networks

There are several qualities of neural networks; however the following are the most crucial ones:

1. Symbolic representation → the neural network programs used to deal with symbols that express the available information.
2. Experimental research → where neural network programs are directed towards problems for which there are no solutions that can be found according to specific logical steps, as the experimental research method is followed.
3. Embracing and representing knowledge → artificial neural network programs must possess a large base of knowledge that contains the link between cases and results.
4. Uncertain data (incomplete) → these programs are able to give solutions if the data is incomplete, and this does not mean that they provide solutions, regardless of whether the solutions are wrong or correct, but they give acceptable solutions.
5. The ability to learn → the ability to learn is a good feature of artificial neural networks, if a person learns by observing and benefiting from past mistakes, then neural networks learn by example and training.

2.2.2.3 Components of Neural Networks

Similar to how humans connect to the outside world through their five senses; neural networks also require input units and processing units that allow us to adjust the weights using mathematical operations and obtain the appropriate responses for each input. Between each of these levels, which connects one layer to the next, is an interface layer where the weights of each interface are set. The input units are located in the input layer, and the processing units are located in the processing layer, which outputs the network results. The neural network may have a single input layer and numerous processing layers, as shown in the following figure (2).

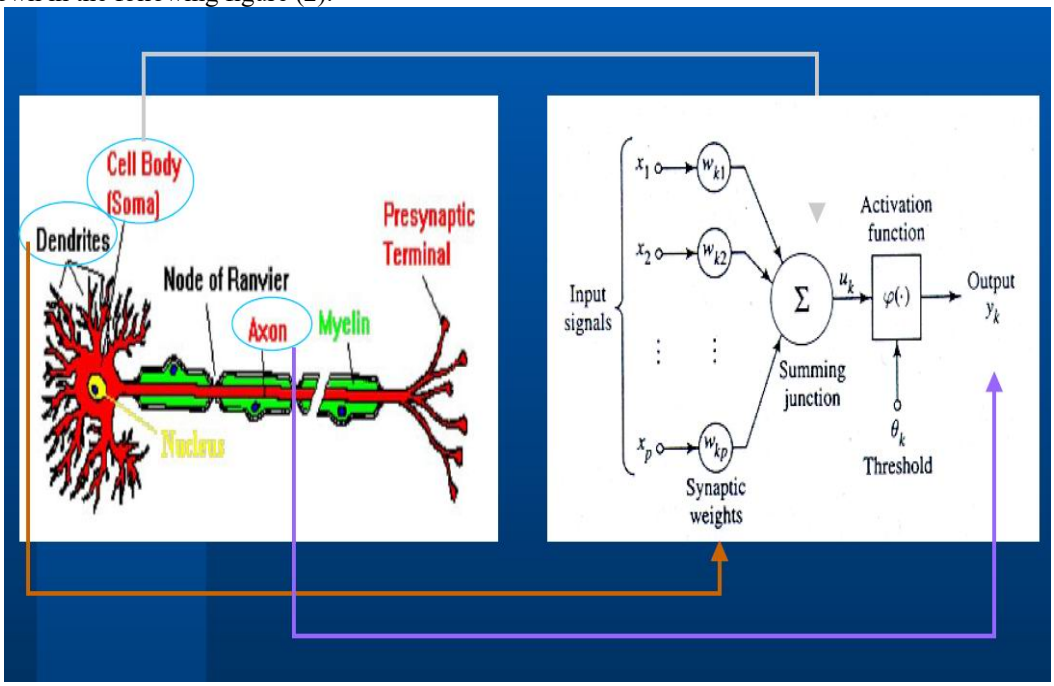

Fig. (2): The Artificial Neuron versus the Human Neuron

According to the concept of neural networks, the previous equation has one output and no hidden layers with a linear stimulus function for the output layer, which is the final output after the processing process .The Transfer Function is an essential component of processing since it affects both the behavior of the neural network's weights and its input-output function. As mentioned before, the transfer function limits the output of the neuron, and it has many properties, where it is a continuous function that can be derived and its derivatives are easy to calculate, in addition to being a non-decreasing streamline [18]. The following figure (3) shows the neural network without hidden layers.

