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	Penser les sociétés en crise Éditorial : Penser les sociétés en crise : résilience, développement et transformations contemporaines----- 5 Prisonniers des rôles : une analyse constructiviste de la permanence de la rivalité entre les États-Unis et l'Iran ----- 9 Actions des leaders d'opinions et des patriotes résistants « wazalendo » à l'épreuve des massacres dans la région de Beni-Lubero ----- 31 Le gel des avoirs de Joseph Kabila : Allumette ou extincteur des dynamiques de la belligérance entre l'AFC-M23 et le régime de Kinshasa ?----- 53 Gouvernance de crise, recomposition socio-économique et résilience en Ville de Goma de janvier 2025 à avril 2026 ----- 69 Décisions d'investissement des petites et moyennes entreprises en contexte des conflits armés : une analyse microéconomique à l'épreuve de la théorie de l'utilité espérée à Goma, République Démocratique du Congo ----- 91 De la vulnérabilité aiguë à la résilience d'urgence d'une institution de microfinance en contexte de conflit armé : Étude de cas de PAIDEK SA 123 Awareness, preventive practices, and socio-demographic determinants of cervical cancer awareness among women in Omu-Aran, Nigeria:----- 151 Caractérisation d'un écosystème artificiel urbain, typologie des polluants et description des conséquences éventuelles sur la santé humaine : ----- 171 Perceived Effects of Environmental Pollution Exposure on Pregnancy Outcomes among Women of Reproductive Age in Ilorin, Kwara State, Nigeria ----- 195 Résidus de pesticides et pratiques phytosanitaires dans les tomates fraîches commercialisées à Butembo (Nord-Kivu, RDC) :----- 221 Activité antibactérienne et antifongique in vitro de l'huile essentielle d'<i>Eucalyptus globulus</i> : revue systématique et méta-analyse des concentrations minimales inhibitrices entre 1990 et 2026 ----- 247 Énergie électrique, politique et développement dans la Région de Beni-Lubero : une approche par l'interconnexion des sources d'énergie----- 273 Prise en charge des impropriétés dans les productions orales des apprenants "baswahili" en classe de français ----- 297
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Perceived Effects of Environmental Pollution Exposure on Pregnancy Outcomes among Women of Reproductive Age in Ilorin, Kwara State, Nigeria

Effets perçus de l'exposition à la pollution environnementale sur les résultats de la grossesse chez les femmes en âge de procréer à Ilorin, État de Kwara, Nigeria

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Abstract

Although environmental pollution is a serious and growing threat to reproductive health, little is known about how women perceive its impact on pregnancy outcomes, particularly in Nigerian communities. This study examined how women of reproductive age in Ilorin, Kwara State, Nigeria, perceived the effects of environmental pollution exposure on pregnancy outcomes. A descriptive survey design was adopted. A multistage sampling approach comprising stratified, proportionate, and convenience sampling techniques was used to select a sample of 402 participants from a target population estimated at 302,666 women of reproductive age in Ilorin Central.

A structured, researcher-designed questionnaire with a dichotomous (Yes/No) response format was used to collect data. Content validity was established through expert review, and reliability was confirmed using the Spearman-Brown prophecy formula, which yielded a coefficient of 0.86. The research questions were answered using descriptive statistics (frequency and percentage), while the hypotheses were tested at a 0.05 significance level using chi-square analysis. The findings showed that 61.1% of respondents believed air pollution had a negative effect on pregnancy outcomes, and 60.1% held the same view regarding water contamination.

Statistically significant perceptions of harm were confirmed by the rejection of both null hypotheses (air pollution: $\chi^2 = 19.26$, $df = 1$, $p < 0.05$; water pollution: $\chi^2 = 15.92$, $df = 1$, $p < 0.05$). Awareness was lowest for complex outcomes such as congenital heart defects and neural tube disorders, while it was highest for dust-related infant respiratory problems (84.6%) and

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waterborne infections (83.3%). Overall, women in Ilorin held strong perceptions of the reproductive risks associated with pollution exposure, although notable knowledge gaps remained for certain congenital outcomes. The study recommends that environmental regulations be strengthened to reduce pollution exposure among women of reproductive age, and that targeted health education programmes be implemented to close these knowledge gaps therefore to protect the population and prevent harms.

Keywords: Environmental pollution, pregnancy outcomes, air pollution, water pollution, reproductive health.

Résumé

Bien que la pollution environnementale constitue une menace grave et croissante pour la santé reproductive, on sait peu de choses sur la manière dont les femmes perçoivent son impact sur l'issue de la grossesse, en particulier dans les communautés nigérianes. Cette étude a examiné la manière dont les femmes en âge de procréer à Ilorin, dans l'État de Kwara, au Nigéria, percevaient les effets de l'exposition à la pollution environnementale sur l'issue de la grossesse. Un devis d'enquête descriptive a été adopté. Une approche d'échantillonnage à plusieurs degrés, comprenant des techniques d'échantillonnage stratifié, proportionnel et de convenance, a été utilisée pour sélectionner un échantillon de 402 participantes à partir d'une population cible estimée à 302 666 femmes en âge de procréer dans le centre d'Ilorin.

Un questionnaire structuré élaboré par le chercheur, avec un format de réponse dichotomique (Oui/Non), a été utilisé pour recueillir les données. La validité de contenu a été établie par une évaluation d'experts, et la fiabilité a été confirmée à l'aide de la formule de prédiction de Spearman-Brown, qui a donné un coefficient de 0,86. Les questions de recherche ont été traitées à l'aide de statistiques descriptives (fréquences et pourcentages), tandis que les hypothèses ont été testées au seuil de signification de 0,05 à l'aide de l'analyse du chi carré. Les résultats ont montré que 61,1 % des répondantes estimaient que la pollution de l'air avait un effet négatif sur l'issue de la grossesse, et 60,1 % partageaient le même point de vue concernant la contamination de l'eau.

Les perceptions statistiquement significatives des effets nocifs ont été confirmées par le rejet des deux hypothèses nulles (pollution de l'air : $\chi^2 = 19,26$, ddl = 1, $p < 0,05$; pollution de l'eau : $\chi^2 = 15,92$, ddl = 1, $p < 0,05$). Le niveau de sensibilisation était le plus faible concernant des issues complexes telles que les malformations cardiaques congénitales et les anomalies du tube neural, tandis qu'il était le plus élevé pour les problèmes respiratoires infantiles liés à la poussière (84,6 %) et les infections hydriques (83,3 %). Dans l'ensemble, les femmes d'Ilorin avaient une perception élevée des risques reproductifs associés à l'exposition à la pollution, bien que des lacunes importantes dans les connaissances subsistent concernant certaines anomalies congénitales. L'étude recommande de renforcer les

réglementations environnementales afin de réduire l'exposition des femmes en âge de procréer à la pollution, et de mettre en œuvre des programmes ciblés d'éducation sanitaire pour combler ces lacunes en matière de connaissances afin de protéger la population et de prévenir les effets nocifs.

