Research Article

Parameters Variation to Estimate Performance Characteristics of 3-Phase Asynchronous Motor

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Abstract

The 3-phase asynchronous squirrel cage motors (SCIM) are main competitor machines placed instead of other motors in the commercial and industrial fields. The stator and rotor material selection and construction topology influence the electrical machine design. The results illustrated with the motor of a 15 KW, variable controlled speed, for the constant frequency of 50 Hz or 60 Hz. The motor parameters created inside the simulation model must be matched with the value of a standard parameter for SCIM to achieve a high dynamic response. This work examines the effect of the parameters variation for synchronous motor on the performance characteristics at starting point and at a load change for different time and speed regions. Changing of the rotor power is taken into consideration, this occurs with dynamic change of the hydraulic pump load from the valve.

In the industrial applications, production, and manufacturing, till present there are still struggles to find the most holistic environment of the SCIM to achieve its efficiency at the lowest cost and same time control the motor performance, so we predicted the method of reducing the most effective motor parameters to improve the efficiency.

The offline method used the SCIM parameters to calculate the time-varying current, torque, and rotor speed. The results illustrated that this method was fully consistent with the experiment tests and the standard theoretical values. A MATLAB program is used to simulate this study. The simulation model proved the feasibility of the proposed method with encouraging performance.

Keywords: SimscopeTM, 3-Phase Asynchronous Motor, Parameters Variation, Simulation Model, Torque and Current, Efficiency.

1. Introduction

Three-phase asynchronous motors are the most frequently encountered in the industries. They are simple, rugged, low-price, and easy to maintain (Wildi, 2006). In the stator design of a 3-phase winding, the rotor currents are generated by the relative motion and interaction between the stator and rotor magnetic fields. Induction torque is generated in the rotating part (Moraes et al., 2003).

The SCIM with its advantages is used as the best traditional AC machine application with high efficiency and mechanical stresses, lower cost, and a simple control circuit (Gieras & Saari, 2012; Uzhegov et al., 2016).

During the machine's operation that runs at a high-speed region to achieve the lowest slip, consequentially reached a high value of power factor compared with the other soiled rotating system. For the wound rotor induction motor (WRIM), chopper resistance control can be inserted into the rotor resistance circuits (Ameen & Aula, 2020). The precision design of synchronous machines required optimum estimation for equivalent electromagnetic parameters of SCIM (Ikeda et al., 1990; Zhou & Wang, 2007), such motors without auxiliary electronic devices have an operating problem at high current values in different modes of operation, which implies inadmissible over-heating in their windings, moreover, these motors usually work at very specific speed regimes (Lindsay & Barton, 1973; Tu et al., 2008). The short circuit ring design is the most important item of the motor (Barta et al., 2016). The advanced design of the rotating part can overcome the mechanical and speed limitations of the machine, and different designed methods for short circuit rings compared to the traditional motor. In recent decades, all researchers studied to provide a feasible solution for a high-speed squirrel cage rotor, although no comparison among different solutions was given.

A typical procedure of the asynchronous machine's model is under study broadly separated into two categories: dynamic model and steady-state model. To achieve our purpose, the transient method with dynamic load and time-varying signals is used.

The predicted off-line method for evaluating the motor circuit parameters (Reed et al., 2016), coincides with standard 112 test results of IEEE, using; DC tests applied to the machine's stator winding, rotor short circuit tests, and free rotor test (Tu et al., 2008). In addition to the resistance and inductance of the stator and rotor parameters, there is a mutual inductance affected between them, and all of these values are per unit. Also, the other input values for a 15 KW motor are per-unit such as voltage, current, frequency, power factor …etc.

To analyze the performance of SCIM, the above parameters require a prediction technique using the computer-simulated model for different times and speeds (Ahmadi Jirdehi & Rezaei, 2016; Stephan et al., 1994).

The motor design aims to manufacture motors that have desired characteristics with high efficiency and low-cost values. Structural optimization ideas in mechanical engineering are described in the early 1960s (Wu et al., 2018).

The major importance of increasing efficiency at the lowest cost value is to improve power factor, as a result, will save a high percentage of power for all drive systems used in the industry fields; therefore, all designers must be interested in reaching a higher efficiency point of operation (Liu et al., 2009), because a few percentage increases in efficiency leads to a large saving in active power and decrease losses (Auinger, 2001).

All SCIM used in AC electrical drive system must run with a load roughly less than its power rating to increase the whole efficiency, consequently, at light load condition the machine run at poor efficiency, therefore, all input parameters simulated in MATLAB are matching the power rating of 15 KW of the asynchronous motor.

The modeling and simulation in this work were done using Matlab-2017. The computer core-i5 is used 8 GB of RAM to implement all functions that represent a 3-phase signal (voltage, current, and frequency) of power source design measuring a whole components instrument of scopes and two-dimensional diagrams, moreover generating a script MATLAB code that shows the response of asynchronous motor over variable time-load affected directly. The output measured values of voltages, currents, torque, powers, speed, slip, and power factor are computed according to the standard of simulation system required for the machine response over the measuring the parameters variation using different types of sensors based on real time in task offloading (Kishor & Chakarbarty, 2021), then to complete the requirements of enhancement the evaluation based on information technology diagram, the efficiency depends on the ratio of the output to input powers.

2. Related Work

There are different methods to control and obtain high performance for a squirrel cage induction motor (SCIM).

The optimum motor design such as rotor, stator, geometric dimensions, and slot types for the two motor parts are calculated to reach structural optimization, also using software simulation for the equivalent circuit parameters that has been explained by Yetgin et al. (2005).

Mohamed et al. (2016) used a mathematical model to study the effect of parameter variation based on the changing voltage and flux equation in the equivalent circuit, these quantities are affected by frequency, saturation, and temperature degree.

Improvements and study of SCIM concerning the equivalent circuit topology researched by Razali (2012). They used intelligent techniques to study the effect of changing motor parameters, such as flux level on the SCIM output characteristic.

Another related research based on the polynomial regression method by Wu et al. (2018) shows the great importance of the induction machine parameters estimating and used signals with time-varying of current, voltage, and speed, which used an example in the analysis of the equivalent circuit.

The investigation of the spiral sheet rotor for a 3-phase asynchronous motor with high starting torque and steady-state operation companionship with acceptable performance are the objectives work of Mujal-Rosas and Orrit-Prat (2011).

Presentation of parameters for a group of 33 SCIM motors operating as a 3-phase of 380 volts and develop a method for performance characteristics calculation over full-load using a conventional equivalent circuit to industrialize all parts of these motors at Egypt SIEMENS factory was thoughtful by Shanab (2021).

Elkholy et al. (2022) provides a pair of strategies for 3-phase induction motor parameters estimation, named as manufacturer's datasheet method (MDSM) and on-service method (OSM) that address based on actual measurements which does not need to release the motor from the connected load.

A MATLAB simulation predictive model for an induction motor is the proposed method of Sharma (2016) for the motor running at a low and high speed with the selection of optimum switching time for AC electrical drives.

3. Methodology

The asynchronous motor equation can be expressed according to the stator synchronous reference frame (Kundur & Malik, 2022) using the park's transformation (dqo) method which illustrated the stator rotating quantities to a reference stationary axis concerning electrical supply frequency.

Letting (s) represent a stator quantity to be transformed by voltage, current, or flux. The (dqo) transformation is defined by Fitzgerald (2003) and Kundur & Malik (2022).

$$\begin{bmatrix} S_d \\ S_q \\ S_o \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} Cos\,\theta_e & Cos(\theta_e - \frac{2\pi}{3}) & Cos(\theta_e + \frac{2\pi}{3}) \\ -Sin(\theta_e) & -Sin(\theta_e - \frac{2\pi}{3}) & -Sin(\theta_e + \frac{2\pi}{3}) \\ 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \end{bmatrix} \begin{bmatrix} S_a \\ S_b \\ S_c \end{bmatrix} \tag{1}$$

S- are the quantities to be transformed.

