Enhancing Oximeter Accuracy: Evaluating Temperature, Nail Polish, Artifacts and Shielding Factors through Measured Data

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***Abstract*— A pulse oximeter is an important medical device that tells you how well your body is working and monitors abnormal heart rate and oxygen saturation. While it is mainly used in medical settings, it has slowly been transferred to homes.**
The aims of this study are the development and evaluation of a pulse oximeter and its transfer to the finger and thigh for appropriate, friendly use, cheapness, reliability, and correctness.
Our goal is to give you a completely different understanding of the pulse oximeter and to use it more carefully when you use it because of the factors that affect its reading accuracy.
It investigates how nail polish, temperature, finger position (Anterior and posterior), finger size, gender, age, time of the day, artefacts, and indoor/outdoor affect detail, height, BSA, and Shielding Factors.
***Index Terms*— Oximeter, Artifacts, Temperature, nail polish, age, Gender.**

I. Introduction

When we talk about a pulse oximeter, we think of red blood cells that contain haemoglobin because it counts the amount of haemoglobin that carries oxygen. Red blood cells carry oxygen throughout it.
The body uses red blood cells to carry oxygen throughout it. Haemoglobin is the oxygen transporter found in red blood cells in all vertebrates except for fish. Iron is found in haemoglobin, which makes up 96% of the dry weight of a red blood cell [1]. Haemoglobin is present in all human bodies. An adult male's average haemoglobin level ranges from 13.8 to 17.2 g/dL [2]. A healthy adult female's haemoglobin level should be between 12.1 and 15.1 g/dL. Haemoglobin consists of a pair of alpha and beta globin chains; the oxygen-linked hemi group is present in every globin chain; the structure of haemoglobin is shown in Figure (1); this shape makes it easy

for oxygen to bind to the lungs and distribute throughout the body.

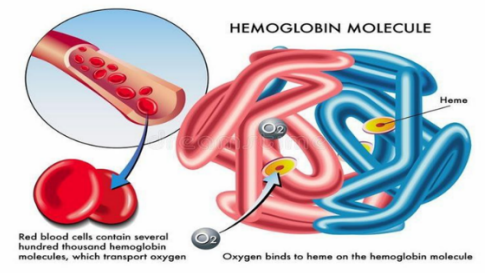

Fig (1); Haemoglobin molecule

II. Background

Oxygen saturation (SPO2%) is essential as a patient's vital sign. Patient's vital signs. The pulse oximeter was developed in 1907 by Takuo Aoyagi. Still, in the 20th century, it was a sophisticated and extensive device used only in clinics [3], but later changed to a small and painless device, as can be seen in Figure (2), that can be made available to a wide range of users respiratory diseases in non-clinical environments.

Fig (2); Pulse oximeter device.

Pulse oximeters are very important in ICUs or intensive care units, operation rooms, and home or non-clinical care due to the increased incidence of respiratory and lung conditions and death during Apnea sleep due to respiratory arrest or diseases chronic obstructive pulmonary disease. Fortunately, there are now tools to check oxygen saturation levels (SPO2%) regularly.

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An indirect primary method is pulse oximetry.
Pulse oximeters during the COVID-19 pandemic were used more frequently, but despite this [4], a lot of attention was paid to pulse oximeters. However, there are still problems, such as a lack of consensus on accuracy, especially from one society to another, such as movement, ambient light, nail polish, finger size, and many other factors; this has led to continuous research to make our results more accurate.
Pulse oximeter Fortunately, we can use it at home, but be careful. Wash your hands. Keep your hands clean. Sit stable and straight. Do not move your hands. Do this until the numbers are constant on the pulse oximeter and measure it at least three times a day because different times affect the accuracy of reading blood oxygen saturation. Changes in blood oxygen saturation values should be taken seriously as they can be associated with a dangerous situation. For any case of low blood oxygen saturation, please do not ignore it and go to the hospital immediately, as it may be a life-threatening alarm [5].

User calibration is not necessary for pulse oximeters. Because of this, users must understand the device's inherent limits, which could result in inaccurate results. Only if the pulse oximeter can identify a modulation in transmitted light will it operate as intended. The signal will be reduced, and the device may make an error or be unable to obtain a measurement if perfusion is reduced and pulse amplitude is minimal [6].