Mots-clés : Pollution environnementale, issue de la grossesse, pollution de l'air, pollution de l'eau, santé reproductive.

Introduction

Reproductive health constitutes a fundamental component of human well-being, encompassing the optimal functioning of the male and female reproductive systems across all stages of life. These systems involve several key organs and endocrine structures, including the pituitary gland, ovaries in females, and testes in males, all of which regulate hormonal balance and reproductive processes. In recent years, however, increasing environmental changes particularly the rise in environmental pollution have posed significant threats to reproductive health (Kshetrimayum et al., 2019). Consequently, reproductive health is no longer viewed solely as a biological issue but also as one that is closely linked to environmental conditions, making it a critical area of public health concern (Hlisníková et al., 2020).

Environmental pollution has emerged as a persistent global challenge in the 21st century, largely driven by rapid industrialization, urbanization, and intensified agricultural activities. The release of pollutants such as airborne particulate matter, toxic chemicals, heavy metals, pesticides, microplastics, and industrial waste has increased significantly over time (Predieri et al., 2022worl). As a result, populations especially women of reproductive age are increasingly exposed to environmental hazards that may compromise their health, affecting pregnancy outcome. According to the Wikuats (2023), environmental pollution contributes substantially to global morbidity and mortality, with earlier estimates attributing approximately 3.2 million deaths annually to pollution-related causes.

Numerous empirical studies have shown a strong correlation between worse pregnancy outcomes and environmental contamination. These outcomes include low birth weight, abortion or miscarriage, preterm birth, stillbirth, and neonatal mortality, all of which pose significant hazards to the health of mothers and their offspring (Wang et al., 2019). An estimated 20 million low birth weight babies and 15 million preterm babies are born each

year worldwide. These alarming statistics underscore the magnitude of the problem and highlight the urgent need to examine environmental determinants of pregnancy outcomes (Green et al., 2021).

Air pollution has been identified as one of the most significant contributors to reproductive health challenges. It comprises harmful constituents including carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), organic compounds such as dioxins and solvents, heavy metals including lead and copper, and particulate matter of varying sizes (PM₁₀ and PM_{2.5}) (Montano et al., 2022). Exposure to these substances has been linked to reproductive dysfunction, including infertility and miscarriage, largely attributed to damage to oocytes during critical periods such as preconception and early pregnancy, as well as disruption of gametogenesis, thereby impairing overall reproductive capacity (Rajmohan et al., 2020).

Environmental pollutants influence reproductive health through multiple biological mechanisms. Certain pollutants are particularly noteworthy for their ovotoxic properties, which can directly harm female gametes and disrupt the physiological processes necessary for fertilization and the maintenance of pregnancy (Simoncic et al., 2020). Such disruptions may result in decreased fertility, hormonal imbalances, and a heightened risk of negative pregnancy outcomes, thereby strengthening the connection between environmental exposure and the deterioration of reproductive health (Ji et al., 2023).

Exposure to environmental chemicals has been linked to various reproductive disorders, such as polycystic ovarian syndrome (PCOS), aneuploidy, and placental irregularities. Air pollution, particularly fine particulate matter (PM_{2.5}), has been demonstrated to negatively impact fetal development (Canipari et al., 2020). Maternal exposure to these pollutants heightens the risk of congenital abnormalities in essential organs, including the brain, heart, and lungs. Furthermore, exposure to PM_{2.5} has been associated with diminished expression of vital neurodevelopmental genes in the placenta, such as brain-derived neurotrophic factor (BDNF), which is crucial for fetal brain development (Saenen et al., 2015). Consequently, exposure to polluted air may impair both neurological and respiratory development in the fetus, predisposing offspring to conditions such as cognitive deficits and asthma.

Heavy metals represent another significant category of environmental contaminants with profound implications for reproductive health. These elements, characterized by their high atomic density, are commonly present in soil, water, and food systems and can accumulate in the human body over time (Mahey et al., 2020). Women are particularly vulnerable to the effects of heavy metals because ovarian germ cells are finite and non-renewable, meaning that prolonged exposure may have irreversible consequences for reproductive capacity (Agedew et al., 2022).

Prolonged exposure to heavy metals like cadmium and nickel has been demonstrated to impair endocrine function by affecting hormone production and receptor activity (Ebdrup et al., 2022). This endocrine disruption may result in embryotoxicity, fetal abnormalities, and impaired steroidogenesis. Additionally, heavy metals induce oxidative stress through the generation of reactive oxygen species (ROS), which damage cellular structures and compromise reproductive function. During pregnancy, such oxidative stress has been associated with complications including abortion or miscarriage in early pregnancy stage and preterm delivery in late stage. Although the placenta provides a partial protective barrier, it does not offer complete protection, allowing certain toxic metals to cross into fetal circulation and exert harmful effects (Yun & Oh, 2022).

Negative reproductive consequences have been associated with arsenic exposure, primarily from contaminated food and water. According to research, arsenic may increase the risk of spontaneous miscarriage and postpone menarche. Arsenic works by interfering with vital enzymes that are necessary for the manufacture of steroid hormones, such as 17 β -hydroxysteroid dehydrogenase and 3 β -hydroxysteroid dehydrogenase (Warwick et al., 2019). Follicle-stimulating hormone (FSH), luteinizing hormone (LH), and estradiol are among the essential reproductive hormones that are reduced as a result of this disruption, which impairs reproductive functioning (Bhardwaj et al., 2021).

Pesticides, widely used in agricultural practices, constitute another major source of environmental exposure. Residual pesticides in food and water have been associated with a wide range of reproductive health problems. Prenatal exposure to compounds such as dichlorodiphenyltrichloroethane (DDT), hexachlorobenzene (HCB), and chlordane has been linked to infertility, spontaneous abortion, stillbirth, low birth weight, preterm

delivery, and developmental abnormalities (Yilmaz et al., 2020). Exposure to pesticides has been linked to ovarian dysfunction and hormonal imbalances, further exacerbating its detrimental impact on reproductive health (Osman et al., 2023).