θe- the electrical angle is given as:

$$\theta_e = \int_0^t 2\pi f dt \tag{2}$$

$1/\sqrt{2}$ -- is the zero-sequence coefficients; f-rated electrical frequency.

The inverse stator voltage transformation defined the (V_a, V_b, V_c) rotating voltages across post ~ 1 and ~ 2:

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} Cos\,\theta_e & -Sin\,\theta_e & 1/\sqrt{2} \\ Cos(\theta_e - 120^o) & -Sin(\theta_e - 120^o) & 1/\sqrt{2} \\ Cos(\theta_e + 120^o) & -Sin(\theta_e + 120^o) & 1/\sqrt{2} \end{bmatrix} \begin{bmatrix} V_d \\ V_q \\ V_o \end{bmatrix} \tag{3}$$

Also, the phase voltage (V_a) is defined as

$$V_a = V_{Line} \frac{\sqrt{2}}{\sqrt{3}} Sin(2\pi f + \theta)\ , \tag{4}$$

Where θ, is the electrical phase shift angle between the rotating phases 'a' and the reference frame.

The Pu stator voltage equations are defined by (Kundur & Malik, 2022; Wu et al., 2018):

$$\left.\begin{aligned} V_d &= R_s i_d + \frac{1}{\omega_b} P\psi_d - \omega_s \psi_q \\ V_q &= R_s i_q + \frac{1}{\omega_b} P\psi_q - \omega_s \psi_d \\ \text{And,}\quad V_o &= R_s i_o + \frac{1}{\omega_o} P\psi_o \end{aligned}\right\} \tag{5}$$

ω_b ; Per-unit base electrical speed.
P; is (d/dt) differentiation factor.
(ψ_d, ψ_q, ψ_o); d-axis, q-axis, and zero-axis sequence stator flux linkages.
R_s ; Stator resistance.
(i_d, i_q, i_o); d-axis, q-axis, and zero sequence component currents.

The rotor voltage equations are defined by Say (1976) and Uzhegov et al. (2016) as follows:

$$\left.\begin{aligned} V_{dr} &= 0 = R_r i_{dr} + \frac{1}{\omega_b} P\psi_{dr} - \theta_r \psi_{qr} \\ V_{qr} &= 0 = R_r i_{qr} + \frac{1}{\omega_b} P\psi_{qr} - \theta_r \psi_{dr} \end{aligned}\right\} \tag{6}$$

V_{dr} and V_{qr} d-axis and q-axis rotor voltages.
ψ_{dr} and ψ_{qr} d-axis and q-axis rotor flux linkages.
$\theta_r = \omega_s - \omega_r$; The angle between the d-axis and a-phase of the rotor.
ω_s ; Per-unit synchronous speed, as a reference, equal to $1\ \mathrm{P.u}$
ω_r ; Per-unit rotational speed.
R_r ; Rotor resistance.

From Equation (2) and Equation (3), the stator and rotor flux linkages can be expressed in terms of (d - q) axes, (Umans et al., 2014) as follows:

Stator flux linkages:

$$\left.\begin{aligned} \psi_d &= L_{ss} i_{ds} + L_m i_{dr} \\ \psi_q &= L_{ss} i_{qs} + L_m i_{qr} \\ \psi_{os} &= L_{ss} i_o \end{aligned}\right\} \tag{7}$$

Rotor flux linkage:

$$\left.\begin{aligned} \psi_{dr} &= L_{rr} i_{dr} + L_m i_{ds} \\ \psi_q &= L_{ss} i_{qr} + L_m i_{qs} \end{aligned}\right\} \tag{8}$$

where:
L_{rr}; rotor self-inductance referred to the stator.
L_{ss}: stator self-inductance, L_{ls} stator leakage inductance, and L_m magnetizing inductance are related by:

$$\mathrm{L_{ss} = L_{ls} + L_m} \tag{9}$$

L_{rr} rotor self-inductance, L_{lr} rotor leakage inductance, and L_m magnetizing inductance are related as:

$$\mathrm{L_{rr} = L_{lr} + L_m} \tag{10}$$

Power, torque, and efficiency

The instantaneous output power of the stator is:

$$P_r = e_e i_a + e_b i_b + e_c i_c \tag{11}$$

The above expression in per-unit gives the rotor power, and explains the d-q components:

$$P_r = V_d i_d + V_q i_q + 2e_o i_o \tag{12}$$

Similarly; the instantaneous power input to the rotor is:

$$P_r = \frac{2}{3}(V_{dr} i_{dr} + V_{qr} i_{qr}) \tag{13}$$

The per-unit rotor torque is defined as (Fitzgerald et al., 2003):

$$T = \psi_d i_q - \psi_q i_d \tag{14}$$

Neglecting the air-gap losses result in motor efficiency:

$$\text{efficiency} = \frac{\text{rotor power}}{\text{primary losses} + \text{rotor power}} \tag{15}$$

Primary (stator) resistance losses due to the stator current flow in the stationary winding that causes a large amount of dissipation heating power (Razali et al., 2012):

$$P_{st} = I_{st}^2 R_s \tag{16}$$

The stator of SCIM resistance (Rs) with a total number of turns (N), electrical conductivity (σ), active conductor length (Lw), and cross-sectional area (Aw) in the slot:

$$\begin{aligned} P_{st} &= (I_{st})^2 * \frac{NL_w}{\sigma \frac{A_w}{N}} \\ &= (I_{st})^2 * \frac{N^2 L_w}{\sigma A_w} \end{aligned} \tag{17}$$

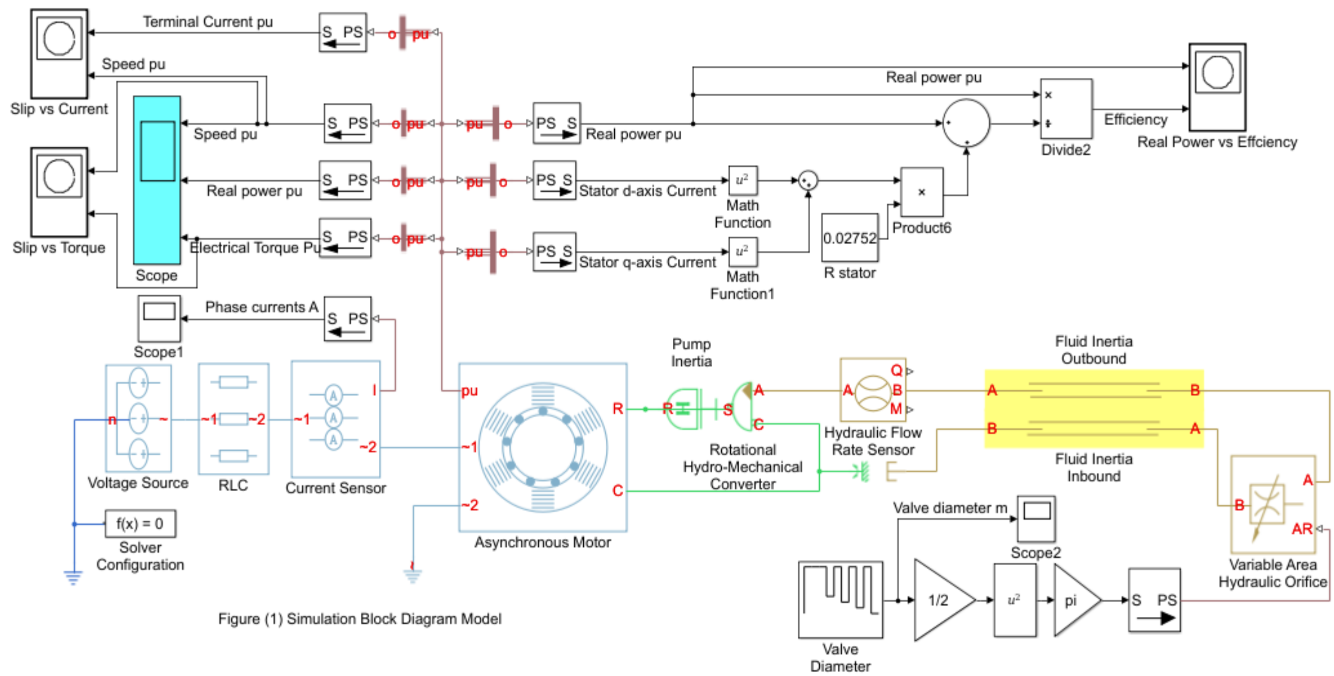
I_{st} - is the r.m.s stator current given as:

$$I_{st} = I_d + jI_q \tag{18}$$

4. Simulation Model

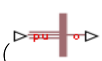
The proposed control model as shown in **Error! Reference source not found.** is varied in MATLAB-Simulink at d ifferent time and speed regions to justify the performance control scheme.

