Public Health Implications of Pesticide Use in Bangladesh: A Comprehensive Review

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ABSTRACT

The increasing use of pesticides in Bangladesh has significantly improved agricultural productivity but poses severe public health concerns. Indiscriminate pesticide application has led to acute and chronic health issues, environmental contamination, and food safety risks, particularly affecting farmers and rural populations. This study aims to assess the public health implications of pesticide use in Bangladesh by reviewing existing literature, government reports, and health surveys. The study identifies key exposure pathways, associated health risks, regulatory gaps, and potential policy solutions. A systematic review was conducted using secondary data from peer-reviewed journal articles, government databases, and international reports. The study categorized findings into pesticide usage trends, health consequences, environmental contamination, and policy challenges. Findings indicate that prolonged pesticide exposure leads to acute poisoning, neurological disorders, cancer, endocrine disruptions, and reproductive issues. Approximately 27% of Bangladeshi farmers experience pesticide-related health issues annually. Additionally, pesticide residues in food and water frequently exceed safety limits, impacting public health. Despite existing regulations, enforcement remains weak due to limited monitoring, counterfeit pesticide sales, and lack of farmer awareness. The study underscores the urgent need for stronger regulations, increased farmer education, and safer pest management alternatives. A coordinated approach involving policymakers, health professionals, and agricultural stakeholders is essential for mitigating pesticide-related health risks. This study provides a comprehensive synthesis of pesticide-related health risks in Bangladesh, highlighting regulatory shortcomings and policy recommendations. It serves as a reference for policymakers and researchers working on sustainable agriculture and public health protection. Unlike previous studies that focus solely on agricultural or environmental aspects, this research integrates public health perspectives, regulatory analysis, and comparative global best practices to propose holistic solutions for pesticide management in Bangladesh.

Keywords: Pesticides, Public Health, Bangladesh, Environmental Impact, Chronic Illnesses

INTRODUCTION

Agriculture remains a vital sector in Bangladesh's economy, with pesticide applications increasing to maximize crop yields. However, indiscriminate use has resulted in health hazards, particularly for farmers and consumers. Several studies have documented the correlation between pesticide exposure and conditions such as respiratory illnesses, neurological disorders, and endocrine disruptions. This review compiles data from scholarly sources to highlight the health risks associated with pesticide usage and suggests policy solutions to mitigate these effects. Agriculture is vital to Bangladesh's economy, contributing 12.9% of GDP and employing 40% of the labor force. Pesticide use has surged from 3,000 metric tons in 1990 to over 45,000 metric tons in 2021, improving yields but posing serious health risks. Nearly 27% of farmers experience pesticide-related illnesses, with links to cancer, neurological disorders, and endocrine issues. Studies show 40% of fresh vegetables and 25% of rice samples exceed FAO/WHO pesticide safety limits, highlighting weak regulatory enforcement and low awareness. This study evaluates pesticide-related health risks, regulatory gaps, and policy solutions. Findings will aid policymakers, promote safer pest control methods, strengthen regulations, enhance public health monitoring, and encourage multisectoral collaboration for sustainable pesticide management in Bangladesh.

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The use of pesticides in agriculture has played a crucial role in increasing crop yields and ensuring food security worldwide. In Bangladesh, where agriculture contributes approximately 12.9% of the GDP and employs over 40% of the labor force pesticides have become an integral part of modern farming practices. However, the indiscriminate and excessive application of these chemicals has raised serious public health and environmental concerns (Jallow et al., 2017).

Rising Pesticide Use and Its Implications

Over the last few decades, Bangladesh has witnessed a dramatic increase in pesticide consumption, particularly in rice and vegetable farming (Dasgupta et al., 2007). Reports indicate that pesticide imports have risen from 3,000 metric tons in 1990 to over 45,000 metric tons in 2021 (DoE, 2022). Organophosphates, carbamates, pyrethroids, and neonicotinoids remain the most widely used chemical classes (Chowdhury et al., 2012). While these chemicals effectively combat pests, their toxic residues persist in food, water, and soil, posing significant health risks to farmers and consumers alike (Singh et al., 2018).

