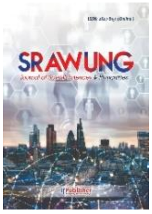

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Hazardous Implications of Large Format Printing on Graphic Design Operation in Nigeria

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ABSTRACT

This study addresses the occupational health implications of hazardous chemical air pollutants in Nigeria's Large Format Printing (LFP) industry. The aim is to raise awareness about the health implications of LFP with a view to proposing measures to safeguard the health of graphic designers during their professional engagement. The methodology employed was a quantitative design, utilizing a typical case sampling strategy to purposively select a single, active LFP press in Somolu for real-time digital air data collection. Samples for TVOCs and HCHO were collected using the Digital Air Quality Detector model VT-6-IN-1 over an 8-hour work shift on five consecutive working days. Based on this exposure time (ET) and exposure frequency (EF), Hazard Index (HI) at non-carcinogenic risks for full-time Operator Graphic Designers (OGDs) was calculated; for Freelance Graphic Designers (FGDs), appropriate ET and EF data were gathered from 150 respondents across 15 LFP shops. Findings reveal that OGDs face serious health challenges, with HI value 2.326 mg/m³ (>1) and exposure levels exceeding NESREA safe standard (TVOC=0.6 mg/m³ and HCHO=0.1 mg/m³). Health implications of this include potential respiratory and neurological injury. For FGDs, HI < 1 indicates safe exposure levels to both pollutants. The study concludes that there is an urgent need to safeguard the health of OGDs in the Nigerian LFP industry, highlights the need for wider free clinical checkups, improved regulatory enforcement, and the implementation of protective measures, such as enhanced ventilation systems, spacious printing workspace, and mandatory use of respiratory equipment with Organic Vapour (OV) cartridge.

Keywords: *Chemical Air Pollutants, Freelance Graphic Designers (FGDs), Health Hazard, Large Format Printing (LFP), Operator Graphic Designers (OGDs)*

INTRODUCTION

The industrial revolution, particularly Industry 4.0, generated ample opportunities in the development of the human race, which includes economic, social, and cultural growth (Ivaldi et al., 2022). It also features hazardous elements that are detrimental to human existence. Its impact is evident in the pollution of the press environment and destruction of human health via indoor and outdoor pollutants (Oláh et al., 2020). According to Pitarma et al. (2016), over ninety percent (90%) of people spend their time in indoor environments characterised by several pollutant sources. As such, the operational health implications of indoor air pollutants to the workforce are of great concern, particularly in recent times. This is peculiar to the printing environment, among other places where Total Volatile Organic Compounds (TVOCs) such as: acetone, arsine, styrene, glycerin, hydrogen sulfide, methylene chloride, nitric oxide, benzene, ethylene, xylene, toluene, tetrachloroethylene etcetera is released. Formaldehyde (HCHO) and particulate matter are equally released during the printing process (Ayeni et al., 2024; Shakir et al., 2025). The sources of these pollutants could be traced to paper dust, ink odour, and organic solvents fume, as evident during the printing production process (Pongboonkhumlarp & Jinsart, 2022). Printing inks, such as cold-set, laser toner, and solvent-based for Offset, direct imaging, and large-format printing, respectively, are sources of volatile organic components and particulate matter capable of building serious health challenges for printing.

In Nigeria, the adoption of digital printing technologies could be traced back to Direct Imaging Offset Printing (DIOP) of Planet Press Limited in 2002, of which nonimpact Direct Image Printing (DIP) and Large Format Printing (LFP) followed suit in the 21st century (Abiodun & Kalilu, 2023). The adoption of digital printing technologies in the country reflects a broader global trend where digital tools and platforms are transforming professional operations, significantly impacting service delivery efficiency (Sain et al., 2025).

In Large-Format Printing (LFP), the image is created directly from digital data and transmitted by spewing ink to create electronic images on specific substrates (Kwon et al., 2020). During this nonimpact printing exercise, large-format presses emit harmful active air into the printing environment. The emission usually takes a longer time to evacuate the printing environment, after the active period of the printing machines (Stefaniak et al., 2021). Hence, there is a need to examine the exposure to the concentration of air pollutants in the printing environment, particularly the degree of harm and extent of health implications on production personnel in the graphics and printing industry.