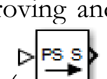
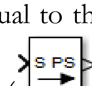
The method of simulating-model has been recognized as a researched tool since the beginning of the twentieth century with the development of computers, and it becomes a powerful tool supporting the design, planning, and analysis of different scientific research. Actually, in an electrical machine simulation which acts as a very important technique needed more other fields. The schematic block of a complete SCIM dynamic model indicates all programmable inputs voltage source of 3-phase ideal power supply to the machine with a cylinder rotor type results in no reluctance torque between rotor and stator field (Saied & Mohammed, 2016) with specific parameters and output of Hydro-Mechanical pump as a dynamic load controlled by mechanical valve based on suitable step functions. MATLAB simulation codes transfer deferential functions into a mathematical system to produce efficient items and static calculations using sensors based on a real-time variation of speed, efficiency, torque, and machine active power in per-



unit multi-degree dimensions.

Figure 1. Simulation model.

Transducer measurement block () as output per unit from an asynchronous machine based on selected values. The per-unit calculation measured by using the value of elements as the input signal vector with mathematical expressions directly outputs the element value from the input signal vector.

A Simulink model has been developed using an important block-set software tool for presenting the relation between physical signal and Simulink leading to improving and modifying a characteristic of the desired units for the output signals. For Physical to Simulink conversion () the input physical signal function comes into commensurate with an electrical unit. If we reach a desired output unit, the output gain of the applied block equal to the conversion factor leads to the output of the Simulink signal. Moreover, the Simulink to Physical conversion (), predicted parameter value controls the actual physical signal at the external port of the simulated block; it will be an input signal for the SimscapeTM physical network.

The per-unit parameters used in the simulation are from Kundur and Malik (2022), see Table 1.

Table 1. Simulation parameters for 15 KW for 3-phase SCIM motor.

Description	Variables	P.U. Values
Supply Voltage	400 V	
Supply Frequency	(50 or 60) Hz	
Reference Speed	ω (rpm)	1
Number of poles	2	
Stator resistance	R_s (Ω)	0.02752
Stator inductance	L_s (H)	0.0992
Rotor resistance referred to stator	R'_r (Ω)	0.015466

Rotor inductance referred to stator	L'_r (H)	0.04522
Mutual Inductance	L_m (H)	1.8730
Mutual Resistance	R_m (Ω)	0.0992

5. Results

This work explained and compared the results of the motor with theoretical values. **Error! Reference source not found.** illustrated a developed representation of SCIM control model results at different speed regions. In the simulation, the motor starts at zero seconds with the reference torque 0.225 P.U. and starting current 72 A from a power supply, where it reaches the rated value at 2.71 seconds, the motor stops after 9 seconds, once the motor attained roughly stop time, the torque becomes at a minimum value near the synchronous rotor speed, also the valve diameter obtain 0.04 m, and measured fluid oil is stopped following from the tank to the hydraulic pump which represents the mechanical load.

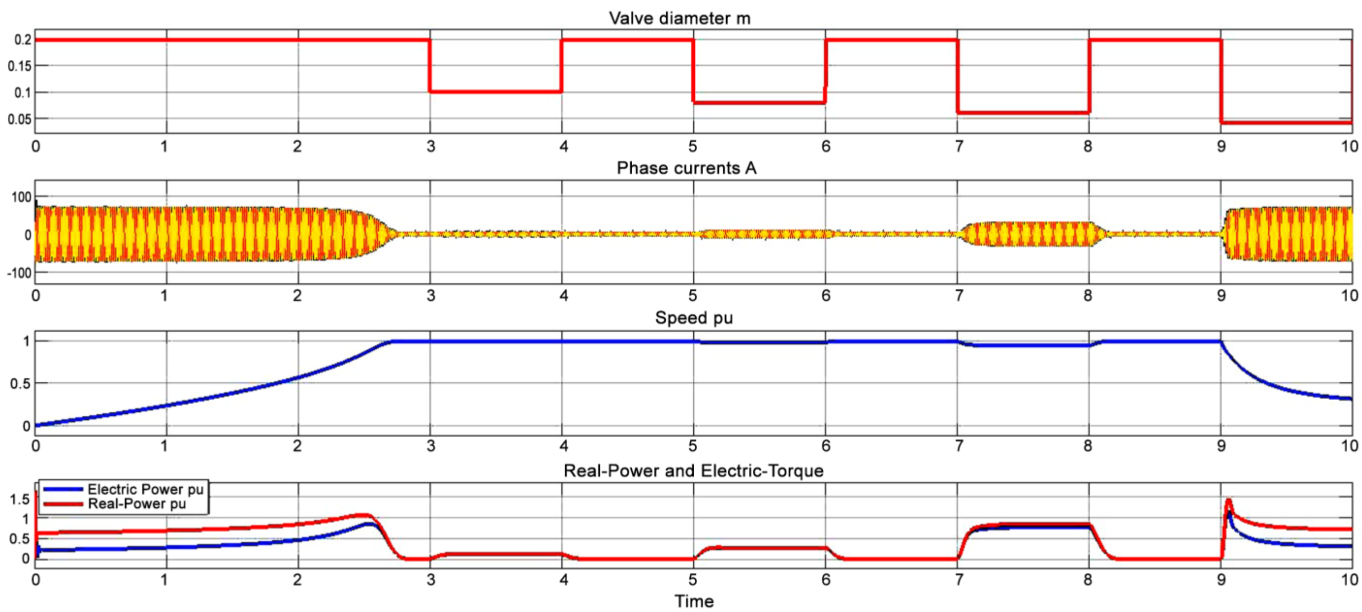


Figure 2 Control model results

Error! Reference source not found. shows the torque and current speed curves of 15 KW, 50 Hz, and 400 V that have parameter values given in Table 1.

With the rising of the rotor resistance by a factor of 1.025 P.U., the new Torque-speed curve indicates that the starting torque is 0.567 P.U., and the motor develops a maximum torque of 0.848 at a slip 0.15 greater than the original slip for the corresponding starting current 3.709 P.U.

If we again change the rotor resistance so that it becomes 1.05 P.U., the torque attains the same breakdown at a high slip value of 0.19, and the locked-motor current is 3.708 P.U.