Reproductive health is known to be negatively impacted by polycyclic aromatic hydrocarbons (PAHs), which are linked to vehicle and industrial emissions. These substances impair ovarian function and lower fertility by interfering with the pituitary-ovarian axis. PAHs have also been associated with increased risks of carcinogenesis and adverse pregnancy outcomes, further underscoring the widespread impact of environmental pollutants (Basilio et al., 2022). While certain elements, such as manganese, are essential for normal physiological function, excessive exposure can result in detrimental health effects, including disruption of the reproductive system.

Conceptual Framework

The Health Belief Model (HBM), which was first created by Rosenstock in 1974, serves as the foundation for this study. It asserts that people's perceptions of their vulnerability to health threats, the perceived seriousness of those threats, the perceived advantages of taking preventive action, and the perceived obstacles to doing so all have an impact on health-related behaviors. Modifying factors, such as social, socioeconomic, and demographic traits as well as cues to action, further influence these impressions.

Exposure to environmental pollution is conceptualized in this study as an environmental health risk that could affect women's perceptions of possible unfavorable pregnancy outcomes. Conditions including ambient air pollution, being close to industrial activities, contaminated or dangerous drinking water, and other sources of environmental contaminants can all lead to exposure. According to the framework, women may be more inclined to adopt protective health behaviors if they believe they are vulnerable to pregnancy issues caused by pollution and that these risks are serious. These behaviors could include reducing exposure to contaminated settings, treating drinking water, attending prenatal care appropriately, and engaging in other pollution-avoidance measures.

The perceived severity and perceived susceptibility components of the HBM are the specific focus of this study. The degree to which women believe

that exposure to environmental pollution increases their risk of experiencing unfavorable pregnancy outcomes is known as perceived susceptibility, and the degree to which they believe such outcomes could have major repercussions for the health of both the mother and the fetus is known as perceived severity. Because actual exposure and perceived risk are related but conceptually different constructs, the framework makes a distinction between objective environmental exposure and subjective risk perception.

Socio-demographic and contextual characteristics, including age, educational attainment, occupation, parity, income level, and place of residence, are treated as modifying factors that may influence women's perceptions of environmental health risks and their adoption of protective behaviours. Cues to action, such as health education, antenatal counselling, public health messaging, and prior experience with pollution-related health problems, may also stimulate preventive responses.

Accordingly, the conceptual framework proposes that environmental pollution exposure represents the environmental risk context, while perceived susceptibility and perceived severity constitute the key psychological constructs through which individuals interpret this risk. These perceptions may, in turn, influence protective health behaviours with implications for pregnancy health and outcomes. However, because the present study primarily assesses women's perceptions of the effects of environmental pollution on pregnancy outcomes, it does not assume that perception itself establishes a causal relationship between pollution exposure and pregnancy outcomes.

Problem statement

All populations should be able to flourish in an ideal environment that is devoid of dangers like pollution. However, extensive pollution brought on by fast industrialization poses serious health dangers to people all over the world. Nigerian women of reproductive age are among the risk groups because they are exposed to transboundary contamination, which includes importation of toxic garbage that are frequently falsely advertized as electronic donations. Maternal health is seriously threatened by hazardous materials such particulate matter, toxic metals, and gaseous pollution. These problems are made worse by activities like unregulated landfills, illegal dumping, and artisanal mining. Additionally, harmful practices continue to

exist due to lax enforcement and inadequate regulation, which may have a negative impact on pregnancy and reproductive outcomes (Innocent & Olusegun, 2019).

Despite growing evidence linking environmental pollution to conditions such as low birth weight, preterm birth, stillbirth, congenital abnormalities, and neonatal mortality, the burden of these outcomes remains persistently high in many developing countries. Poor waste management, reliance on biomass fuels, industrial emissions, and widespread use of agricultural chemicals all contribute to environmental pollution in Nigeria, but women of reproductive age are still largely unaware of the potential risks these environmental factors pose to their pregnancy outcomes.

Furthermore, most prior research has focused on the biological and clinical effects of pollution exposure, giving women's views and knowledge of these dangers comparatively little consideration. Preventive measures and health-seeking activities are examples of health behaviors that are influenced by perception. Furthermore, there is a lack of localized data investigating the perceptions of women of reproductive age in communities with limited resources regarding the impact of exposure to environmental pollution on pregnancy outcomes. By examining the perceived impacts of exposure to environmental pollution on pregnancy outcomes among women of reproductive age in Ilorin, Kwara State, this study closes this gap.

The study was guided by the following research questions:

1. Will exposure to air pollution affect pregnancy outcomes as perceived by women of reproductive age in Ilorin, Kwara State?
2. Will exposure to water pollution affect pregnancy outcomes as perceived by women of reproductive age in Ilorin, Kwara State?

The following null hypotheses were evaluated at the 0.05 level of significance:

H₀₁: Exposure to air pollution will not significantly affect pregnancy outcomes as perceived by women of reproductive age in Ilorin, Kwara State.

H₀₂: Exposure to water pollution will not significantly affect pregnancy outcomes as perceived by women of reproductive age in Ilorin, Kwara State.

Methodology

This study employed a descriptive survey research design. The target population consisted of all women of reproductive age in Ilorin Central, Kwara State, estimated at 302,666 according to the National Population Commission (2023). Using an online sample size calculator (calculator.net, 2025), an initial sample size of 363 was found to be adequate for a population of 302,666 at a 95% confidence level and a 0.05 margin of error. A final sample of 402 individuals was obtained by increasing the sample size by 11% to account for possible attrition.

Stratified, proportional, and convenience sampling techniques were combined in a multistage sampling strategy. The Ilorin metropolis was divided into three local government areas (LGAs) in the first stage using stratified sampling: Ilorin West, Ilorin East, and Ilorin South. The population distribution within each LGA is shown in Table 1.

Table 1: Population Distribution across Local Government Areas in Ilorin Central

S/N	Ilorin Central LGA	Population
1	Ilorin South	106,666
2	Ilorin East	81,000
3	Ilorin West	115,000
	Total	302,666

Source: National Population Commission (2023)

In Stage 2, a proportional sampling method was utilized to choose 25% of the wards from each stratum. Consequently, two wards were chosen from Ilorin South, three from Ilorin East, and three from Ilorin West, as illustrated in Table 2.