Traditional occupational health assessments in the printing industry have primarily focused on press operators, prepress technicians, and finishing personnel, and often overlooking the unique and increasingly central role of graphic designers (Ibrahim et al., 2019; Panchani et al., 2026; Singh et al., 2026). This study introduces a novel categorisation framework that recognizes graphic designers not as homogeneous production professionals, but as those with distinct exposure profiles based on their employment context and technological specialization. By grouping designers into two primary categories: In-House Designers and Freelance Designers. In-house designers are further divided into Quality Assurance Designers (QADs) for offset printing and Operator Graphic Designers (OGDs) for nonimpact printing, such as Large Format Printing (LFP). Professional satisfaction and the effectiveness of these practitioners in Nigerian printing industries are significantly influenced by educational qualifications and years of experience, rather than just age or gender (Olusoji, 2023).

Shi et al. (2022) acknowledge those categorization that a graphic designer's relationship to printing processes, whether combined as a machine operator, quality assurance specialist, or solely a freelancer, fundamentally shapes their exposure duration to chemical pollutants in the printing workspace. Cantamessa et al. (2020) also believe that this framework responds to the evolving nature of graphic design practice, where technological accessibility has merged traditional boundaries between creative conceptions, designing, and physical production, creating new occupational health challenges that require role-specific assessment and operational intervention strategies to mitigate health implications associated with the profession.

In-house graphic designers represent professionals employed in organisations for production capabilities. OGDs represent multi-functional professionals who combine design expertise with hands-on equipment operation, primarily in nonimpact printing industry. This role is most prevalent in smaller studios and in-plant facilities where specialised staffing is limited, requiring designers to both create designs and operate the equipment that produces them (Shawon, 2022). The convergence of these functions in nonimpact digital printing technologies, particularly large-format printing, has made this dual role increasingly common in Nigerian printing hubs.

However, freelance designers representing independent professionals who work with various printing providers typically lack a fixed production workspace. This category encompasses designers working across several digital printing technologies such as Digital Offset Printing (DOP), Direct Imaging Printing (DIP), and Large Format Printing (LFP). The designers, by their transient nature and relationship to the production workspace, spend limited work hours within chemical polluted environment. While this designer’s categorization acknowledges multiple responsibilities of graphic designers, indicating possibilities of exposure to hazardous air pollutants in the printing industry, the subsequent analysis concentrates specifically on chemical exposures, with a detailed examination of Total Volatile Organic Compounds (TVOC) and Formaldehyde (HCHO) as representative and significant chemical hazardous elements in the LFP industry.

Against this background, this paper examines operational health hazards of LFP on Press Operator Graphic Designers (OGDs) and Freelance Graphic Designers (FGDs) in Nigeria. The objectives of the study are: to examine the concentration levels of TVOC and HCHO emitted by LFP during printing activities via digital air sampler, and to analyse its health implications on graphic designers in Nigeria using Somolu, Lagos as a case study. This is to create awareness of health implications, serving as a safety and productive guide for LFP users in the graphic and printing industry.

LITERATURE REVIEW

Occupational health research has consistently highlighted the significant risks inherent in industrial environments where chemical substances are a primary component of production. Scholarly investigations into these hazards generally focus on the short-term symptoms and long-term systemic damage caused by exposure to toxic materials. In the printing and manufacturing sectors, the analysis of hazardous substances in raw materials and the study of practitioners' exposure to Volatile Organic Compounds (VOCs) have become central themes (Kalilu & Adebowale, 2023; Othman et al., 2017). These studies collectively suggest that while the industry is essential for visual communication, it carries a high physiological and environmental cost.

The source of these hazards is fundamentally rooted in the chemical composition of the inks employed during production. Othman (2017) focused on identifying the specific hazardous substances present in the raw materials used to produce printing inks, evaluating three main categories: cold-set, heat-set, and sheet-fed inks. A key finding was that every category of raw material contained hazardous chemical substances, primarily localized within solvents, pigments, and additives. According to Othman, solvents contain the highest percentage of hazardous substances, followed by additives and pigments. This composition renders workers in ink production units highly vulnerable to systemic health issues. To mitigate these risks, Othman advocates for a multi-layered control strategy involving automated mixing systems, staggered shifts, safety training, and the rigorous use of Personal Protective Equipment (PPE).