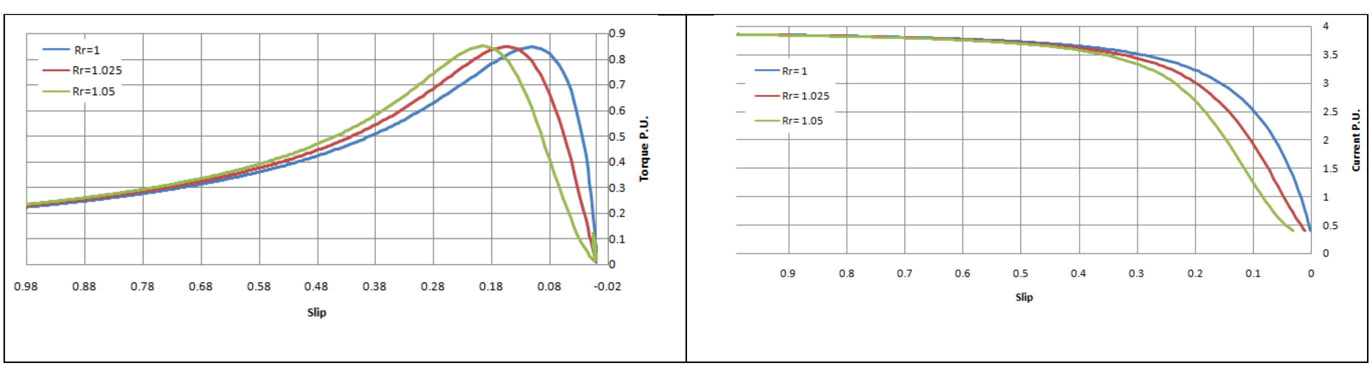


Figure 3 (a)	Figure 3 (b)

Figure 3. (a) Torque slips characteristic, (b) Current vs. slip.

In summary, the torque and speed curves are greatly affected by a change of motor parameters, a high parameters value is eligible due to appropriate with a high starting torque (Kundur & Malik, 2022) and withstand a high current for start. **Error! Reference source not found.** illustrates three different electrical motor parameters, which are the key to c ontrolling output power and minimizing the losses (Erdogan et al., 2015) in Equation (16).

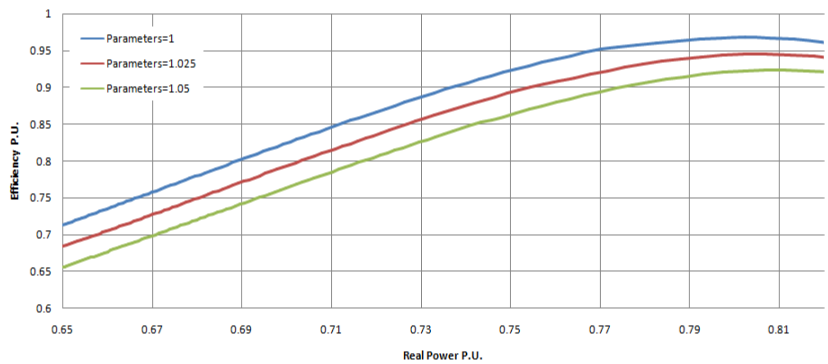


Figure 4. Effect of changing parameters on Efficiency vs. output-power

Error! Reference source not found. describes the speed-efficiency characteristic, that explained the increase of o utput efficiency with the load increases, constant over a narrow power domain, then slowly begins to decay. This visualized typical for all electrical machines efficiency curves (Wildi, 2006). At all times electrical motor manufacturers endeavor to achieve a high-efficiency level at full load.

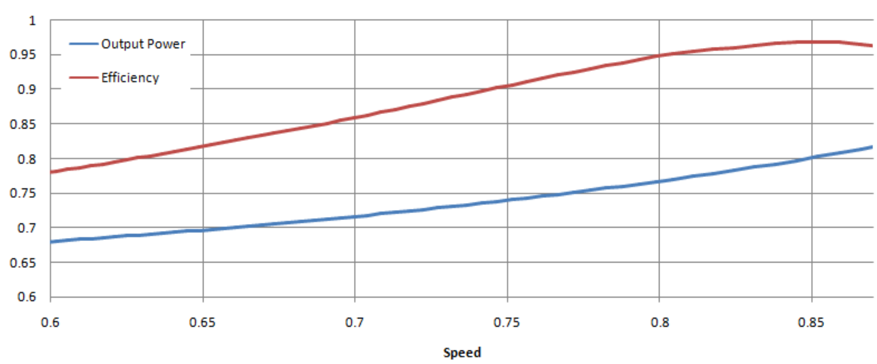


Figure 5. Efficiency and output-power vs. speed curves.

6. Conclusion

Combined with rapid technological progress, the squirrel cage induction motors SCIM drivers have been widely used instead of the other motors at different modes of operation in the industrial application. The parameters and performance with associated losses of the designed machine are not constant and differ according to operation speed regions. The manufacturing design objectives are to obtain a high-performance characteristic, also to control the developing torque at a high rotational speed at the motor's shaft with an acceptable efficiency level. Predesign techniques are used to evaluate motor operation using parameters variation of SCIM model to obtain time-varying of current-signal, power, torque, efficiency, and motor speed to investigate the external performance characteristics with dynamic results of the simplified modeling parameters adjusted and compared, consequently, they validate mathematical values and confirm with a steady-state performance of SCIM operation.

The theoretical dynamic model can mathematically be developed in the form (d - q) axis of the park's transformation equations used in implementation, the selected frequencies related to the actual value of 50 Hz or 60 Hz. The dynamic model is computed for a 15 KW motor under different times and speed regains from rest to synchronous speed.

Our purpose is to obtain a desired output performance characteristic by predicting and simulating equivalent circuit parameters for the SCIM model, and the stator resistance can be controlled to increase the system's efficiency.

All the measured data of the motor have been illustrated in set output graphs. All graphs agree with the predicted analysis value of various model off-line parameters.

MATLAB with required advantages including the ability of measurement and control to obtain all motor performance values used in this research, it is flexible to avoid any undesired procedure in parameter estimation to reach the optimal results.

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Research Article

Epidemiological Study of Breast Cancer in Erbil, Kurdistan Region

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Abstract

Breast cancer is the most diagnosed cancer and the second leading cause of cancer death among women in the world. Compared to some other regions in the world, amount of information available about breast cancer epidemiology in the Kurdistan Region of Iraq is scarce. This study is an attempt to enrich our knowledge about different epidemiological aspects of breast cancer in the region since epidemiological studies contribute quite significantly to the current knowledge of environmental and genetic risk factors and to the current treatment strategies for breast cancer. In addition, studies has shown that the past and ongoing research has a massive implication in improving the outcome of this common disease. This work takes all women diagnosed with breast cancer at Nanakaly Hospital in Erbil, Iraq as sample of the study. Patient characteristics were captured then statistical analysis was performed on these data sets. The majority of patients were found to be city dwellers and about 46% were diagnosed at stage II and 40% at stage III. The vast majority of cases tested positive for hormone receptors but negative for HER2.

Keywords: Breast Cancer, Epidemiology, Hormone Receptor, HER2, Therapeutic Interventions, Erbil.

1. Introduction

Alarming trends in cancer incidence rates have been identified globally (Jemal et al., 2010). In developing countries, breast, colon, and lung cancers are frequently diagnosed and are considered the leading causes of high morbidity and mortality. Breast cancer is the commonest cancer in females and is responsible for approximately 32% of all cancers in women worldwide (Ibrahim et al., 2014). It is presently one of the most prevalently identified cancers and is the fifth leading cause of cancer-related death with an estimated number of 2.3 million cases worldwide according to the GLOBOCAN 2020 report (Sung et al., 2021). Numerous procedures, such as general preventive behaviors and screening programs, are critical for reducing the occurrence rate of breast cancer (Łukasiewicz et al., 2021). Long-term fertility, which occurs with early menarche and late menopause, is among the most significant risk factors for breast cancer. Overweight after menopause, hormone replacement therapy, lack of physical activity, and alcohol consumption have all been linked to an increased risk of breast cancer (Jiang et al., 2022; Vinogradova et al., 2020). Pregnancies and breastfeeding, on the other hand, can be among the preventive factors (Ghoncheh et al., 2016). Limited data on breast cancer incidence rate and geographical distribution are the main impediments to the better planning health status and etiological studies, as a result of the scarcity of research on this subject (Ghoncheh et al., 2016). A limited number of research on cancer incidence have been conducted in the Kurdistan Region of Iraq, and hence, there is inadequate data on the latest changes in the prevalence of common cancers. To address this deficiency, this study was conducted to outline vital information and incidence of breast cancer in the region.

