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ORIGINAL ARTICLE

Effect of Different Dark Shade Nail Polish Colours on Pulse Oximetry SpO_2 Readings: A Clinical Observational Study

Aanchal Chaudhary[1], Krati Sharma[2], Aarushi Sharma[3], Shipra Gangwar[4]

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ABSTRACT

Background: Hospitalized patients frequently have their SpO_2 levels monitored using fingertip pulse oximetry. Although it is a practical, non-invasive tool, things like nail polish can compromise its accuracy. It is unclear whether and to what degree changing nail paint colors alter readings.

Objective: Using a fingertip pulse oximeter, determine how nine dark nail polish colors—black, yellow, brown, red, orange, pink, green, blue, and purple—affect SpO_2 values.

Methods: A total of one hundred hospitalized women, with an average age of forty-two, were included. Each fingernail received one of nine different nail paint colors; the tenth nail was kept naked as a control. A BPL OXYlite oximeter was used to measure SpO_2. Dunnett's multiple comparisons test ($p < 0.01$) and one-way ANOVA were used to analyze the data.

Results: The largest decrease in SpO_2 was caused by black nail polish (mean reduction 2.00 ± 0.93; $p < 0.0001$). Second place went to Red (1.81 ± 1.02; $p < 0.0001$). They were both statistically significant. The remaining colors showed no discernible changes: pink (0.17 ± 0.59), yellow (0.20 ± 0.57), orange (0.23 ± 0.58), purple (0.45 ± 0.59), brown (0.47 ± 0.73), blue (0.56 ± 0.69), and green (0.70 ± 0.94).

Conclusion: SpO_2 measurements were considerably lowered by black and red nail paint. To avoid erroneous readings and potential mistakes in clinical care, nail

AUTHOR'S AFFILIATION:

[1] Assistant Professor, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.

[2] Student, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.

[3] Student, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.

[4] Assistant Professor, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.

CORRESPONDING AUTHOR:

Shipra Gangwar, Assistant Professor, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.

E-mail: gangwardrshiprapt@gmail.com

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polish—especially deeper shades—should be removed before to pulse oximetry.

KEYWORDS

• SpO_2 • oxygen saturation • Nail paint • Fingertip oximeter • Pulse oximetry • Dark nail polish colors

INTRODUCTION

The fingertip pulse oximeter is one of the most commonly used devices in clinical settings for monitoring oxygen saturation (SpO_2). It works by passing red (660 nm) and near-infrared (940 nm) light through the finger and calculating the ratio of oxygenated to deoxygenated haemoglobin.[1] It is used across a wide range of situations — from post-operative recovery to emergency and intensive care — because it gives a quick, continuous reading without the need for blood sampling.

Like any device, the pulse oximeter is not perfect. Its accuracy can be affected by things like poor blood flow to the fingers,[5,6] high bilirubin or lipid levels in the blood,[9,10] bright ambient light,[3,4] injected dyes,[11] and dark skin pigmentation.[7,8] Nail polish in female patients is another factor that has been discussed in the literature,[2] but its effect is not clearly understood.

Nail polish contains coloured pigments that could absorb or scatter the specific wavelengths of light used by the oximeter. This can interfere with the signal and give a falsely low SpO_2 reading.[12] However, studies done so far have not agreed with each other. Some studies found that blue, purple, and black nail polish can reduce SpO_2 readings by 3–6%,[17,20,23,24] while others found no significant effect with these same colours.[18] For red and brown-red nail polish, the results have also been conflicting.[13,15,16,25]

Current clinical guidelines recommend removing nail polish before pulse oximetry, especially before surgery or in emergency situations.[1] In practice though, this is not always done — and in urgent situations, there simply may not be time. If it turns out that most nail polish colours do not affect readings, the blanket recommendation to remove all nail polish may need to be reviewed.

We carried out this study to look at how nine dark nail polish colours affect SpO_2 readings in hospitalised women, using a consistent measurement method and proper statistical testing.

METHODS

1. Study Design and Ethical Approval

This was a prospective observational study done at Teerthanker Mahaveer University Hospital. All participants were given a full explanation of the study and signed a written consent form before taking part.

2. Participants

100 women admitted to different departments of the hospital — respiratory, OBG, orthopaedics, general medicine, and surgery — were included. Their mean age was 42 years. Women with severe anaemia, abnormal nail beds, very pale or very dark finger skin, or conditions that could affect peripheral blood flow were not included. Any existing nail polish was removed before the study began.