Table 2: Number of Selected Wards in Each Local Government Area

S/N	Ilorin Central LGA	No. of Wards	25% Selected
1	Ilorin South	11	2
2	Ilorin East	12	3
3	Ilorin West	12	3
	Total	35	8

Source: Researchers' Design (2026)

In Stage 3, a proportional sampling method was used to select 0.12% of the population from each ward in Ilorin South, Ilorin East, and Ilorin West, as outlined in Table 3.

Table 3: Distribution of Sample across Selected Wards in Each Local Government Area

S/N	LGA	Selected Ward	Ward Population	0.12%
1	Ilorin East	Agbeyangi/Gbadamu/Osin Ward	27,000	32
		Oke Oyi/Oke Ose/Alalubosa Ward	26,000	31
		Gambari I Ward	28,000	33
2	Ilorin South	Akanbi I Ward	63,333	76
		Balogun Fulani Ward	43,333	52
3	Ilorin West	Ajikobi Ward	38,333	46
		Baboko Ward	41,341	50
		Badari Ward	35,326	43
	Total		302,666	363

Source: Researchers' Design (2026)

In Stage 4, convenience sampling was used to select respondents within each ward. This allowed the researchers to distribute the instrument to willing participants at different sites within their respective wards until the target sample size was reached.

Data Collection Instrument and Validation

Data were gathered through a structured questionnaire, designed by researchers, entitled "Perceived Effects of Environmental Pollution Exposure on Pregnancy Outcomes as Perceived by Women of Reproductive Age." The development of this instrument occurred in three phases. Initially, a comprehensive set of items was created based on a literature review concerning the reproductive and pregnancy-related impacts of environmental pollution, with a focus on air and water pollution. The item set included frequently reported outcomes such as low birth weight, preterm birth, stillbirth, congenital cardiac and neural tube defects, respiratory distress, and waterborne infections, along with less frequently acknowledged outcomes. This methodology was employed to ensure a broad representation of participants' perceptions regarding various pregnancy-related health outcomes.

Second, a panel of five experts in mother and child health, public health, and environmental health reviewed the draft questionnaire. The items were evaluated by the experts for appropriateness, relevance, clarity, and adequate topic coverage. A content validity index (CVI) was computed from the expert ratings to provide quantitative proof of the instrument's content validity after

items were either kept, changed, or removed based on their assessments and consensus.

Thirdly, thirty women of reproductive age who were not involved in the main trial participated in a pilot test of the updated questionnaire. Participants were selected from a geographically separate but similar community. Prior to the instrument's final administration, the pilot study sought to assess the items' comprehensibility and clarity, spot any ambiguities, and examine the response distribution.

There were two sections to the final questionnaire. Participants' age, marital status, level of education, occupation, parity, and local government area of residence were all evaluated in Section A. Participants' judgments of how environmental pollution exposure affects pregnancy outcomes in regard to the study's research topics were evaluated using 11 items in Section B. A dichotomous Yes/No response style was used for each item, with "Yes" denoting the respondent's perception that the given environmental pollution exposure had a detrimental impact on pregnancy outcomes.

Section B's internal consistency reliability was evaluated using the split-half method, and the Spearman-Brown prophesy formula was used to adjust the resulting coefficient. The instrument's dependability for evaluating the perceived effects of exposure to environmental pollution on pregnancy outcomes is supported by the reliability coefficient of 0.86, which shows strong internal consistency.

Data Collection and Analysis

Before the collection of data, verbal informed consent was secured from every participant. Respondents were assured that all information shared would be treated with the utmost confidentiality and used exclusively for research purposes. Descriptive statistics (frequency counts and percentages) were used to answer the research questions, while chi-square analysis and binary logistic regression were used to test the hypotheses at a 0.05 significance level.

Results

Research Question 1: Perceived Effect of Air Pollution on Pregnancy Outcomes

Table 4: Frequency and Percentage Distribution of Respondents' Perceptions on Air Pollution and Pregnancy Outcomes (N = 402)

S/N	Item	Yes f (%)	No f (%)
1	Maternal exposure to smoke is perceived to cause fetal neurological/brain defects	210 (52.2%)	192 (47.8%)
2	Inhalation of polluted air is associated with complications such as low birth weight	315 (78.4%)	87 (21.6%)
3	Proximity to heavy traffic or industrial emissions is linked to congenital cardiac issues (e.g., patent ductus arteriosus)	188 (46.8%)	214 (53.2%)
4	Chronic dust exposure during pregnancy is perceived to cause neonatal respiratory distress	340 (84.6%)	62 (15.4%)
5	Exposure to harmful gases during pregnancy can lead to septal defects (hole in the heart)	175 (43.5%)	227 (56.5%)
	Weighted Average	245 (61.1%)	157 (38.9%)

Source: Field Survey (2026)

Table 4 shows that most respondents perceived a significant link between air pollution and adverse pregnancy outcomes. A large proportion (84.6%) agreed that chronic dust exposure during pregnancy can cause neonatal respiratory distress (Item 4), and 78.4% believed that inhalation of polluted air is associated with low birth weight (Item 2). However, awareness of more complex congenital conditions was comparatively lower: 56.5% disagreed that exposure to harmful gases can lead to septal defects (Item 5), and 53.2% disagreed that proximity to industrial emissions is linked to congenital cardiac issues (Item 3). The weighted average indicates that 61.1% of respondents perceived air pollution as having adverse effects on pregnancy outcomes.

Research Question 2: Perceived Effect of Water Pollution on Pregnancy Outcomes

Table 5: Frequency and Percentage Distribution of Respondents' Perceptions on Water Pollution and Pregnancy Outcomes (N = 402)

S/N	Item	Yes f (%)	No f (%)
6	Consumption of contaminated water is perceived to increase the risk of spontaneous abortion (miscarriage)	298 (74.1%)	104 (25.9%)
7	Exposure to untreated water sources is associated with an increased risk of stillbirth	260 (64.7%)	142 (35.3%)
8	Exposure to chemicals in water during pregnancy may harm the unborn baby	305 (75.9%)	97 (24.1%)
9	Exposure to sewage or fecal matter in water is perceived to lead to neural tube defects (e.g., spinal defects)	140 (34.8%)	262 (65.2%)
10	Consuming rainwater carrying dirt during pregnancy may lead to difficulty walking or paralysis in the baby	112 (27.9%)	290 (72.1%)
11	Waterborne pollutants are perceived to cause systemic infections that compromise gestational health	335 (83.3%)	67 (16.7%)
	Weighted Average	241 (60.1%)	161 (39.9%)

Source: Field Survey (2026)

Table 5 shows that respondents demonstrated high awareness of the link between waterborne pollutants and systemic infections (83.3%), miscarriage (74.1%), and fetal harm (75.9%). Conversely, lower proportions perceived a relationship between water quality and spinal defects (34.8%) or infant paralysis/difficulty walking (27.9%). The weighted average indicates that 60.1% of respondents perceived water pollution as negatively affecting pregnancy outcomes.