III. MATERIALS AND METHOD

Throughout this study, we collected data from 294 people of both genders (83 males, 95 females, 36 school children, and 44 babies) who had no problems with participation and were non-smokers who agreed to participate. We have information from babies ages between [3 months years] and school children.We Fig (4): The value of SpO2% for different Heights of males.have data for women, such as nail polish (7 different colours such as red, dark, white, yellow, brown, and blue), and we have data for men working furn (4 different furn).This research uses a pulse oximeter device (Lpow A34) to measure oxygen saturation (SPO2%) and a Digital Sphygmomanometer Heart rate. And digital thermometer for measuring temperature in the furnace.In this research, using the Vernier caliper as a measuring device and evaluating different measurements such as the width and diameter finger size of body parts like fingers is very important for accurate medical evaluation.

In this research, a device, an illuminometer, or light meter, is used to measure light brightness in a certain place, measuring instruments for evaluating different measurements, unit measurements, and lux or foot candles.

In this sense, we used a microwave oven (Newal 50Hz 700W 230-240V) device that we took data for about 10 people who were using electric fields and magnetic fields as electrical fields and horizontal magnetic fields، which led to decreased accuracy in Spo2%. We took a heater and measured SPO2% to see if the heat (Newal) of the heaters affected it and if the mobile and internet (FTTH) waves influenced reading accuracy SpO2%.

Fig(3);Time of data acquisition on effect a microwave oven(Newal)

IV. RESULT AND DISCUSSION

1-Effect High on the pulse oximeter (SPO2%) reading:

Taller people have bigger lungs, which means they have more lung capacities.

Because of height (those with bigger chests typically have greater lung capacity overall) and Location (residents of high altitudes typically possess more capacity to offset the effects of decreased atmospheric pressure). Because men's airways are more extended than women's, the respiratory system experiences more particular resistance. Women need more oxygen than men do when exercising to the same degree because they must work more to breathe in order to live more deeply.

However, lifestyle (smokers and obese individuals typically have more excellent ventilation rates and lesser capacity) and blood oxygen saturation levels are influenced by a number of essential parameters, including general health, fitness, and respiratory function [7].

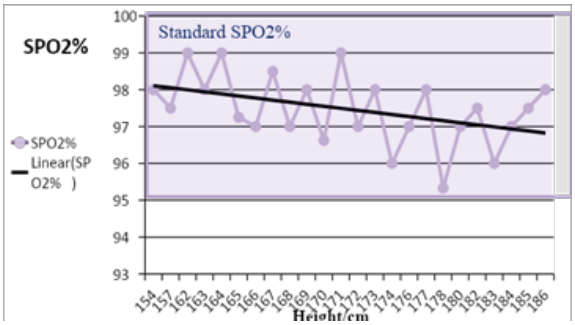

Fig (4): The value of SpO2% for different Heights of males.

2- Effect of temperature on the SPO2% reading;

The accuracy of a pulse oximeter is affected by temperature but for various reasons, such as changing the temperature of the sensor and affecting the accuracy and sensitivity or temperature affecting blood circulation. Incorrect readings in cold blood vessels narrow and reduce blood flow to the surrounding, which

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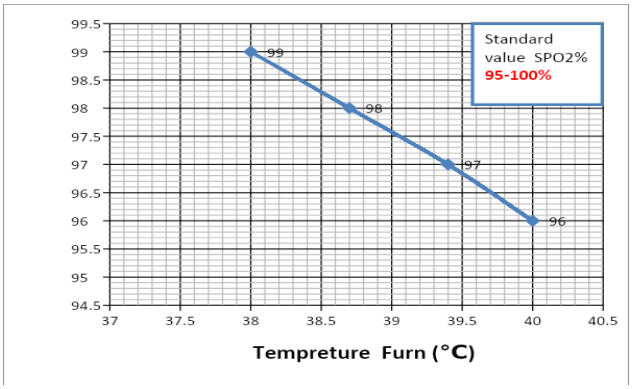
is an incorrect reading [8].

Lower body temperatures may impact the accuracy of pulse oximeters. This is because low perfusion and vasoconstriction brought on by cold extremities can make it challenging for the probe to pick up a strong pulse signal [9].

From figure (5), SPO2% for workers in furn warm temperatures result in vasodilation. High temperature causes blood vessels to dilate and increase blood flow. The relationship between temperature and blood oxygen saturation (SPO2%) is inverse and non-linear, but on the other hand, temperature may change the composition of blood protein structure [10].