The environmental and occupational impact of these chemicals has prompted a shift toward fundamental changes in ink formulation. Aydemir and Özsoy (2020) examined the chemical footprint of the printing industry, specifically investigating how the evaporation of VOCs, such as toluene and xylene, degrades indoor air quality. They argue that protecting practitioners requires a transition toward green chemistry, moving away from petroleum-based solvents in favor of vegetable-oil-based inks—such as those derived from soy or linseed—and UV-curable systems. Aydemir and Ozsoy conclude that true sustainability in the printing industry is only attainable when eco-friendly ink formulations are paired with strict waste management protocols, thereby reducing the overall environmental and health hazards of graphic communication.

Recent research has provided medical evidence regarding how these chemicals affect the body at a biological level. Nedozi et al. (2025) conducted controlled samples of VOC levels typically found in Lagos-based printing workplaces. Their findings provide a cogent warning that chronic inhalation of these chemicals triggers significant oxidative stress, leading to neurological hazards and noticeable behavioural changes. Beyond neurological impairment, the researchers identified measurable damage to internal organs, with hepatic distress and kidney dysfunction being the most prominent conditions. A particularly significant discovery in the study by Nedozi et al. (2025) was the heightened vulnerability of female subjects to these toxins, suggesting that biological sex may influence the metabolic processing of industrial pollutants. Their research, alongside the work of Avino et al. (2025), underscores an urgent need for specialized medical monitoring and superior air sampling systems within the Nigerian press workspace.

Despite the clear evidence of physiological danger, a persistent gap remains in the implementation of safety measures in practical settings. While existing research has comprehensively addressed health hazards in general printing industries, material production factories, and studio-based artistic practices, there is a notable absence of literature dedicated specifically to the health implications of Large Format Printing (LFP) in 21st-century Nigerian graphic design practice. This scholarly gap represents the primary focus of this paper, aiming to bridge the gap by identifying and mitigating LFP air-quality operational hazards that challenge both press operator graphic designers and freelance practitioners in the Nigerian context.

RESEARCH METHODOLOGY

Sampling Location

Characterisation of sampling sites is essential in various fields of research, particularly in production and environmental sciences (De Vivo et al., 2024). Understanding site characteristics helps to interpret sampling results appropriately, especially when comparing the results with other related findings. For this study, sampling location selection was based on a purposive sampling technique, which is often used in quantitative research to gather in-depth insights about an occurrence and to explore a specific phenomenon. Somolu, being one of the biggest and oldest printing hubs in Lagos, Nigeria, was selected to collect data for this study.

Somolu is a densely populated area with a diverse socioeconomic makeup, primarily inhabited by Yoruba, with significant representation from Ijebu, Egba, Awori, and Ilaje-speaking people. Other Nigerian ethnic groups are also represented from Eastern and Northern Nigeria. It is a major printing hub with a mixture of commercial activities and residential areas. Housing in Somolu is predominantly residential, although some have been converted for commercial purposes, particularly for graphics and printing productions. It is located on Latitude 6.54028 ° N and Longitude 3.37167 ° E.

Figure 1 Lagos Map and Its Sample Site Location
Source: Sketchbubble (2025)

Sampling Technique and Site Characteristics

A typical case sampling technique of the purposive method was adopted. This type of sampling is a representation of average, typical, or normal experience within a context (Nyimbili & Nyimbili, 2024). An inventory of printing presses was determined through oral interviews, augmented by a walkthrough survey in the study area. The total number of large-format printing shops in Somolu is estimated at three hundred (300), comprising about six hundred (600) commercial Large-format presses that use solvent-based ink (plate 1). The majority of the printing shops have only one press, while a few others have more than one. Therefore, by the typical case sampling technique, a printing shop with only one press operating at a time was employed for data collection (Plate 2). Detailed characteristics of the sampling site are provided in Table 1.