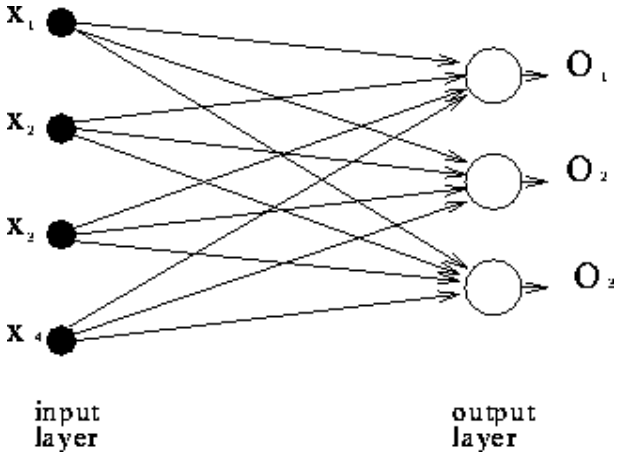

Fig. (3): The Neural Network without Hidden Layers

In order to clarify the impact of economic, social and demographic variables on the mother's access to health care during childbirth, data were entered into the SPSS statistical program package and by conducting the necessary analyzes, the following results emerged:

The following figure (4) shows the effect of the previous variables on the mother's access to health care during childbirth through a number of hidden layers (1 layer) through 10 hidden units, which the network has trained on through the transformation function.

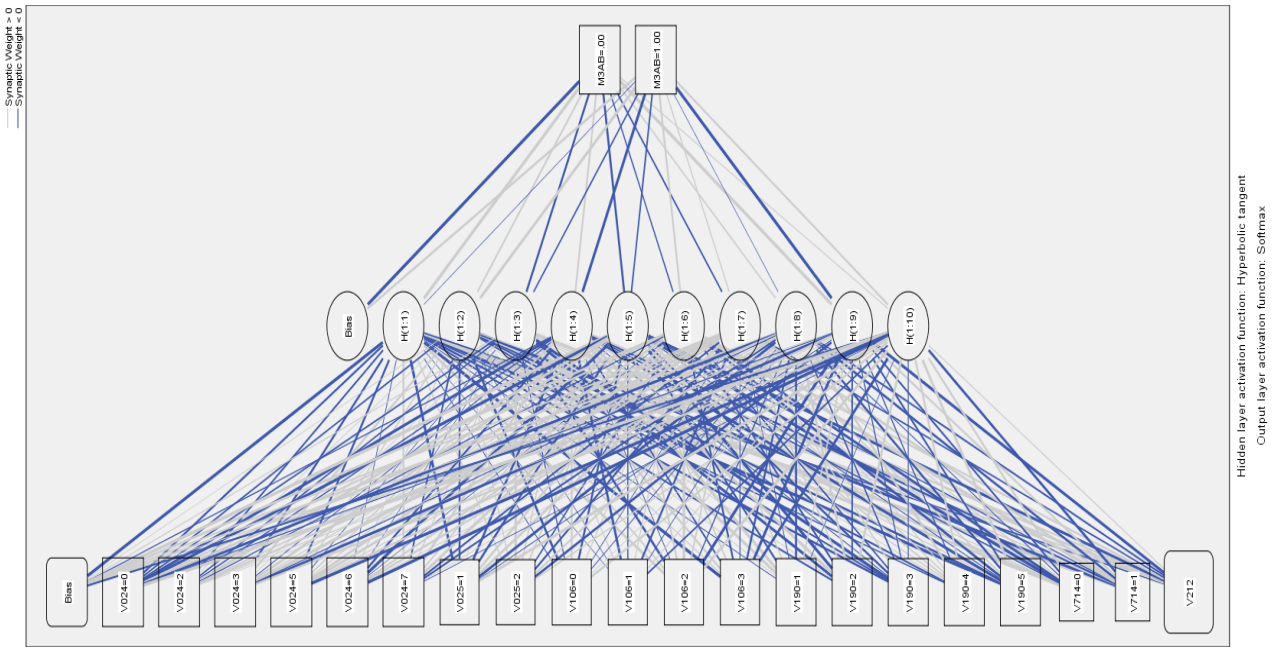

Fig. (4): A Single-Layer Hidden Neural Network Model of the Effect of Explanatory Variables on the Mother's Chances of Receiving Care during Childbirth

Table no. (13) shows the overall the efficient division of the neural networks model (training - testing), Through the testing process, it was found that there are 10,196 mothers classified as being among the mothers who received health care during childbirth and it actually happened and it was classified correctly by 99.9%. While there are 849 mothers that were misclassified, as they were expected to be among the mothers who received care, and it was found that they were among those who did not receive health care during childbirth. The total efficient division ratio of the model reached 92.2%, which is a very high percentage. Rock curve's undersurface area was 0.794, which is a good percentage that confirms that the model is not due to chance.