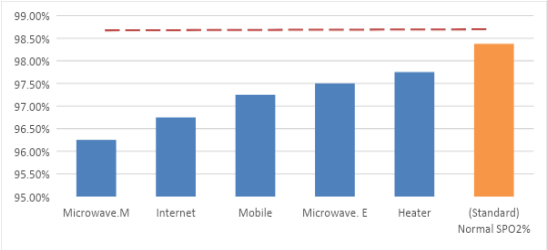
Fig(5): Effect temperature on the SPO2% in the bakery(furn).

3-Effect Artificate on the pulse oximeter (SPO2%) reading:

Radiofrequency EME is produced via satellite communications, smart meters, mobile phones and their base stations, and radio and television transmission. Microwave ovens are another source of radio waves [11].

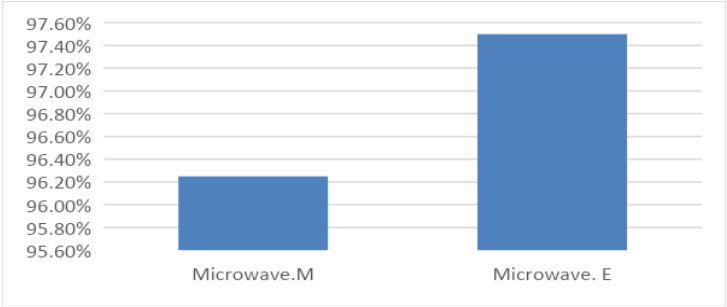
Infrared (IR) sensors in pulse oximeters can be affected by magnetic fields, IR radiation (from heaters) and cell phone release radiofrequency. These are hidden reasons that work in detail oxygen saturation (SpO2%).

Figure (6) shows that radiation emitted from mobile phones decreased the amount of light detected by the oximeter. Microwaves, a type of electromagnetic radiation related to radio waves, are used in microwave ovens to heat food. Microwaves enable their application in cooking: they are reflected by metal, and they pass through materials such as glass, paper, and plastic [12].



Fig(6); Effect Artificate on the SPO2% reading.

Absorbed by oxygen gas (Molecule O2) because of the way its magnetic moment interacts with electromagnetic fields .result absorption of energy from the microwaves. This interaction results in the absorption of energy from the microwaves by the oxygen molecules [13].

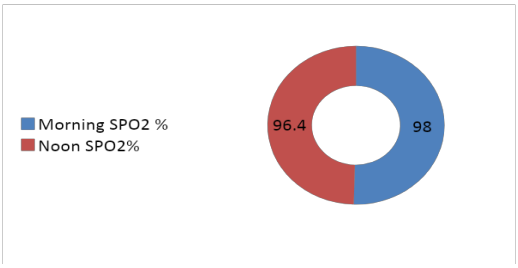


Fig(7); Effect of Magnetic field & Electric field with SPO2%.

4-Effect Time of the day on the pulse oximeter (SPO2%) readings:

Oxygen saturation (SpO2%) readings can fluctuate during the day due to factors such as physical activity and breathing patterns. Usually, oxygen saturation (SpO2%) levels may be slightly lower during sleep or in the early morning, which is influenced by factors such as posture and daily physical activity.

Fig(8): Effect Time of the day(morning, noon) on the pulse oximeter (SPO2%) readings.



In general, SpO2 levels are often stable around noon, but individual health factors can influence them. It is normal for oxygen saturation (SpO2%) levels to decrease naturally at night. In healthy people, the average oxygen saturation at night is approximately 96%, and the levels of oxygen may rise a little bit in the morning.

Because of respiration, oxygen concentrations can drop dramatically at night. Because photosynthesis has been going on all day, late afternoon is often when DO concentrations are at their maximum. Hypoxemia connected to sleep is usually the result of another medical problem. Hypoxemia brought on by sleep has been linked to a number of illnesses, such as pneumonia, sickle cell anaemia, and COPD [14]. Low blood oxygen levels during sleep can also be a symptom of central and obstructive sleep apnea.

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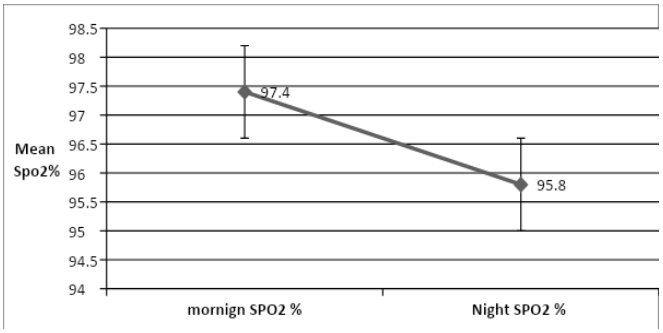


Fig (9): Effect Time of the day (morning, night) on the pulse oximeter (SPO2%) readings.