3. Nail Polish Application

Nine non-glittered nail polish colours were applied — one per fingernail — in a fixed sequence: red, yellow, brown, pink, green, black, orange, blue, and purple. A single coat was applied to each nail. The index finger of the left hand was left bare as the control finger. Measurements were only taken after the polish had dried completely.

4. SpO_2 Measurement

A BPL OXYlite fingertip pulse oximeter was used. Participants sat in a comfortable position. The oximeter was placed on each finger one by one, from index to little finger on both hands, and the SpO_2 reading was noted only once the display had stabilised. The control (bare)

finger was measured last. All nail polish was removed after the study was complete.

5. Statistical Analysis

Data analysis was done using GraphPad Prism 9.0. SpO_2 values for each colour are reported as mean ± SD (n = 100). The reduction in SpO_2 compared to the bare control was also calculated for each colour. One-way ANOVA was used first to check for any overall differences across groups, and then Dunnett's multiple comparisons test was used to compare each colour against the control. A p-value of < 0.01 (99% confidence interval) was taken as statistically significant.

RESULTS

All 100 participants completed the study. SpO_2 was recorded from all ten fingers for each participant. The bare (control) finger showed a mean SpO_2 of 97.69 ± 2.28%, which was used as the baseline for comparison.

Black nail polish caused the greatest drop in SpO_2, with a mean reduction of 2.00 ± 0.93 (mean SpO_2 with black polish: 95.69 ± 2.53%; $p < 0.0001$). Red nail polish came next, with a reduction of 1.81 ± 1.02 (mean SpO_2: 95.88 ± 2.53%; $p < 0.0001$). These were the only two colours that showed a statistically significant difference from the control.

The remaining seven colours did not produce significant changes at the 99% or 95% confidence level. Among these, pink caused the smallest reduction (0.17 ± 0.59), followed by yellow (0.20 ± 0.57), orange (0.23 ± 0.58), purple (0.45 ± 0.59), brown (0.47 ± 0.73), blue (0.56 ± 0.69) and green (0.70 ± 0.94). Full results are shown in Table 2.

Table 1: SpO_2 values, mean reductions and statistical significance by nail polish colour (n=100)

Statistics	Black	Yellow	Brown	Red	Orange	Pink	Green	Blue	Purple	Without NP
SpO_2 Mean±SD	95.69±2.53	97.49±2.19	97.22±2.26	95.88±2.53	97.46±2.19	97.52±2.21	96.99±2.42	97.13±2.31	97.24±2.31	97.69±2.28
Reduction Mean±SD	2.00±0.93	0.20±0.57	0.47±0.73	1.81±1.02	0.23±0.58	0.17±0.59	0.70±0.94	0.56±0.69	0.45±0.59	–
p-value	<0.0001	0.49	0.87	<0.0001	0.98	0.99	0.19	0.42	0.67	–
Result	Significant	ns	ns	Significant	ns	ns	ns	ns	ns	–

NP = nail polish; ns = not significant; values as Mean ± SD; p-values from Dunnett's test

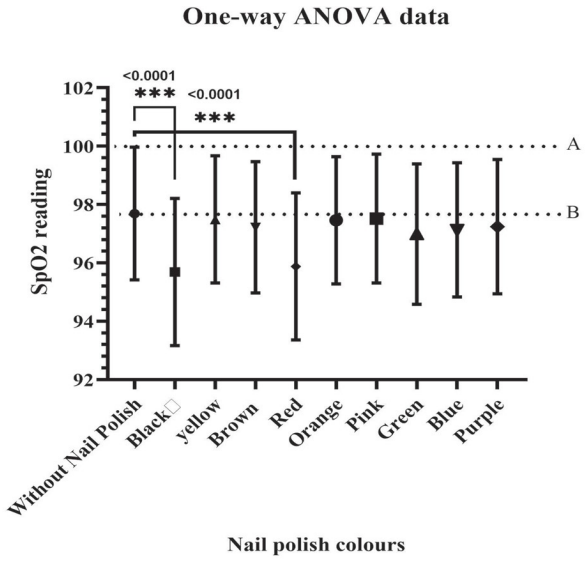

Figure 1: Mean ± SD SpO_2 values for each nail polish colour and bare nails (dotted line B). Black and red polish show clearly greater reductions compared to the rest.