Hypothesis Testing**Table 6: Binary Logistic Regression of Socio-Demographic Factors Associated with Positive Perception of Air Pollution Effects on Pregnancy Outcomes**

Predictor	AOR	95% CI	p-value
Age			
18–24 years	1.00	Reference	
25–34 years	1.278	0.715–2.284	.407
35–44 years	0.546	0.289–1.032	.062
≥45 years	0.856	0.330–2.218	.749
Marital status			
Single	1.00	Reference	
Married	2.416	1.244–4.693	.009
Widowed	0.685	0.374–1.257	.222
Divorced/Separated	1.130	0.452–2.826	.794
Education			
No formal education	1.00	Reference	
Primary	1.301	0.726–2.331	.378
Secondary	1.508	0.785–2.896	.218
Tertiary	3.811	0.772–18.805	.100
Occupation			
Unemployed	1.00	Reference	
Trading	0.850	0.392–1.843	.681
Civil service	0.673	0.323–1.406	.293
Artisan	0.886	0.413–1.899	.756
LGA of residence			
Ilorin South	1.00	Reference	
Ilorin East	0.341	0.183–0.635	.001
Ilorin West	0.676	0.341–1.340	.262

After controlling for other socio-demographic characteristics, married respondents were approximately 2.4 times more likely than single respondents to hold a positive perception of air pollution effects (AOR = 2.416, 95% CI: 1.244–4.693, $p = .009$). Respondents residing in Ilorin East were significantly less likely than those in Ilorin South to hold a positive perception (AOR = 0.341, 95% CI: 0.183–0.635, $p = .001$). No other socio-demographic characteristic was a statistically significant predictor.

Table 7: Binary Logistic Regression of Socio-Demographic Factors Associated with Positive Perception of Water Pollution Effects on Pregnancy Outcomes

Predictor	AOR	95% CI	p-value
Age			
18–24 years	1.00	Reference	
25–34 years	0.785	0.463–1.330	.368
35–44 years	0.465	0.255–0.845	.012
≥45 years	0.432	0.184–1.012	.053
Marital status			
Single	1.00	Reference	
Married	0.338	0.185–0.617	<.001
Widowed	0.313	0.172–0.569	<.001
Divorced/Separated	1.039	0.437–2.471	.931
Education			
No formal education	1.00	Reference	
Primary	0.576	0.326–1.018	.057
Secondary	0.349	0.189–0.644	.001
Tertiary	0.333	0.099–1.123	.076
Occupation			
Unemployed	1.00	Reference	
Trading	1.217	0.602–2.460	.585
Civil service	1.070	0.544–2.104	.845
Artisan	0.853	0.425–1.712	.655
LGA of residence			
Ilorin South	1.00	Reference	
Ilorin East	0.977	0.552–1.728	.935
Ilorin West	0.921	0.505–1.679	.789

Respondents aged 35–44 years were significantly less likely than those aged 18–24 years to hold a positive perception of water pollution effects (AOR = 0.465, 95% CI: 0.255–0.845, $p = .012$). Compared with single respondents, married respondents (AOR = 0.338, 95% CI: 0.185–0.617, $p < .001$) and widowed respondents (AOR = 0.313, 95% CI: 0.172–0.569, $p < .001$) were significantly less likely to hold a positive perception. Respondents with secondary education were also significantly less likely than those with no formal education to hold a positive perception of water pollution effects (AOR = 0.349, 95% CI: 0.189–0.644, $p = .001$).

Table 8: Summary of Chi-Square Test Results for Both Hypotheses

Hypothesis	χ^2 Calculated	df	Critical Value	p-value	Remark
H ₀₁ : Air Pollution & Pregnancy Outcome	19.26	1	3.84	< 0.05	Rejected
H ₀₂ : Water Pollution & Pregnancy Outcome	15.92	1	3.84	< 0.05	Rejected

Source: Field Survey (2026)

Both hypotheses were rejected, indicating that women of reproductive age in Ilorin hold statistically significant, not incidental, perceptions that both air and water pollution negatively affect pregnancy outcomes. The air-pollution association ($\chi^2 = 19.26$) was stronger than the water-pollution association ($\chi^2 = 15.92$), though both exceeded the critical value at $p < .05$.

Discussion

Air pollution

The results for Hypothesis 1 show that pregnant women in Ilorin, Kwara State who are of reproductive age recognize a strong correlation between poor pregnancy outcomes and air pollution. This conclusion is in line with the findings of Singh et al. (2020), who discovered that pregnant women exposed to air pollution are more likely to experience abnormalities, particularly those that affect the heart, brain, and lungs. Air pollution has been linked to several disorders of the central nervous system and interferes with normal development of the embryonic brain.

In particular, a marked reduction in the placental expression of brain-derived neurotrophic factor (BDNF) and synapsin 1 (SYN1), two genes essential for typical fetal neurodevelopmental trajectories, has been linked to higher in-utero exposure to PM_{2.5}. (Saenen et al., 2015). In addition to disrupting fetal lung development, prenatal exposure to air pollutants has been repeatedly linked to an increased risk of juvenile asthma and wheezing (Hehua et al., 2017). Additionally, mothers who are exposed to air pollutants are more likely to give birth to low-birth-weight infants.

Environmental stress signals can also cause oxidative damage, pro-inflammatory cytokine responses, ion channel activation, and altered cellular proliferation and differentiation. Daughter progenitor cells may subsequently inherit these aberrant changes. Although comprehensive validation in human tissue samples is still lacking, associations between preconceptional,

periconceptual, and prenatal toxic exposure and the adult onset of non-communicable diseases like obesity, autoimmune disease, type 2 diabetes, cardiovascular disorders, cancer, neurodegenerative conditions, and mental illness suggest that epigenetic mechanisms, including DNA methylation, histone modification, and micro-RNA expression, may be involved (Canipari et al., 2020).