Table 1 Sampling Site Characteristics

Site Location	Printing Type	No. of Press	Ink Type	Chemical Air Pollutants	Ventilation and Air circulation	Sampling Space Area (m^2)
Somolu	Large-Format	1	Solvent-based ink	TVOC HCHO	Fan	11.48

Source: Researchers' Fieldwork (2025)

Figure 2 Solvent-Based Ink
Source: Photographed by Abiodun (2025)

Figure 3 7-Feet Large Format Press
Source: Photographed by Abiodun (2025)

Real-time continuous concentrations of air pollutants from the large-format press were measured using a Digital Air Quality Detector, Model: VT-6-IN1 device (Plate 3), manufactured by Shenzhen Technology Co. Ltd., China. The measuring instrument was a multi-functional Air Quality Monitor, which can simultaneously measure HCHO, TVOC, PM2.5, PM10, CO, and CO2. It has four Colour indicators that represent varying air quality levels: green indicates good air quality, while yellow, orange, and red signify progressively poorer air quality. The capacity of the instrument's pollutants detection range for PM2.5 is from 0 to 999 micrograms per cubic meter ($\mu g/m^3$). For PM10, the range is also from 0 to 999 micrograms per cubic meter ($\mu g/m^3$). HCHO can be detected in the range of 0 to 9.999 milligrams per cubic meter (mg/m^3). TVOC detection ranges from 0 to 9.999 milligrams per cubic meter (mg/m^3). CO detection ranges from 0 to 1000 parts per million (ppm). CO2 detection ranges from 400 to 5000 parts per million (ppm) (Shenzhen Technology, 2025).

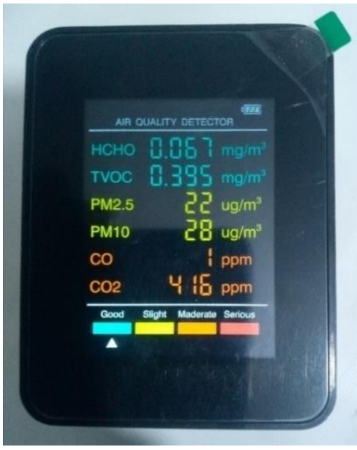

Figure 4 Digital Air Quality Detector Model VT-6-IN1
Source: Photographed by Abiodun (2025)

The instrument (Plate 3) was used to simultaneously measure the concentration of TVOCs and HCHO in the stipulated printing shop near the printing machine during the printing process encompasses runtime and downtime as in a typical production setting. The reading was carried out for eight (8) work hours per day for five (5) work days per week, and the reading was recorded at intervals of thirty (30) minutes of the eight hours. The detector was set up at a relative height to the designers' respiration level, because the exposure pathway for health risk evaluation was based on inhalation, excluding injection and skin touch. The distance of the gadget from the press walls was not less than 1 meter, following the standard practice (Ayeni et al., 2024; Zaki & Bari, 2022).

Visibility of Instrument

The viability of the instrument was validated after calibration by performance evaluation, using an assumed well-ventilated and air pollutant-free room to test known pollutants such as HCHO, TVOC, and CO_2 for instrument response evaluation. The reading indicates the following concentration range: 0.004-0.008 mg/m^3, 0.005-0.012 mg/m^3, and 400-417 ppm for HCHO, TVOC, and CO2, respectively. This was set against standard references from regulatory organisations such as National Environmental Standards and Regulations Enforcement Agency-NESREA (HCHO-0.1 mg/m^3, TVOC-0.6 mg/m^3, and CO2-800 ppm). The reading did not exceed the excellent safe limit of the standard guidelines of the organisations. This validation was used as a control for data collection.

Health Hazard Evaluation

Health hazard evaluation of TVOC and HCHO was done at non-carcinogenic risk, via inhalation exposure pathway, using the following three formulas:

1. $EC = \frac{C \times ET \times EF \times ED}{AT}$
2. $HQ = \frac{EC}{RfC}$
3. $HI = \sum HQ_i$

(EPA, 2026; Pongboonkhumlarp & Jinsart, 2022).