5-Effect of nail polish on pulse oximeter (SPO2%) readings:

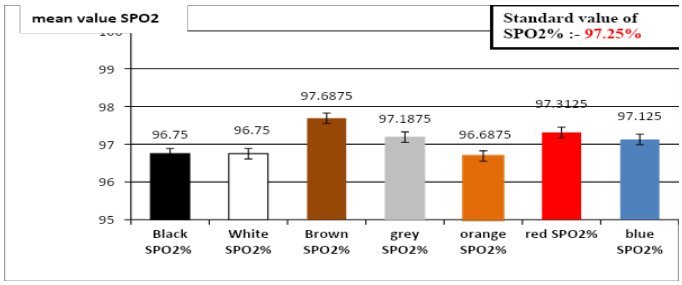
Nail polish, for the most part, contains solvents, film formers, shades, and extra substances. Added substances such as plasticisers, gums, and stabilisers are regularly included to progress the polish's viability and life span. Consequences of Nail polish [15], which is extensively used worldwide nail polish can interfere with the pulse oximeter reading, but this varies depending on the colour of the nail polish, which can lead to incorrect estimates because the sensor relies on light passing through the nail bed to determine blood oxygen saturation (SPO2%) depends on light passing through the nail bed to assess oxygen saturation levels.

Dark saturated fats may have a greater effect on blood oxygen saturation (SPO2%) and absorb light, affecting light transmission and reducing the amount received by the sensor, causing incorrect blood measurements. Therefore, it is best to remove nail polish before using the pulse oximeter [16].

However, nail polish cannot be removed in every case, for example, in a hospital emergency, so we have fortunately found a solution to this problem that involves placing your finger in a suitable Anterior(Dorsal position) oximeter [17].

Fig(10); dorsal position of hand during SPO2% measured.

Figure (11) shows the mean value of SPO2% versus Nail polish light-coloured, such as white nail polish, less affects pulse oximeter reading but dark-coloured, such as black nail polish, more affect pulse oximeter [18].



Fig(11); mean value of SPO2% versus the Nail polish effec

Brown-coloured nail polish retains a broader light range spectrum and a higher risk oxygen saturation (SpO2%) reading. Orange-coloured nail polish can result in the lowest readings (SPO2%) or inaccuracies in pulse oximeter because of the aptitude to absorb more light [19].

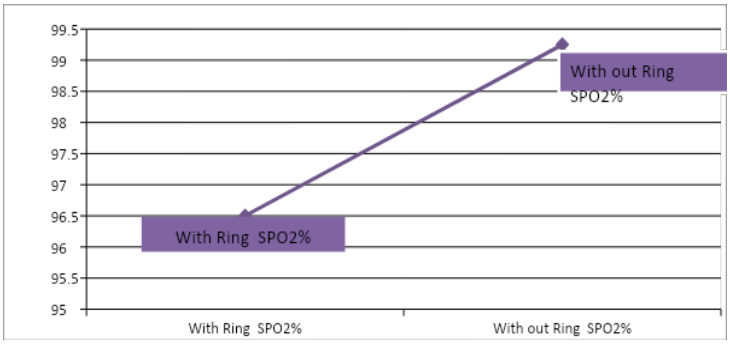
The red nail polish did not influence oxygen saturation levels. However, measures of white and black nail polish were affected.[20]

While lighter colours may cause less effect due to the expanded penetration of light, the difference, colour, and SPO2% are different.

6-Effect Ring on the pulse oximeter (SPO2%) readings:

Here, we will discuss the effect of the ring on the accuracy of the oxygen saturation (SpO2%) reading because it puts pressure on the finger and affects the blood flow in the area. One type of jewellery that is worn on the fingers is a ring. People wear rings for a variety of reasons, such as fashion, spirituality, religion, or emotional connections. Some people wear the same ring on the same finger for years at a time, which might be risky, mainly if you have changed your weight during that period[21].

Blood circulation ring effect: A condition known as Raynaud's phenomenon results in reduced blood circulation to the fingertips[22].



Fig(12); Ring Factor Effect to SPO2%.

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