Water pollution

The findings for Hypothesis 2 indicate that women in Ilorin who are of reproductive age think there is a direct link between water contamination and poor pregnancy outcomes. This conclusion is supported by Singh et al. (2020), who demonstrated that the quantity and quality of water consumed by pregnant women can have a significant impact on both maternal and fetal health. The chemical and microbiological components of water quality include things like salinity, fluoride levels, and arsenic. The hepatitis E virus (HEV), which is mostly transmitted thru fecal contamination of drinking water, disproportionately affects pregnant women. Local dangers of waterborne exposure were further highlighted by a research carried out in Uyo, Nigeria, which found 38% and 45% non-compliance with Standard Organization of Nigeria (SON) and ARGOSS recommendations for borehole water quality, respectively.

This outcome is also consistent with the findings of Manisalidis et al. (2020), who examined contamination patterns in both surface and groundwater sources. Significant effects on birth outcomes have been observed in arsenic-endemic areas; pregnancies affected by arsenic produced babies that were, on average, 30 grams lighter and had higher rates of premature delivery. These findings are significant since the ovaries have a limited supply of germ cells and heavy metals eventually enter the human body thru eating. The synthesis and function of endogenous hormones and their receptors can be disrupted by long-term exposure to metals such as nickel (Ni) and cadmium (Cd). This can lead to fetal deformity, steroidogenic dysfunction, and embryotoxicity.

The binary logistic regression results (Tables 6 and 7) indicate different sociodemographic drivers for the two pollution domains in addition to the bivariate correlation verified by the chi-square tests. While married and widowed respondents were significantly less likely to view water pollution as harmful (AOR = 0.34 and 0.31, respectively), married respondents were

significantly more likely than single respondents to view air pollution as harmful (AOR = 2.42). This disparity warrants more qualitative investigation since it implies that marital status functions thru distinct mechanisms for the two exposures, likely reflecting different family roles in water source and treatment versus general exposure to environmental health messaging. Additionally, respondents with secondary education were significantly less likely than those without formal education to view water pollution as harmful (AOR = 0.35, $p = .001$). This finding is surprising and may be the result of either desensitization from frequent exposure to clearly turbid or untreated water sources or a genuine gap in the way secondary-level curriculum cover health hazards related to water (as opposed to general environmental ones). Although there was no linkage with the perception of water pollution, living in Ilorin East was associated with a lower perceived risk of air pollution (AOR = 0.34), indicating that information environments are localized rather than uniform throughout the city. Taken together, these models indicate that the socio-demographic architecture of pollution perception in Ilorin is not uniform across exposure types, and that health education programming may need to be tailored separately for air- and water-related risk communication rather than treated as a single undifferentiated “environmental health” message.

In qualitative research of women and medical professionals in oil-producing Niger Delta areas, Oghenetega, Ojengbede, and Ana (2020) discovered that both groups thought that oil pollution was bad for the health of mothers and newborns. However, these views were largely shaped by personal experiences and cultural attitudes rather than by official health instruction. This is generally in line with the pattern seen in Ilorin, where perception was lowest for less obvious outcomes like neural tube deformities and fetal cardiac malformations and highest for concrete, experientially relevant outcomes like dust-related respiratory distress and waterborne infection. This suggests that, in Nigerian contexts, perception is more likely to follow lived and visible exposure than underlying biological mechanisms.

A different, nationally representative analysis of the 2018 Nigeria Demographic and Health Survey found that stillbirth was much more common in households using unclean fuel than in those using clean fuel, with 89% of the women surveyed using unclean cooking fuel as their primary source of cooking (Roberman, Emeto, & Adegboye, 2021). They support the recent findings that Nigerian households have a high level of exposure to air

pollution and the ensuing repercussions. Ilorin responders, however, showed comparatively little knowledge of the specific kind of prenatal and neurodevelopmental harm that this exposure is mechanistically associated with. This lends credence to the assertion that biomedical evidence of harm is surpassing common knowledge in Nigerian communities.

Home air pollution in rural areas as reported by pregnant women Butajira, Ethiopia, concentrated on both fetal effects, which they described as simply lower birth weight, and directly observable consequences, such as coughing, eye discomfort, and asthma-like symptoms (Shine et al., 2023). That qualitative assessment reflects the pattern in the Ilorin data, where congenital consequences that are less obvious are less common than immediately apparent symptoms. This implies that rather than being specific to Kwara State, this imbalance may be a common aspect of the region's public perception of environmental risk.

In contrast, a qualitative study of low-income women's perceptions of pregnancy risk in Accra, Ghana, found that participants' spontaneously generated risk factors concentrated on poverty, inadequate nutrition, inactivity, and pre-existing medical conditions; environmental pollution hardly showed up among the risks they identified on their own (Anafi & Mprah, 2022). This is a big change from the current survey, where the great majority of participants from Ilorin publicly endorsed the negative impacts of pollution. While the Accra study's open-ended qualitative elicitation required spontaneous remembering, the current study's structured Yes/No item format effectively stimulates detection of a specific risk.

This distinction should be noted as a methodological rather than solely substantive finding. It is therefore possible that the high perceived-susceptibility rates reported here partly reflect the instrument's response format rather than pre-existing, freely recalled awareness, and this should be read as a limitation of the descriptive prevalence estimates rather than as evidence that pollution risk is spontaneously salient to Ilorin women in the way, for example, nutrition or poverty appears to be to women in Accra.

On water specifically, a photovoice study of women's water-related risk perceptions in Kenya found that inadequate water, sanitation, and hygiene access was associated with an increased water-collection burden, environmental pollution exposure, and other compounding harms across the life course (Varickanickal, Bisung, & Elliott, 2020). That study frames water

risk as inseparable from women's daily labour burden, a structural dimension the present survey instrument does not capture but which represents a promising avenue for future mixed methods work extending the current findings in Ilorin.

Lastly, it is important to compare these perception findings to the extensive body of international epidemiological research on the relationship between ambient air pollution and pregnancy outcomes. Large birth-cohort studies carried out in China have established statistically significant dose-response relationships between exposure to PM_{2.5}, PM₁₀, and NO₂ and outcomes such as low birth weight, gestational diabetes, and preterm birth. These studies are based on individually estimated exposure data from cities such as Chongqing and Wuhan. Ilorin women's perceptions are given external validity by the existence of this well-established international evidence base. While there was little awareness of specific congenital outcomes, the widespread belief that air and water pollution negatively impact pregnancy is consistent with a substantial and expanding global evidence base, not just a locally held belief without external support.

Strengths and Limitations of the Study

This research possesses several strengths. It employed a multistage, probability-informed sampling framework that integrated stratified, proportionate, and convenience sampling across three local government areas, yielding a sufficiently large sample size (N = 402) with an acceptable instrument reliability coefficient of 0.86. By focusing on perception rather than clinical or biomarker data, the study addresses a recognized gap in the literature from Nigeria and the broader West Africa region, where investigations have predominantly concentrated on the biomedical mechanisms of pollution-related reproductive harm, rather than on community-level awareness, which is essential for behavior change and health-seeking actions.