From formula 1, EC is the exposure concentration, C is the concentration of the pollutant, ET is the exposure time (8hrs / day), EF is the exposure frequency (250 days/year) ED is the exposure duration (25 years for non-carcinogenic risk), AT is the average time (AT = ED x 365 days x 24hrs / day, for non-carcinogenic risk) (EPA, 2026). From formula 2, HQ is the hazard quotient; RfC is the reference concentration of the pollutants HCHO and TVOC using National Environmental Standards and Regulations Enforcement Agency (NESREA)'s safe standards, 0.1 mg/m3 and 0.6 mg/m3, respectively (Ayeni et al., 2024; NESREA, 2021).

From formula 3, exposure to multiple chemical and particle pollutants was calculated. HI is Hazard Index, HQi is the hazards quotient for each pollutant, and ∑ is the sum of the Hazard Quotients for all the pollutants. In reference to this, if HI ≤ 1, the risk is considered not hazardous and adverse health effects are not likely to occur. On the contrary, if HI ≥1, the risk is considered hazardous, and adverse effects may occur (EPA, 2026).

In this evaluation, full-time Operator Graphic Designers (OGDs) and part-time Freelance Graphic Designers (FGDs) are considered. For OGDs, hazard evaluation was done in reference to the standardized eight (8) work hours per day and five (5) work days per week (-250 days/ 1year). However, for the FGDs, average exposure time (EP) = 2 hours per day (Table 2) and exposure frequency (EF) = 3 days per week (Table 3), meaning 150 days per year. These data were quantitatively gathered from fifteen (15) LFP shops, indicating 5% of the total estimated number of three hundred (300) LFP shops in Shomolu by administering 180 questionnaires, 12 per shop; among which 150 were returned and used as a basis to calculate Hazard Quotient (HQ) and Hazard Index (HI) of freelance graphic designers. Health hazard evaluation of TVOC and HCHO was done at non-carcinogenic risk, via inhalation exposure pathway using formulas 1, 2, and 3.

Table 2 Daily Average (Avg) of Freelance Graphic Designers Exposure Hour(s) to LFP Indoor Air Pollutants (IAP)

Hour	F	%	Avg
1-3	146	97.33	2
4-6	04	2.67	5
7-9	00	00	0
Total	**150**	**100**	**2**

Source: Researchers' Fieldwork (2025)

Table 3 Weekly Average (Avg) of Freelance Graphic Designers Exposure Day (s) to LFP Indoor Air Pollutants (IAP)

Day	F	%	Avg
1-3	107	71.34	2
4-6	43	28.66	5
Total	**150**	**100**	**3**

Source: Researchers' Fieldwork (2025)
Note: The average hours and days are represented in 1 significant figure.

RESULTS AND DISCUSSION

Statistical analysis of data for this study was done using IBM SPSS Statistics 25. The concentrations of each pollutant, TVOCs, and HCHO from eight (8) work hours reading at thirty (30) minute intervals, a day within five (5) consecutive work days per week were determined (figures 1 and 2). Consequently, the hazard quotient

(HQ) was determined (Table 4). In the same vein, total concentrations of all the pollutants were calculated as the hazard index (HI), as evident in Table 5.