2. Study Sample, Results, and Discussion

This section contains the study sample, results of the data, and discussion.

a. Study Sample

All the breast cancer patients who were recorded in Nanakaly Hospital in Erbil, Iraq, from January 1st, 2016 to December 31st, 2020, were registered in this study. The study was approved by the Ethical Committee of Pharmacy College in Hawler Medical University. Data that was recorded included patient and disease characteristics. These data were tabulated and subjected to statistical analysis. This study does not actually indicate the real number of breast cancer cases in the Kurdistan Region because not all the patients were referred to this particular hospital, as there were other oncology centers in the region.

b. Results

The present study investigated a total number of 95 patients with breast cancer in the period between January 2016 and December 2020. All patients were in the age group between 25 and 70 years, and majority were from urban areas and were unemployed. Table (1) demonstrates incidence and characteristics of 95 cancer patients from 2016 to 2020.

Table 1. Patients Demographic Information.

Characteristic	Variable	Frequency	Percent (%)
Age	<25	1	1.1%
	25-50	45	47.4%
	51-75	48	50.5%
	>75	1	1.1%
Total	**95**		
Residency	Urban	89	93.7%
	Rural	6	6.3%
Total	**95**		
Employment	Employed	20	21.0%
	Unemployed	75	78.9%
Total	**95**		
Year of diagnosis	2016	13	13.7%
	2017	21	22.1%
	2018	26	27.4%
	2019	15	15.8%
	2020	20	21.1%
Total	**95**		

Majority of the studied patients with 67.7% underwent modified radical mastectomy (MRM) and only 32.3% underwent breast conserving surgery (BCS). All patients received axillary lymph node dissection (ALND) or sentinel lymph node biopsy (SLNB), and more than half had 0-3 positive lymph nodes. Approximately 60% of patients had more than three lymph nodes positive, and slightly less than 20% had 9 or more nodes positive. All the patients were diagnosed following presentation with a breast lump. The most common histopathology was invasive ductal carcinoma (IDC) with 84.8%. Invasive lobular carcinoma (ILC) constituted 16.3% of cases, and tubular carcinoma was diagnosed in 2 cases with 2.2%. Majority of patients were diagnosed with stage II and III disease with 45.7% and 40.2% respectively. Most of the patients had grade 2 disease with 73.4%. In regard to predictive markers, majority of cases were ER and PR positive with 87.4% and 85.5% respectively, and approximately a third of cases with 33.7% were

HER2 positive. Ki67 was <25 in 61.8% of cases. Table (2) demonstrates distribution of cancer cases according to histopathological subtype.

Table 2. Distribution of Cancer Cases According to Histopathological Subtype.

Characteristic	Variable	Frequency	Percent (%)
Surgery Type	Wide Local Excision	30	32.3%
	Modified Radical Mastectomy	63	67.7%
Total	**93**		
ALND or SLNB	Performed	93	98.9%
	Not performed	1	1.1%
Total	**94**		
Tumor Size	< 30 mm	44	47.3%
	30-50 mm	43	46.2%
	> 50 mm	6	6.5%
Total	**93**		
Number of positive nodes	0-3	55	59.1%
	4-8	21	22.6%
	> 9	17	18.3%
Total	**93**		
Stage at Diagnosis	Stage I	8	8.7%
	Stage II	42	45.7%
	Stage III	37	40.2%
	Stage IV	5	5.4%
Total	**92**		
Histopathological Type	Ductal	78	84.8%
	Lobular	15	16.3%
	Medullary	0	0.0%
	Tubular	2	2.2%
	Other	0	0.0%
Total	**95**		
Tumor Grade	Grade 1	3	3.2%
	Grade 2	69	73.4%
	Grade 3	22	23.4%
Total	**94**		
LVSI	Present	41	43.2%
	Absent	46	48.4%
	Unknown	8	8.4%
Total	**95**		
ER Status	Positive	83	87.4%
	Negative	12	12.6%
Total	**95**		
PR Status	Positive	81	85.3%
	Negative	14	14.7%
Total	**95**		
Her2 Status	Positive	32	33.7%
	Negative	63	66.3%
Total	**95**		
Ki67 Percentage	<25%	55	61.8%
	25-50%	27	30.3%
	51-75%	5	5.6%
	>75%	2	2.2%
Total	**89**		

Patients received chemotherapy in either adjuvant or neoadjuvant setting. In neoadjuvant setting, regimens included AC (3%), AC-T (5.4%), No FEC, FEC-T (1.1%), TC (1.1%) and others (1.1%); whereas in adjuvant setting, regimens included AC (18.5%), AC-T (48.9%), No FEC, FEC-T (2.2%), TC (4.3%) and others (2.2%). Adjuvant radiotherapy was given to 62.8% of patients, while adjuvant anti-HER2 therapy and adjuvant Bisphosphonates were used in 33% and 17 % of patients respectively. Table (3) demonstrates therapeutic interventions of cancer cases.

Table 3. Therapeutic Interventions of Cancer Cases.

Characteristic	Variable	Frequency	Percent (%)
Neoadjuvant Chemotherapy	None	82	88.2%
	AC	3	3.2%
	AC-T	5	5.4%
	FEC	0	0.0%
	FEC-T	1	1.1%
	TC	1	1.1%
	Others	1	1.1%
Total	**93**		
Adjuvant Chemotherapy	None	22	23.9%
	AC	17	18.5%
	AC-T	45	48.9%
	FEC	0	0.0%
	FEC-T	2	2.2%
	TC	4	4.3%
	Others	2	2.2%
Total	**92**		
Adjuvant Radiotherapy	Not Used	35	37.2%
	Used	59	62.8%
Total	**94**		
Adjuvant Hormonal Therapy	None	13	13.8%
	Tamoxifen	34	36.2%
	Aromatase Inhibitors	47	50.0%
Total	**94**		
Anti-Her2 Therapy	Not Used	63	67.0%
	Used	31	33.0%
Total	**94**		
Adjuvant Bisphosphonates	Not Used	78	83.0%
	Used	16	17.0%
Total	**94**		

c. Discussion

The number of women diagnosed with breast cancer rises in accordance with the increase in average lifespan, resulting in an even greater rise in the number of elderly women diagnosed with breast cancer (Louwman et al., 2007). Cancer patients frequently present with a variety of symptoms and complications, making treatment of those patients a serious concern. Early detection of the disease, prior to the appearance of signs and symptoms, significantly improves the quality of care (Mjali et al., 2021). This study aimed to analyze clinico-pathological and epidemiological pattern of breast cancer patients registered in Nanakali hospital in Erbil city over a period of 5 years. It has been reported that 5-year survival for women with breast cancer was 76% for women less than 74 years and 69% for women above 75 years (Kunkler et al., 2015). In terms of past publication from 2020 experience, 86% of breast cancer patients were housewives (Abdulrazzaq & Ahmed, 2020). It has been revealed in several studies that the urban population constituted majority of breast cancer cases. This is correlated to overweight due to absence of daily physical activity (Kartal et al., 2013). Age of patients, stage at diagnosis, and comorbidity were found to be negatively associated with rate of survival in the multiple regression model. Breast cancer management requires a multidisciplinary approach, including surgery, chemotherapy, and radiotherapy, all of which require additional resources. Moreover, expertise in identifying genes linked to breast cancer necessitates precise procedures and incurs enormous costs (Yip et al., 2015). In a study, infiltrative ductal carcinoma (IDC) was found the most common type of breast cancer with 76.6%. Infiltrative lobular carcinoma constituted 5.46% (Amir et al., 2009). In HER2-positive tumors, the presence of carcinoma in situ was significantly lower. In addition, a significant correlation was found between the presence or absence of axillary lymph nodes and the various molecular subtypes (Al-Thoubaity, 2020). Stage and lymph node involvement were reported to be one of the main important factors associated with survival rate (Schwartz et al., 2014). In regard to tumor grade, majority of patients in the present study were grade II with 73.4%. Only 2.3 % of patients were grade I and 23.4% were grade III. Previous research has shown that late-stage diagnoses and a lack of adequate treatments accounted for more than a half of all cancer deaths worldwide in developed countries (Dunyo et al., 2018; Wijeratne et al., 2021). Many factors, including insufficient screenings, lack of education, and cultural awareness, have been linked to cancer diagnoses made at a late stage (Sathwara et al., 2017; Swinny et al., 2022). As a consequence, several breast cancer cases are only discovered in their later stages.