However, there are a few limitations that should be noted. First, the study examined perceived rather than actual pollution exposure; no environmental or biomarker data were gathered to validate the accuracy of respondents' risk assessments against objective pollution levels or to support respondents' self-reported exposure. Second, the cross-sectional design makes it impossible to draw conclusions about the causal relationship between perception and any protective behavior or pregnancy result that may follow. Third, since

recognition of a listed item is typically easier than spontaneous recall, the dichotomous Yes/No item format may have inflated apparent perception in comparison to open-ended elicitation techniques used in similar qualitative studies elsewhere in the region. Future research could benefit from pairing this instrument with open-ended items to distinguish prompted recognition from unprompted awareness. Lastly, the use of verbal rather than written informed permission and in-person administration may have added social desirability bias, particularly on delicate subjects.

Implications for Policy and Maternal Health Programmes

The findings of this study carry direct implications for health policy and programme design in Kwara State and comparable Nigerian contexts. First, the disparity in knowledge of less obvious pollution-related consequences (neural tube defects: 34.8%; congenital cardiac defects: 46.8%; paralysis/mobility impairment: 27.9%) indicates that prenatal care platforms are an underutilized resource for environmental health counseling. This awareness gap could be closed at a point of care where pregnant women are already interacting with the health system by incorporating brief, organized environmental risk counseling into routine prenatal appointments provided by qualified nurses, midwives, or community health extension workers.

Second, community health workers and Primary Health Care (PHC) facilities should be equipped with simple, visually oriented educational materials, such as illustrated flip charts or short audio-visual content in local languages, that specifically address the lower-awareness items identified in this study, rather than relying solely on general pollution-awareness messaging that tends to emphasize more commonly known outcomes.

Third, at the policy level, the findings support stronger inter-agency collaboration between the Kwara State Ministry of Health and the Ministry of Environment, given that health-side interventions such as awareness-raising alone cannot substitute for reduced exposure. Education-based interventions would be enhanced by stricter enforcement of industrial emissions regulations, regulation of artisanal and small-scale waste disposal, and better water quality monitoring in the tested LGAs.

Lastly, rather than treating environmental and reproductive health policy as distinct domains, these findings could support the inclusion of environmental risk communication as a component of maternal health

education indicators in Nigeria's larger Reproductive, Maternal, Newborn, Child, and Adolescent Health (RMNCAH) strategic framework.

Conclusion

This study examined how women of reproductive age in Ilorin, Kwara State, perceived the effects of environmental pollution exposure on pregnancy outcomes. The results show that most respondents believe water and air pollution have a major negative impact on pregnancy outcomes. In particular, women demonstrated remarkably high awareness of the links between dust exposure and respiratory problems in newborns, between polluted air and low birth weight, and between contaminated water and illness and miscarriage. On the other hand, there was comparatively little knowledge of less evident or more complicated consequences, like neural tube abnormalities and congenital cardiac problems. This pattern, which shows that visible and experientially salient harms are recognized more easily than less visible congenital and neurodevelopmental harms, closely resembles findings from similar studies in the Niger Delta, Ethiopia, and other parts of Nigeria, indicating that it may not be a finding unique to Ilorin but rather a more widespread regional feature of lay environmental risk perception.

Considering the findings, the following recommendations are presented:

1. To increase women's awareness of the reproductive risks linked to air and water pollution, health authorities and community health workers should create and implement context-specific health education programs. They should pay special attention to less well-known effects like neural tube defects and congenital heart defects.
2. To lower industrial emissions, illicit dumping, and the improper use of agricultural chemicals in residential areas, the Kwara State government should tighten environmental legislation and enforcement practices.
3. Given that the logistic regression models show marital status, education, and LGA of residence predicting perception differently for air versus water pollution, future research should combine this survey instrument with open-ended qualitative methods to determine how much of the observed perception reflects prompted recognition versus freely recalled awareness, and to explore the mechanisms underlying these socio-demographic differences.

References

- Agedew, E., Tsegaye, B., Bante, A., Zerihun, E., Aklilu, A., Girma, M., et al. (2022). Zinc deficiency and associated factors among pregnant women's attending antenatal clinics in public health facilities of Konso Zone, Southern Ethiopia. *PLoS ONE*, 17(7), e0270971. <https://doi.org/10.1371/journal.pone.0270971>
- Amechi, E. P., & Oni, B. A. (2019). Import of electronic waste into Nigeria: The imperative of a regulatory policy shift. *Chinese Journal of Environmental Law*, 3(2), 141–166.
- Anafi, P., & Mprah, W. K. (2022). Knowledge and perception of risk in pregnancy and childbirth among women in low-income communities in Accra. *Women*, 2(4), 385–396. <https://doi.org/10.3390/women2040035>
- Basilio, E., Chen, R., Fernandez, A. C., et al. (2022). Wildfire smoke exposure during pregnancy: A review of potential mechanisms of placental toxicity, impact on obstetric outcomes, and strategies to reduce exposure. *International Journal of Environmental Research and Public Health*, 19, 13727. <https://doi.org/10.3390/ijerph192113727>
- Bhardwaj, J. K., Paliwal, A., Saraf, P., et al. (2021). Effects of heavy metals on reproduction owing to infertility. *Journal of Biochemical and Molecular Toxicology*, 35, e22823. <https://doi.org/10.1002/jbt.22823>
- Canipari, R., De Santis, L., & Cecconi, S. (2020). Female fertility and environmental pollution. *International Journal of Environmental Research and Public Health*, 17(23), 8802.
- Ebdrup, N. H., Schullehner, J., Knudsen, U. B., Liew, Z., Thomsen, A. M. L., Lyngsø, J., ... & Ramlau-Hansen, C. H. (2022). Drinking water nitrate and risk of pregnancy loss: A nationwide cohort study. *Environmental Health*, 21(1), 87.
- Green, M. P., Harvey, A. J., Finger, B. J., & Tarulli, G. A. (2021). Endocrine disrupting chemicals: Impacts on human fertility and fecundity during the peri-conception period. *Environmental Research*, 194, 110694.