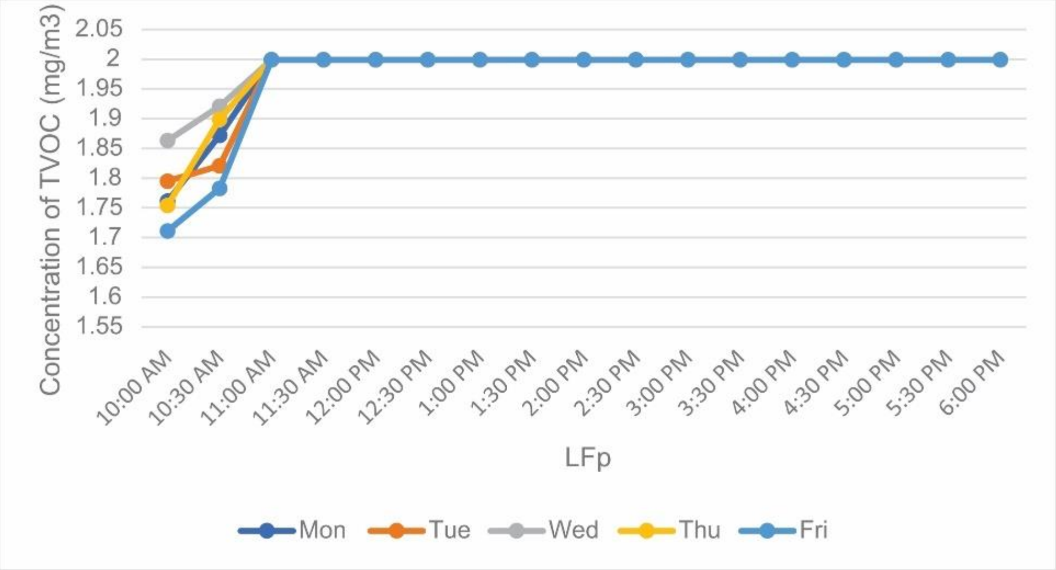

Figure 6 Time Series Concentrations of TVOC, 8 Hours per Day in Five Working Days
Source: Researchers' Fieldwork (2025)

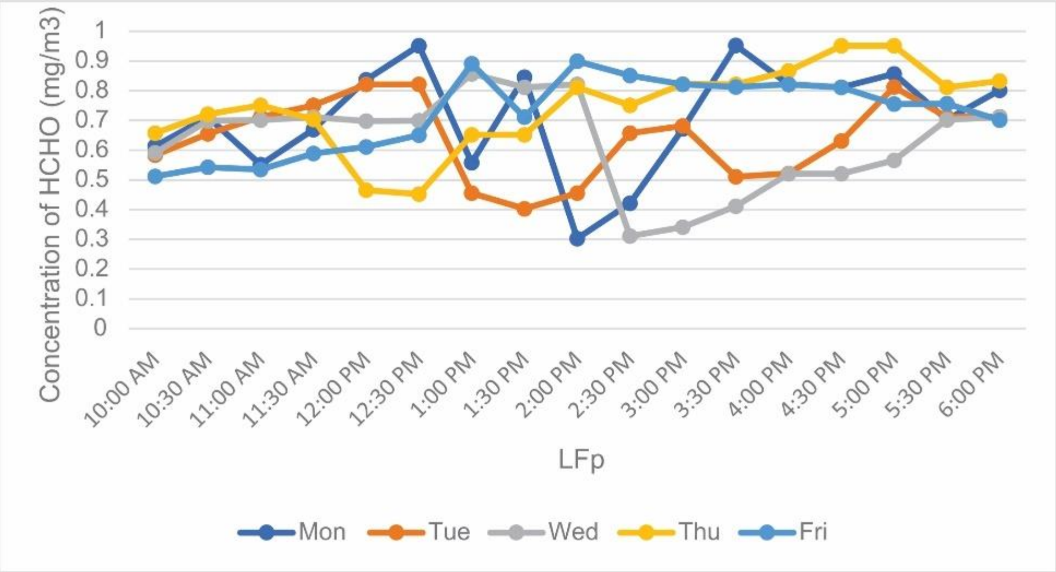

Figure 5 Time Series Concentrations Of CHHO, 8 Hours per Day in Five Working Days
Source: Researchers' Fieldwork (2025)

Table 4 Daily TVOC and HCHO Hazard Quotient (HQ) of LFP

Professional	Pollutants	Mon	Tue	Wed	Thu	Fri	Avg
Press Operator Graphic Designers	TVOC (mg/m^3)	0.752	0.752	0.756	0.753	0.749	0.752
	HCHO (mg/m^3)	1.622	1.463	1.433	1.702	1.648	1.574
Freelance Graphic Designers	TVOC (mg/m^3)	0.113	0.113	0.113	0.113	0.112	0.113

Professional	Pollutants	Mon	Tue	Wed	Thu	Fri	Avg
	HCHO (mg/m^3)	0.243	0.219	0.215	0.255	0.247	0.236

Source: Researchers' Fieldwork (2025)

Table 5 Hazard Index (HI) of LFP

Professional	Mon	Tue	Wed	Thu	Fri	Avg
Press Operator Graphic Designers	2.374	2.215	2.189	2.455	2.397	2.326
Freelance Graphic Designers	0.356	0.332	0.328	0.368	0.359	0.349

Source: Researchers' Fieldwork (2025)