3. Conclusions

Breast cancer is the most frequently diagnosed cancer in women and ranks second among causes for cancer related death in women. Slightly less than a hundred patients with breast cancer in the Kurdistan Region of Iraq were investigated to shed light on epidemiological aspects of the disease. It was revealed that most patients were urban. Approximately 46% were stage II at diagnosis, and 40% were stage III. The majority of cases were hormone receptor positive and HER2 negative. Generally, our results were consistent with study results undertaken elsewhere in the world.

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Research Article

Variety of Antibody Responses to BNT162b2 and BBIBP-CorV Vaccinations Against COVID-19 Infections in Baghdad and Fallujah, Iraq

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Abstract

The huge impact of COVID-19 worldwide led to the rapid development of vaccines with inadequate data about its longevity, effectivity, and safety. This study aims to evaluate the effectiveness and safety of COVID-19 vaccines available in Iraq and to measure longevity of created antibody response among different time points of both Pfizer-BioNTech and Sinopharm vaccines in Baghdad and Fallujah, Iraq.

A two-axis method was used: the first was cross sectional study on the vaccination state for COVID-19 in Baghdad and Fallujah, using an online survey contained questions about city, vaccine type, side effect, pre and post infections, and chronic diseases. The second part involved a prospective observational study of the vaccine's immunological effectiveness and stability in 60 serum samples from completely vaccinated individuals (second dose) of Pfizer or Sinopharm along different time points (1 - 6 months) by measuring the SARS-CoV-2 Anti-RBD-IgG concentration and evaluating its correlation with pre-infection with COVID-19.

Among different types of vaccines available in Iraq, people in Baghdad and Fallujah preferred Pfizer vaccine over other available types, particularly those with chronic diseases. No statistically significant difference was noticed between IgG concentrations at different points of time, IgG concentrations in Pfizer vaccinated individuals were more elevated than Sinopharm, and all of Pfizer vaccinated people showed positive results. Our study established a synergistic impact between recent COVID-19 infection and vaccination, leading to increased levels of IgG antibodies, notably in individuals who received the Pfizer vaccine. Additionally, our findings demonstrate that IgG concentrations remained stable in vaccinated individuals even six months after completing the vaccination with second dose.

Keywords: Antibody Responses, BNT162b2, BBIBP-CorV, COVID-19, IgG.

1. Introduction

The huge impact that COVID-19 had worldwide, increase morbidity and mortality, paralysing world economics, in addition to the psychological consequences on individuals and communities (Tsang et al., 2021) as the vaccine development process had to be fast and accurate. The current advance in molecular biology and genetics and the fact that almost all structural and functional components of SARS-CoV-2 have been deciphered, paved the way towards the development of several vaccine types (Marian, 2021). Urgency for vaccine development, along with the need to surpass certain trial requirements, placed immense pressure on researchers to conduct a thorough study of the vaccine's safety and efficacy. This was crucial in order to alleviate doubts or reservations among the general public (Lazarus, 2021). The need to promote vaccine uptake and prevent its transmission from COVID-19 infected individuals to others, including ineligible friends and family members and individuals at higher risk of severe illness, has prompted the need for a study on the efficacy of vaccines in Iraq particularly Baghdad and Fallujah cities, preference of vaccine type among male and female individuals, and the safety of vaccination for individuals with chronic illnesses.

Several published reports and studies have documented various side effects and efficacy outcomes associated with the administration of vaccines. Many of these studies have focused on investigating the duration of immunity conferred by the vaccine, as well as the interplay between vaccination and infection in modulating individual immune responses. Such investigations aim to elucidate the factors underlying differences in vaccine efficacy and immunity with the ultimate goal of optimizing vaccine strategies to enhance protective immunity (Almufty et al, 202; Bulut & Kato, 2020).

The study aimed to evaluate the effectiveness and safety of COVID-19 vaccines available, namely Pfizer's 'BNT162b2', Sinopharm's 'BBIBP-CorV', and Oxford-AstraZeneca's 'ChAdOx1', in some areas of Iraq. For the rest of the paper, the vaccine types will be referred to by their company names for simplicity. In addition, our study aimed to report the vaccine with the highest side-effects, the effect of recent infection or post-infection on side-effect, to measure the SARS-CoV-2 Anti-RBD-IgG concentration in different time points after periods of 1, 2, 3, 4, 5, and 6 months of vaccination to estimate the duration of antibody lasting and the decrease in antibody titer over time. Furthermore, we investigated the relationship between recent infection (one that has occurred more than two- three weeks prior to vaccination) (Centers for Disease Control and Prevention, 2021) and the type of vaccine and individual's age and gender in response to the time points.

2. Material and Methods

The first part of the study is a survey on the vaccination state of COVID-19 vaccines in Baghdad and Fallujah, which was conducted on 498 participants. The questionnaire was distributed from 20 August 2021 using an online survey platform to 20 November 2021. The following information was collected in the questionnaire: gender, age, address, having any chronic diseases, an infection of COVID-19 before vaccination, type of vaccine (restricted to the types used in Iraq: Pfizer, Sinopharm, and Oxford-AstraZeneca), number of doses, side-effects following vaccination, and infection with COVID-19 after vaccination.

The second part of the study was carried out at the laboratories of the College of Applied Sciences, University of Fallujah in Falluja, Iraq with the aim of quantifying IgG antibody concentrations in randomly selected samples of forty-six blood specimens. The specimens were obtained from individuals residing in Fallujah city who had been fully vaccinated two doses with either Pfizer or Sinopharm vaccines between the 30 of December 2021 and 26 of January 2022. The study participants were asked to provide information about their age, gender, vaccination status including type of vaccine received, and time elapsed since completion of the second dose ranging from 1 to 6 months for each vaccine type. In addition, any prior COVID-19 infections were assessed to exclude any confounding effects of infection-induced antibodies on the measured vaccine-induced antibodies. Notably, none of the selected blood specimens exhibited evidence of SARS-Cov2 infection after vaccination.

Venipuncture was used to collect blood samples drawn into gel tubes containing a clotting activator. The samples were then centrifuged at 1210 xg for 10 minutes (BOECO, Germany). The supernatant was transferred to plain tubes and stored at -18° C until further use.

2.1. Determination of IgG Concentration Using MINI-VIDAS Immune Analyser

Serum samples were used after warming to room temperature, then using VIDAS® SARS-COV-2 IgG (BIOMÉRIEUX, France) kit, SARS-COV-2 IgG test was performed by MINI-VIDAS immune analyser (BIOMÉRIEUX, France). Results were interpreted as follows:

$i < 1.00$	Negative	IgG antibodies to SARS-CoV-2 (not detected)
$i \geq 1.00$	Positive	IgG antibodies to SARS-CoV-2 (detected)

2.2. Statistical Analysis

The Statistical Analysis System- SAS (2012) and SPSS v.26 programs was used to conduct a Chi-square test to compare percentage under probability (0.05 and 0.01).