- Hehua, Z., Qing, C., Shanyan, G., Qijun, W., & Yuhong, Z. (2017). The impact of prenatal exposure to air pollution on childhood wheezing and asthma: A systematic review. *Environmental Research*, 159, 519–530. <https://doi.org/10.1016/j.envres.2017.08.038>
- Hlisníková, H., Petrovičová, I., Kolena, B., Šidlovská, M., & Sirotkin, A. (2020). Effects and mechanisms of phthalates' action on reproductive processes and reproductive health: A literature review. *International Journal of Environmental Research and Public Health*, 17(18), 6811.
- Ji, N., Johnson, M., Eckel, S. P., Gauderman, W. J., Chavez, T. A., Berhane, K., ... & Breton, C. V. (2023). Prenatal ambient air pollution exposure and child weight trajectories from the 3rd trimester of pregnancy to 2 years of age: A cohort study. *BMC Medicine*, 21(1), 341.
- Kshetrimayum, C., Sharma, A., Mishra, V. V., & Kumar, S. (2019). Polycystic ovarian syndrome: Environmental/occupational, lifestyle factors; an overview. *Journal of the Turkish German Gynecological Association*, 20(4), 255.
- Mahey, S., Kumar, R., Sharma, M., Kumar, V., & Bhardwaj, R. (2020). A critical review on toxicity of cobalt and its bioremediation strategies. *SN Applied Sciences*, 2(7), 1279.
- Manisalidis, I., Stavropoulou, E., Stavropoulos, A., et al. (2020). Environmental and health impacts of air pollution: A review. *Frontiers in Public Health*, 8, 14.
- Montano, L., Pironti, C., Pinto, G., Ricciardi, M., Buono, A., Brogna, C., ... & Motta, O. (2022). Polychlorinated biphenyls (PCBs) in the environment: Occupational and exposure events, effects on human health and fertility. *Toxics*, 10(7), 365.
- National Population Commission. (2023). Population distribution in Ilorin Central, Kwara State. Abuja: NPC.
- Nie, Z., Xu, H., Qiu, M., Liu, M., Chu, C., Bloom, M. S., & Ou, Y. (2024). Associations of maternal exposure to multiple plasma trace elements with the prevalence of fetal congenital heart defects: A nested case-control study. *Science of the Total Environment*, 912, 169409.

- Oghenetega, O. B., Ojengbede, O. A., & Ana, G. R. E. E. (2020). Perception determinants of women and healthcare providers on the effects of oil pollution on maternal and newborn outcomes in the Niger Delta, Nigeria. *International Journal of Women's Health*, 12, 197–205. <https://doi.org/10.2147/IJWH.S235536>
- Osman, A. I., Hosny, M., Eltaweil, A. S., et al. (2023). Microplastic sources, formation, toxicity and remediation: A review. *Environmental Chemistry Letters*, 21(4), 2129–2169.
- Predieri, B., Iughetti, L., Bernasconi, S., & Street, M. E. (2022). Endocrine disrupting chemicals' effects in children: What we know and what we need to learn. *International Journal of Molecular Sciences*, 23(19), 11899.
- Rajmohan, K. S., Chandrasekaran, R., & Varjani, S. (2020). A review on occurrence of pesticides in environment and current technologies for their remediation and management. *Indian Journal of Microbiology*, 60, 125–138.
- Roberman, J., Emeto, T. I., & Adegboye, O. A. (2021). Adverse birth outcomes due to exposure to household air pollution from unclean cooking fuel among women of reproductive age in Nigeria. *International Journal of Environmental Research and Public Health*, 18(2), 634. <https://doi.org/10.3390/ijerph18020634>
- Rosenstock, I. M. (1974). Historical origins of the Health Belief Model. *Health Education Monographs*, 2(4), 328–335.
- Saenen, N. D., Plusquin, M., Bijmens, E., Janssen, B. G., Gyselaers, W., Cox, B., Fierens, F., Molenberghs, G., Penders, J., Vrijens, K., De Boever, P., & Nawrot, T. S. (2015). In utero fine particle air pollution and placental expression of genes in the brain-derived neurotrophic factor signaling pathway: An ENVIRONAGE birth cohort study. *Environmental Health Perspectives*, 123(8), 834–840. <https://doi.org/10.1289/ehp.1408549>
- Shine, S., Tamirie, M., Kumie, A., Addissie, A., Athlin, S., Mekonnen, H., Girma, E., Molla, M., & Kaba, M. (2023). Pregnant women's perception on the health effects of household air pollution in rural Butajira, Ethiopia: A phenomenological qualitative study. *BMC Public Health*, 23, 1633. <https://doi.org/10.1186/s12889-023-16578-8>

- Simoncic, V., Enaux, C., Deguen, S., & Kihal-Talantikite, W. (2020). Adverse birth outcomes related to NO₂ and PM exposure: European systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 17(21), 8116.
- Singh, L., Anand, M., Singh, S., & Taneja, A. (2020). Environmental toxic metals in placenta and their effects on preterm delivery: Current opinion. *Drug and Chemical Toxicology*, 43(5), 531–538.
- Varickanickal, J., Bisung, E., & Elliott, S. J. (2020). Water risk perceptions across the life-course of women in Kenya. *Health Promotion International*, 35(4), 639–648. <https://doi.org/10.1093/heapro/daz055>
- Wang, W., Zhou, W., Wu, S., Liang, F., Li, Y., Zhang, J., & Wang, Y. (2019). Perfluoroalkyl substances exposure and risk of polycystic ovarian syndrome related infertility in Chinese women. *Environmental Pollution*, 247, 824–831.
- Warwick, D., Young, M., Palmer, J., & Ermel, R. W. (2019). Mercury vapor volatilization from particulate generated from dental amalgam removal with a high-speed dental drill – a significant source of exposure. *Journal of Occupational Medicine and Toxicology*, 14(1), 22.
- Wikuats, C. F. H., Nogueira, T., Squizzato, R., de Freitas, E. D., & Andrade, M. D. F. (2023). Health risk assessment of exposure to air pollutants exceeding the new WHO air quality guidelines (AQGs) in São Paulo, Brazil. *International Journal of Environmental Research and Public Health*, 20(9), 5707.
- Yilmaz, B., Terekeci, H., Sandal, S., & Kelestimur, F. (2020). Endocrine disrupting chemicals: Exposure, effects on human health, mechanism of action, models for testing and strategies for prevention. *Reviews in Endocrine and Metabolic Disorders*, 21(1), 127–147.
- Yun, S., & Oh, K. (2022). The Korea National Health and Nutrition Examination Survey data linked cause of death data. *Epidemiology and Health*, 44, e2022021.