The operational health implications of LFP in the Nigerian printing industry in high-density printing hubs such as Somolu, Lagos presents an array of serious chemical health challenges against graphic designers, particularly Operator Graphic Designers (OGDs). While the technology is advancing in the graphic industry, it serves as a significant source of volatile chemical emissions that require urgent attention. This examination analyses the exposure hazards of Total Volatile Organic Compounds (TVOCs) and Formaldehyde (HCHO) using field-monitored air pollutants time-series data from a typical LFP shop in Somolu, Lagos, Nigeria. Hazard Quotients (HQ), and their cumulative, Hazard Indices (HI) were calculated by formulas to 1, 2, and 3. The reference thresholds used to calculate HQ are 0.1mg/m^3 and 0.6 mg/m^3 for HCHO and TVOC, respectively (NESREA, 2021).

Analysis of atmospheric air flow and pollutants' time-series concentrations of pollutants in LFP showcases the quality of air present in the workspace, defined by the continuous emission of chemical agents during the printing and curing processes. The pollutant air monitoring was conducted within an 8-hour daily period across five consecutive work days, which revealed distinct behavioural patterns for both TVOCs and HCHO. These patterns provide essential insights into how pollutants accumulate in the workspace and the potential duration of exposure for various professionals working with LFP, particularly Operator Graphic Designers (OGDs) and Freelance Graphic Designers (FGDs).

TVOC in the LFP workspace exhibits an accumulation pattern across the monitoring period, with starting concentrations at 10:00 am ranging from 1.711 mg/m^3 to 1.863 mg/m^3. Within a single hour of activity, these levels speedily rose to a peak of 1.999 mg/m^3, a level that was maintained without deviation from 11:00 am until the end of the shift at 6:00 pm every day (fig 1). The maintenance of these peak TVOC concentrations for seven consecutive hours indicates a critical challenge in the LFP workspace. This peak effect suggests that the printing shop suffers from a severe lack of adequate space and poor ventilation, which prevents the effective dilution of solvent vapours. The saturation of the air at 1.999 mg/m^3 implies that the workspace is frequently congested, even when the press is in the down state. The lingering nature of the pollutants means that the residue of TVOC in the shop is capable of evoking health hazards in the users of the space.

In contrast to the stagnant TVOC profile, Formaldehyde (HCHO) concentrations exhibit a more dynamic flow that mirrors the active duty cycle of the press. Weekly readings generally fluctuated between a minimum of 0.303 mg/m^3 and a peak of 0.952 mg/m^3 (Fig 2). Unlike TVOCs, HCHO appears to vanish more easily into the atmosphere when the press is not in operation. The pollutant concentration reduced steadily until it dissipated, indicating that while peak concentrations are high, the risk is primarily associated with the active printing periods. To evaluate the toxicological significance of these concentrations, the data were converted into Hazard Quotients (HQ) for OGDs and FGDs. The HQ was done based on a non-cancer risk implication, using the NESREA standard of 0.1 mg/m^3 and 0.6 mg/m^3 for HCHO and TVOC, respectively. Any HQ value that is greater than one (1) indicates a potential threat to human health.

For Operator Graphic Designers, the exposure measurement calculation signifies a dangerously compromised workspace. They face a daily average HQ for TVOC of 0.752 mg/m^3. More alarming is the hazard from Formaldehyde, which shows a weekly average HQ of 1.574 mg/m^3. The daily HCHO HQ at its peak was 1.702 mg/m^3 on Thursday, consistently greater than 1. This identifies formaldehyde as a primary chronic health hazard threat for full-time graphic designers (OGD) in the Nigerian LFP industry (Table 4).

Conversely, Freelance Graphic Designers (FGD) exhibit a much lower risk profile, primarily due to their reduced weekly exposure frequency and duration of the time spent in the printing workspace. Their average hazard from TVOC is minimal at 0.113 mg/m^3, and their average hazard from Formaldehyde is 0.236 mg/m^3 (Table 4). These results reveal that for freelance designers, the hazard exposure remains within safe limits for both chemical pollutants. The sharp divergence in risk between OGDs and FGDs definitively identifies the industrial printing process with its reliance on heavy solvents, inks, and cleaning agents, which are suspected to be the primary source of hazardous pollutants.