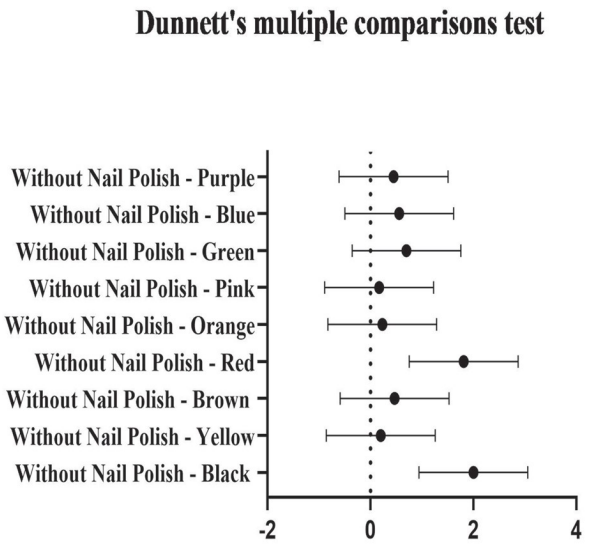

Figure 2: Comparison of SpO_2 reduction across nine nail polish colours. Pink showed the least impact; black showed the most. The gradient illustrates how colour shade relates to the degree of interference with oximetry readings.

DISCUSSION

Our study found that nail polish, particularly in dark shades, does affect SpO_2 readings. However, the effect was clinically and statistically significant only for black and red. This is an important finding because these are common nail polish colours, and their effect on oxygen saturation readings is large enough to potentially change clinical decisions.

The most likely reason for this interference is that dark nail polish pigments absorb light at the wavelengths used by the pulse oximeter — specifically around 660 nm and 940 nm. When this happens, the ratio of transmitted light changes, and the device calculates a lower SpO_2 than the actual value.[12,13] Black polish absorbs broadly across wavelengths, which explains why it had the biggest effect. Red polish, on the other hand, may absorb light in a way that mimics the spectral signature of deoxygenated haemoglobin, leading to a falsely low reading.[13,16,25]

The seven other colours tested did not reach significance, which partially agrees with earlier work by Yamamoto *et al.*[18] who also found no significant effect from multiple colours including blue and green. That said, some of the non-significant reductions in our study — particularly green (0.70%) and blue (0.56%) — are not trivial. In a patient with a borderline SpO_2 of 93–94%, even a small underestimation could prompt unnecessary intervention. A case report by Zhu *et al.*[27] documented exactly this kind of clinical error during thyroid surgery, where nail polish contributed to a false hypoxia reading that influenced the transfusion decision.

It is worth noting that none of our participants had cardiac disease or pre-existing hypoxia. So even though the reduction with black and red was statistically significant, it may not always translate into a clinically dangerous reading in healthy individuals. In contrast, patients with respiratory conditions, poor cardiac output, or borderline oxygenation are much more vulnerable to even small drops in SpO_2 accuracy.

Previous studies on this subject have shown varied results, and differences in oximeter brand and model, nail polish type, number of layers applied, participant characteristics, and measurement technique all contribute to the inconsistency.[14,19,21,22] In this study, we used a single coat of non-glittered polish and a consistent protocol, which helps with reproducibility.

There are limitations to keep in mind. This was a single-centre study with a relatively similar patient group. We did not test different brands of nail polish, multiple coats, gel nails, or acrylic extensions, all of which may behave differently. Interaction with other factors like low haemoglobin or poor peripheral circulation was also not specifically studied.

Based on our results, we recommend that nail polish be removed before pulse oximetry in clinical settings, especially if the patient is wearing black or red. Where removal is not possible quickly, the reading should be interpreted carefully, and the lateral surface of the finger or an alternative site such as the earlobe may be used.

CONCLUSION

This study shows that black and red nail polish significantly reduce SpO_2 readings measured by a fingertip pulse oximeter. The other seven dark shades tested — pink, yellow, orange, purple, brown, blue and green — did not produce statistically significant changes, though small reductions were still observed. The chromogenic properties of nail polish interfere with the light-based measurement used by these devices, and this can lead to false readings. We recommend removing nail polish, especially dark shades, before measuring SpO_2 — particularly in patients who are already at risk of hypoxia or who have underlying respiratory or cardiovascular conditions.

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