3. Results

The t study surveyed a sample of 498 individuals who had been vaccinated with one of three available vaccines against COVID-19, namely (Pfizer's 'BNT162b2', Sinopharm's 'BBIBP-CorV', and Oxford-AstraZeneca's 'ChAdOx1'). Our results indicate that the Pfizer vaccine was significantly preferred by residents of Baghdad and Fallujah as demonstrated in Table (1).

Moreover, the data collected from the study group, which represents a subset of the Iraqi population, revealed significant age-related differences ($p<0.01$) in vaccination uptake regardless of the vaccine type. The highest number of vaccinated individuals (377) belonged to the young adults (20-29 years old), the majority of which received the Pfizer vaccine (see Table 1).

Table 1. The distribution of vaccinated individuals with different types of vaccines according to their ages and gender state.

Type of vaccine/Age groups	Pfizer		Oxford- Astrazeneca		Sinopharm		Total
	Male	Female	Male	Female	Male	Female	
<20 year	12	27	3	4	4	8	**58**
20-29 year	81	223	7	12	23	31	**377**
30-39 year	12	10	24	15	24	21	**106**
40-49 year	15	5	9	9	32	8	**78**
>50 year	21	18	12	13	20	9	**93**
Total	**141**	**283**	**55**	**53**	**103**	**77**	**498**

Our results also revealed that among the vaccinated individuals, those who received the Pfizer vaccine experienced significantly higher incidence of side effects, with fever being the most predominant (220 cases), followed by fatigue and pain at the injection site, as shown in Table (2).

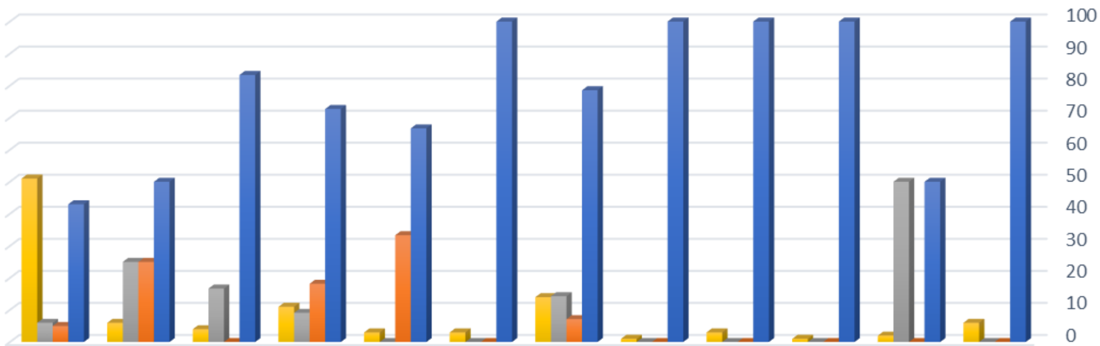
Table 2. Number of vaccinated individuals with three types of vaccines classified based on having specific types of side effects after first and second doses of vaccination.

Type of Vaccine	Fever	Fatigue	Nausea	Headache	Pain At Injection Site	Muscle Pain	Lymph Enlargemen t	Tachycardia
PF	82%	82%	88%	89%	88%	83%	100%	100%
AS	8%	7%	0 %	5%	6%	6%	0%	0%
SI	10%	10%	13 %	6%	6%	11%	0%	0%
Total	**220**	**164**	**8**	**79**	**140**	**36**	**3**	**3**

Out of the total 498 vaccinated individuals, 51 were identified as having recent chronic diseases, and these cases were distributed as shown in Figure (1).

The analysis revealed significant differences in vaccine preference among individuals with chronic diseases, with the Pfizer vaccine being the most commonly chosen option. In addition, no significant correlation between recent COVID-19 infection and the incidence of contraindications after vaccination. Moreover, the vaccination does not seem to prevent infections with COVID-19 later; neither after partial (first dose) nor complete vaccination (second dose), as shown in Table (3).

The second part of our study investigates the difference in IgG concentrations between two types of COVID-19 vaccines, Pfizer and Sinopharm over different periods, and the results demonstrated significant difference ($P=0.034$). The study included individuals with a mean age of 23.5 years and no significant correlation between IgG concentrations and gender was found.



	total number of vaccinated for the vaccine	bronchial allergy or bronchitis %	asthma %	diabetes %	heart disease %	hyper allergy %	hypertension %	hypothyroidism %	migrain %	polycystic ovarian disease %	tachycardia %	non detected disease %
PF	43	50	83	73	67	100	79	100	100	100	50	100
AS	5	25	0	18	33	0	7	0	0	0	0	0
SI	6	25	17	9	0	0	14	0	0	0	50	0
total number	51	6	4	11	3	3	14	1	3	1	2	6

Figure 1. Percentage of patients vaccinated with specific vaccine relevant to the presence of chronic disease.

Table 3. Distribution of (Pfizer and Sinopharm vaccines) vaccinated individuals, based on their recent infection and post-infection status.

Type of vaccine	Recent infection	Post-infection	Total patient vaccinated
PF	82%	84%	402
AS	4%	16%	30
SI	13%	0%	66
Total	**210**	**25**	**498**

The results indicated a significant difference in IgG concentrations between the two vaccine types studied with Pfizer-vaccinated individuals exhibiting higher concentrations than Sinopharm-vaccinated individuals. In the first few months after vaccination, the IgG concentration results for the Pfizer group were convergent but lower than the initial period, with no significant differences between those periods. In contrast, the highest concentration of IgG in the Sinopharm group was observed six months after vaccination (20.1950 ± 18.91924) as shown in Table (5).

The difference in IgG concentrations between individuals with recent COVID-19 infection and those with no recent infection have been examined and the results show that those with recent infection had higher IgG concentrations (21.3880±15.89587) than those without, but the difference was not statistically significant. This indicates that the production of IgG as a response to infection did not significantly affect the IgG concentration resulting from vaccination as demonstrated in Table (4).

Table 4. IgG concentration distribution means based on the onset of recent infections with two types of vaccine (BNT162b2 and BBIBP-CorV).

Infection	Mean	SD	No.
NO	19.6943	15.47323	35
YES	21.3880	15.89587	11

able 5. IgG concentration of individuals with different types of vaccine (Pfizer ‘BNT162b2’ and Sinopharm ‘BBIBP-CorV’) according to the period of vaccination and gender.

Period after vaccination	Type of vaccine	Gender	Mean	SD	No. of samples
1M*	PF	F	39.4025	6.08782	4

		M	0	0	0
		Total	39.4025	6.08782	4
	SI	F	2.1700	-	1
		M	0	0	0
		Total	2.1700	-	1
	Total	F	31.9560	17.46562	5
		M	0	0	0
		Total	31.9560	17.46562	5
2M	PF	F	36.2500	6.59024	2
		M	35.7067	10.39968	3
		Total	35.9240	8.06369	5
	SI	F	2.4800	-	1
		M	0	0	0
		Total	2.4800	-	1
	Total	F	24.9933	20.04628	3
		M	35.7067	10.39968	3
		Total	30.3500	15.44135	6
3M	PF	F	28.2300	9.77222	2
		M	36.7933	3.37000	3
		Total	33.3680	7.17995	5
	SI	F	25.4200	-	1
		M	4.0050	.00707	2
		Total	11.1433	12.36396	3
	Total	F	27.2933	7.09790	3
		M	23.6780	18.11632	5
		Total	25.0338	14.33314	8
4M	PF	F	22.7467	14.07661	3
		M	18.6900	-	1
		Total	21.7325	11.67111	4
	SI	F	3.9533	2.26144	3
		M	.2700	-	1
		Total	3.0325	2.60790	4
	Total	F	13.3500	13.68440	6
		M	9.4800	13.02491	2
		Total	12.3825	12.69661	8
5M	PF	F	14.5650	8.54892	2
		M	30.2133	6.64894	3
		Total	23.9540	10.66941	5
	SI	F	0.4500	0.22650	3
		M	0.4900	0.53740	2
		Total	0.4660	0.31358	5
	Total	F	6.0960	8.83553	5
		M	18.3240	16.94755	5
		Total	12.2100	14.27879	10
6M	PF	F	22.5725	9.81420	4
		M	10.7700	-	1
		Total	20.2120	10.00493	5
	SI	F	20.2150	19.77778	2
		M	20.1750	26.12760	2
		Total	20.1950	18.91924	4
	Total	F	21.7867	11.72626	6
		M	17.0400	19.25644	3
		Total	20.2044	13.57483	9
Total	PF	F	27.8959	11.79563	17

		M	30.6909	10.27705	11
		Total	28.9939	11.11313	28
	SI	F	7.6100	11.34143	11
		M	7.0871	14.01215	7
		Total	7.4067	12.04279	18
	Total	F	19.9264	15.22768	28
		M	21.5117	16.48088	18
		Total	20.5467	15.56769	46

* A significant difference (p value=0.03) between IgG concentrations in types of vaccines along different time points.