While individual pollutants are significant, the cumulative Hazard Index (HI) provides the most comprehensive view of the health implications by summing all the individual HQs. The HI results indicate a present health crisis for full-time designers. The average HI for OGDs is 2.326 mg/m^3, which is far greater than 1, indicating a health risk. Daily readings for the same operators fluctuated between 2.189 mg/m^3 and 2.455 mg/m^3 (Table 5), indicating that at no point during the work week was the printing workspace safe for full-time designers, particularly in the festive periods such as March-April and November-December when the data was collected.

The higher-level exposure concentrations placed on Operator Graphic Designers expose them to a range of adverse health hazards. These include respiratory irritation, neurological symptoms such as chronic headaches and dizziness, and inflammation of the eyes and mucous membranes (Kochavi et al., 2025). Furthermore, persistent exposure to these concentrations carries the potential for long-term liver or kidney damage. In contrast, the HI for FGDs averages 0.349 mg/m^3, which is far below 1, indicating relative safety in the LFP workspace.

The empirical data from this study reveal a critical disparity in occupational risk between Operator Graphic Designers (OGDs) and Freelance Graphic Designers (FGDs). The high exposure profile of OGDs aligns with the findings of Ayeni *et al*. (2024), who observed that press operators in Northern Nigeria are subjected to pollutant concentrations that bypass international safety margins, primarily due to poor localized ventilation and high-volume throughput.

Similarly, the potential for respiratory and neurological injury among OGDs corroborates the health risk analysis conducted by Pongboonkhumlarp and Jinsart (2022). Their research in the Thai printing industry similarly identified a direct correlation between high VOC concentrations and long-term carcinogenic and non-carcinogenic risks, specifically targeting the central nervous system. This is further reinforced by Shakir et al. (2025), whose systematic review emphasises that in school-based environments, the accumulation of TVOCs leads to significant declines in cognitive performance and respiratory health of the students.

Kalilu and Adebowale (2023) focused on the dermatological and systemic implications of oil-based media on studio artists; the current findings extend this concern to the digital large-format sector. The breach of NESREA safe standards in a large-format printing workspace suggests that the transition from traditional studio practices to high-tech printing has not necessarily mitigated chemical hazards; rather, it has concentrated them. This scenario validates the urgent call by Kalilu and Adebowale (2023) for rigorous medical monitoring and the adoption of less hazardous, vegetable-ink-based alternatives to protect the Nigerian creative workforce.

CONCLUSION

This research identifies that graphic designers, particularly those categorized as Operator Graphic Designers (OGDs), are uniquely vulnerable to chemical hazards due to their frequent and prolonged proximity to industrial printing machinery. Large Format Printing (LFP) in Somolu presents a confirmable health risk for full-time graphic design professionals, with Hazard Index (HI) values reaching 2.362 mg/m^3 (>1) (Table 5). The drivers of these chemical hazards are Total Volatile Organic Compounds (TVOCs) and Formaldehyde (HCHO), emitted during the printing process and drying of LFP substrates. Long-term exposure to the pollutants in the workspace presents a multi-systemic health challenge where chemicals surpass natural human defence to cause chronic physiological damage. Respiratory and pulmonary disorders are among the most prevalent health implications, as the prolonged inhalation of these substances acts as a potent irritant to the pulmonary tract. This often manifests as occupational asthma, marked by chronic airway inflammation and bronchial hyper-responsiveness. In high-exposure settings, the exposure can progress to Chronic Obstructive Pulmonary Disease (COPD), leading to irreversible lung function decline.

RECOMMENDATIONS

To mitigate these chemical hazards and foster a safer working environment for Nigerian graphic designers, a multichannel approach involving technical, administrative, and educational reforms is necessary. First, commercial printing firms/shops, utilizing LFP technology, must prioritize the implementation of technical controls. This includes installing localized exhaust ventilation systems at the primary sources of air pollutant emissions, specifically near ink fountains. This will effectively reduce the concentration of TVOCs and HCHO before they disperse into the broader workspace. To complement these physical measures, printing organizations should adopt administrative risk control strategies such as an effective work shift schedule. For example, Operator Graphic Designers (OGDs) who use eight-hour production shifts can be reduced to four-hour sessions.

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