Table (13): The Effective Division of the Model of a Neural Network

Observed		Expected		
		No	Yes	Correct Ratio
Training	No	10	849	1.2%
	Yes	12	10196	99.9%
	Total Division Ratio	0.2%	99.8%	92.2%
Test	No	1	402	0.2%
	Yes	6	4372	99.9%
	Total Division Ratio	0.1%	99.9%	91.5%

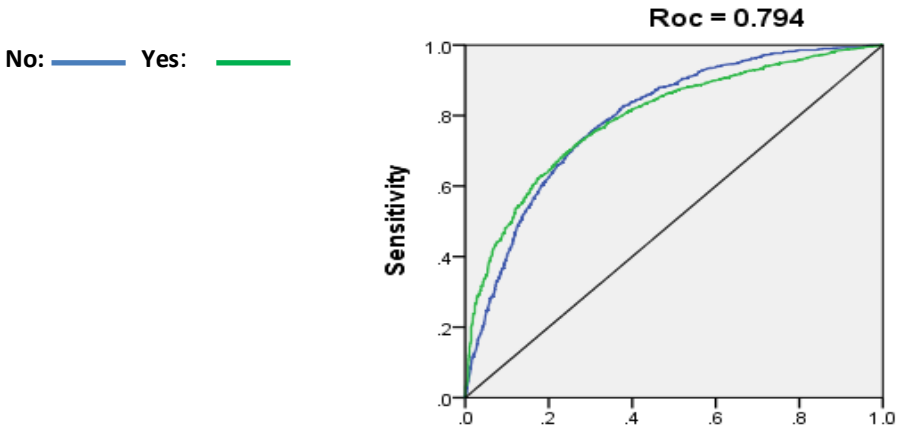

Fig. (5): The Region under the Neural Networks Model's Rock Curve
(The Dependent Variable is Access to Care during Childbirth)

The following Table (14), Figure (6), demonstrate the relative weights of the model's explanatory variables and how they affect the mother's access to care during childbirth .It was found that the mother's age at the first birth was one of the variables most affecting the mother's access to health care during childbirth, with a relative importance of 35.3%, followed by the place of residence with a percentage of 17.9%, and the wealth index came in third place with a relative importance of 15.8%, while the educational status came with a relative importance of 14.0%, the residence came with a percentage of 13.2%, while the working status of the mother came in the last rank in terms of relative importance, which amounted to 3.8%.

Table (14): The Relative and Standardized Importance of the Explanatory Variables

Variables	Relative Importance	Standardized Importance
Place of Residence	0.179	50.7%
Residence	0.132	37.4%
Educational Status	0.140	39.6%
Wealth Index	0.158	44.8%
Mother's Working Status	0.038	10.9%
Mother's Age at the First Birth	0.353	100.0%

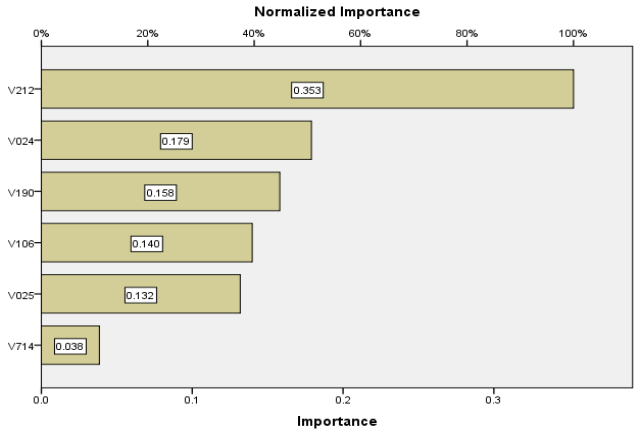

Figure (6): The Relative Importance of the Explanatory Variables and Their Impact on the Mother's Access to Care during Childbirth

3 Results and Discussion

3.1 Results

The study has produced a number of significant findings, the most significant of which are listed below:

- The results of the study showed that there is a significant correlation between several demographic, economic and social variables and the mother's access to care during childbirth.
- There is a positive effect of the place of residence on the mother's probability of obtaining health care during childbirth, as the probability of obtaining health care during childbirth increases in the urban governorates and urban areas of Upper Egypt, while the probability of the mother's access to health care during childbirth decreases in urban and rural Lower Egypt.
- There is a statistically significant effect of the mother's educational status on the mother's probability of obtaining health care during childbirth, as the results showed an increase in the chances that the mother will receive health care for those who have completed secondary school or higher by more than three times compared to those who completed primary school, and more than two and a half times for those who have completed preparatory school and some secondary school. There was a positive relationship between the educational level of the mother as one of the economic indicators and the mother's access to proper health care during childbirth.
- The results also showed that there is a statistically significant effect of the wealth index on the mother's probability of obtaining health care during childbirth, as the mother's probability of obtaining health care in average families increases by one and a half times compared to poor families, whose results were not statistically significant, also The chances of a mother getting health care in rich families are more than two and a half times more likely than in poor families. In general, there is a direct relationship between the wealth index and the mother's access to quality health care during childbirth.
- The order of the newborn has an important role in the mother's access to health care during childbirth, as the chances of the mother obtaining health care with the first child increase by a large percentage, as there was an inverse relationship between the order of the newborn and the mother's access to health care during childbirth, where the mother is more likely to receive care in lower-ranked births than in higher-ranked births.
- There is a statistically significant effect of the mother's working status on health care during childbirth, as the chances of the mother obtaining health care increase for women who do not work more than women who do. This suggests that a mother's ability to get high-quality medical treatment during childbirth is inversely related to her employment position.
- The statistical hypothesis tests showed that the explanatory variables have a statistically significant impact on the likelihood that a mother will receive medical attention during childbirth. Subsequently, the hypothesis that the economic, social, and demographic variables under study have a statistically significant impact on the likelihood that a mother will receive medical attention during childbirth was accepted.
- The logistic regression model shows a remarkable superiority over the neural networks models in analyzing the relationship between the explanatory variables (demographic, economic and social) on the one hand, and the mother's access to good care during childbirth as a dependent variable on the other hand, where the area under the rock curve in the logistic regression was greater than its counterpart in neural networks.

3.2 Discussion

- To improve the health of the mother and child and lower the mortality rate for both moms and children, we must concentrate on providing high-quality treatment during childbirth.
- The need to provide effective programs that affect the provision of health care to the mother during childbirth in order to avoid the risks to which the mother and the newborn are exposed
- Paying attention to awareness programs to educate mothers about the need to obtain quality care during pregnancy and childbirth.
- Increasing interest in rural areas and educating women there about the importance of effective care during childbirth and its role in preserving the health of the mother and child, in addition to the need to direct more care to rural health units.
- The need to raise the age of marriage for girls so that it is no less than 21 years, and to enact and activate laws to reduce the phenomenon of early marriage because of its grave dangers to the health of the mother and child.
- The need to reduce the gap between urban and rural areas in the provision of health care services to mothers.
- Spreading awareness about the importance of maternal health care during childbirth among the various segments of society by broadcasting more visual, audio and print media messages about the importance of the role of maternal health care during childbirth in preserving the health of the mother and child and thus preserving the safety of society.

4 Acknowledgments

I am grateful to my colleagues involved in this paper for their unwavering cooperation, support, and guidance throughout the research process. Their experience and patience have been invaluable to me and have played a crucial role in the success of this paper. In particular, Prof. Dr. Ibrahim Musa Abdel-Fattah, Professor of Statistics and former Dean of the Faculty, agreed to participate and supervise this research paper. I am grateful to all those involved in the preparation of the Egyptian Demographic Health Survey (DHS) for making available all the information and data required for me to conduct my research and for all the resources and support they provided me. I do not forget to thank my colleagues at the College of Languages and Translation at Imam Muhammad bin Saud Islamic University for their review of the formulations and grammar of the research. Finally, I extend my sincere thanks and gratitude to the editorial board of Journal of Statistics Applications & Probability (JSAP) for their acceptance of the arbitration of that research and their selection of distinguished reviewers with a prudent opinion, as their constructive observations and questions were useful in increasing the importance and effectiveness of the research.

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