4. Discussion

With the emergence of new variants of the SARS-CoV-2 virus, the importance of minimizing the negative effects it had on the human communities became crucial to restore normal life routine. Many vaccines have been developed, and it became necessary to study their side effects and effectiveness in minimizing the risk of disease. Such studies may aid addressing some mis-informed persons and to dispel any misinformation surrounding them.

The result suggests that, out of the Pfizer, Sinopharm and AstraZeneca vaccine types available in Iraq, Pfizer vaccine is the most acceptable and chosen vaccine in Baghdad and Fallujah cities. The preference of the Pfizer vaccine is likely to be due to its reputation based on the report published by the Centers for Disease Control and Prevention (2022).

There appears to be gender difference in the willingness to take different COVID-19 vaccines in our study, with females showing greater reluctance towards receiving the AstraZeneca and Sinopharm vaccines, with 53 and 77 vaccinated female individuals, respectively, compared to a total of 283 female individuals vaccinated with the Pfizer vaccine. This may be attributed to published reports indicating a higher incidence of adverse effects in females vaccinated with AstraZeneca, including life-threatening clotting issues (Urakawa, 2022). This finding is consistent with the results reported by Almufty (2021) stating that "*female gender was at significant risk factor for adverse effects (P value 0.028) where younger individuals and females tend to develop stronger immune responses than older individuals and males*".

Of the 332 women included in the study, 259 experienced a range of significant side effects, which may be explained by many factors; some are related to the general female immune response to vaccines (Demonbreun, 2021), and some are related to SARS-CoV-2 vaccines exclusively (Fischinger et al., 2019).

According to Ricotta, 2022, COVID-19 poses a threat to chronic disease patients. Therefore, the tendency of chronic disease patients toward the Pfizer vaccine more significantly, can be attributed to several factors that influence their choice of vaccine type. These factors include the lack of sufficient information regarding the safety of vaccines for individuals with chronic diseases, the guidance provided by Iraqi government healthcare authorities, and the recommendations from the World Health Organization (WHO) encouraging these patients to receive vaccination in order to mitigate the heightened risk of contracting the infection. (World Health Organization, 2022) All of these factors may cause such patients to choose the 'safest' vaccine type based on available information. According to the report of WHO, 2021 the AstraZeneca vaccine was mainly administered to individuals aged 50 years and older, most of which had comorbidities.

In a study by Almufty, 2021 both ages of participant (less than 50 years old) and gender factors affected AstraZeneca vaccinated individuals, particularly those with comorbid disease such as hypertension, diabetes, asthma, etc., who represent the most susceptible people to develop symptoms after vaccination, especially in females. Other studies suggested that COVID-19 infections in type 1 diabetic's patient for example, may be more fatal (Grzelakowska, 2021 & Gurbel, 2021).

According to the published information by (CDC, 2022), the most commonly reported systemic side-effects were fever, fatigue and headache, which agrees with the findings of Almufty et al. (2021), which were significantly higher in AstraZeneca followed by Pfizer and Sinopharm vaccines.

The largest number of adverse effects obtained in this study was from the Pfizer vaccine. While most of these effects were mild contraindications, the higher number may be attributed to the fact that the largest number of individuals in the study were vaccinated with the Pfizer vaccine. However, it has been stated that three cases of tachycardia reported in individuals who received the Pfizer vaccine, which were not related to the presence of pre-existing chronic tachycardia prior to vaccination.

According to a study by Kang (2021) the presence of intense local or systemic reactions after a second dose of BNT162b2 vaccine can be attributed to the mRNA vaccines structure, and lipid nanoparticle (LNP) delivery agents, such as LNPs and polyethylene glycol. It is important to note that adverse events, while associated with stronger immune responses may have implications for antibody production. Subsequently, the occurrence of fewer adverse events could potentially lead to reduced levels of antibody production (Mitchell & Casella, 2017).

The humoral antibody response (measured by IgG titers) was evaluated following vaccination with Pfizer and Sinopharm vaccines. AstraZeneca was excluded from the study due to the small number of individuals been vaccinated with it at the time (Buonfrate et al., 2021; Polack et al., 2020). The persistence of antibody levels up to 6 months after the second dose of the vaccine (ranging from 1 to 6 months) have been assessed. Sinopharm produced lower IgG concentration with a number of seronegative patients compared to Pfizer, representing a lower effectiveness of this vaccine (Ferenci & sarkadi, 2022).

A drawback that was encountered in the study was that IgG in the period (1-6 months) for the same patient were not assessed. This was caused by the length of time required for watching and measuring IgG and the difficulty of monitoring the patients for this extended period. The study results indicated higher IgG concentrations in Pfizer-vaccinated than Sinopharm-vaccinated individuals as shown in Table (5). Additionally, it is noteworthy that a significant proportion of vaccinated individuals in this study were either asymptomatic or experienced minimal symptoms. As a result, their antibody production levels may be comparatively lower (Demonbreun et al., 2021).

All participants in the study vaccinated for Pfizer were seropositive for IgG. The mean concentration of IgG after one month of vaccination with Pfizer was 39.4025±6.08782 IU/mL which is higher than the results obtained by Heyming (2021) where 98.4% tested positive for IgG and the average was 22.1 after 17–36 days of patients that received BNT162b2.

The presence of mild to more severe symptoms during past SARS-CoV-2 infection has been shown to enhance antibody response after vaccination (Buonfrate et al., 2021). The efficacy of the BNT162b2 vaccines against symptomatic laboratory-confirmed SARS-CoV-2 infection has been reported in a large randomized controlled clinical trial as 95% after the second dose of the vaccine (Walsh et al., 2020; Polack et al., 2020).

The potential correlation between age and the level of immune response (IgG concentration) have not been investigated due to the distribution of data that have been collected. The average age of the study's participants was 23.5 years which may indicate the presence of good antibody response in Pfizer vaccinated individuals. Additionally, as the immune system tends to weaken with age, it may result in a less robust immune response to vaccines in older individuals compared to younger ones. Moreover, it has been observed that women generally mount stronger immune response than men, which may also contribute to differences in vaccine response between genders (Fischinger et al, 2019).

The study states a decline in the overall antibody titre observed with increasing age in the case of Sinopharm vaccine. Additionally, a significant proportion of elderly individuals (>50 years) vaccinated with Sinopharm vaccine had undetectable antibody levels.

The results show that Pfizer vaccine is the most, and Sinopharm and AstraZeneca vaccines are the least, vaccines used in Baghdad and Fallujah cities of Iraq amongst the populations that have been examined. The highest age group recipient of vaccines was 20-29 years. IgG concentrations after vaccination with Pfizer vaccine was significantly higher than Sinopharm vaccine. There were no significant differences in IgG concentrations observed between different time points up to six months after complete vaccination (two doses). Additionally, recent infection did not appear to have an effect on IgG concentration after a two-dose vaccination.

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