Health Consequences of Pesticide Exposure

Research has established a strong link between pesticide exposure and adverse health effects, ranging from acute poisoning to long-term chronic illnesses. According to a World Bank study (2020), nearly 27% of Bangladeshi farmers experience pesticide-related illnesses annually. Furthermore, long-term exposure has been associated with cancer (Kabir et al., 2015), endocrine disruption (Mnif et al., 2011), neurodegenerative diseases (Mostafalou & Abdollahi, 2013), and reproductive issues (Bonner & Alavanja, 2017). Children and pregnant women in farming communities face higher vulnerability due to pesticide bioaccumulation (Gilden et al., 2010).

Environmental and Food Safety Concerns

Organochlorine pesticide residues in paddy fields along the Ganga-Brahmaputra River Basin, emphasizing the risks of long-range atmospheric transport and environmental contamination (Chakraborty et al., 2018). Studies by Hossain et al. (2018) and Shammi et al. (2020) reveal that nearly 40% of fresh vegetables and 25% of rice samples contain pesticide residues exceeding FAO/WHO safety limits.

Gaps in Regulation and Awareness

Despite the presence of Pesticide Act (1985) and Pesticide Rules (1985), regulatory enforcement remains weak due to limited monitoring, illegal imports, and counterfeit pesticide sales (BBS, 2021).

Objectives of the Study

This review aims to assess the public health implications of pesticide use in Bangladesh by synthesizing existing literature, government reports, and health surveys. The study highlights key exposure pathways, documented health risks, environmental contamination levels, and regulatory gaps. Furthermore, it explores potential policy recommendations to reduce pesticide-related health hazards and promote sustainable agricultural practices.

METHODOLOGY

This study employs a systematic review approach to assess the public health risks associated with pesticide use in Bangladesh. The research synthesizes findings from peer-reviewed journal articles, government reports, and international health organizations to provide a comprehensive understanding of pesticide exposure, health effects, and regulatory challenges.

Data Collection

Relevant literature was identified using keyword-based searches in major scientific databases, including PubMed, Scopus, Web of Science, Google Scholar, and ScienceDirect. Keywords such as "pesticide exposure

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in Bangladesh," "public health risks of pesticides," "agricultural chemical toxicity," and "pesticide regulation" were used.

Selection Criteria

1) Inclusion Criteria:

   a) Studies published between 2014 and 2024 to ensure relevance.
   b) Research focusing on Bangladesh or South Asian countries with similar agricultural practices.
   c) Peer-reviewed studies and government reports analyzing pesticide exposure, health effects, and policy interventions.

2) Exclusion Criteria:

   a) Studies without empirical data or those focusing only on laboratory-based pesticide toxicity without human impact analysis.
   b) Articles not published in English or Bengali.
   c) Duplicates or studies with conflicting data without adequate validation.

Article Screening and Selection

The initial search yielded 250 articles related to pesticide use and public health risks. After title and abstract screening, 120 articles were shortlisted based on relevance. Following full-text reviews, 50 articles meeting the inclusion criteria were selected for final synthesis.

Data Analysis and Validation

The selected studies were categorized based on themes:

1. Pesticide usage trends and exposure pathways
2. Health impacts of pesticide exposure
3. Environmental contamination and food safety risks
4. Regulatory frameworks and enforcement challenges

A meta-analysis approach was applied where possible, comparing statistical findings across multiple studies. The systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure reliability. Cross-validation was conducted by comparing multiple data sources, and findings were aligned with reports from WHO, FAO, and the Bangladesh Ministry of Health for consistency.

This methodology ensures a robust and evidence-based assessment of the public health implications of pesticide use in Bangladesh.

Ethical Considerations

Since this study relies solely on secondary data, no direct human or animal involvement was required. All sources were properly cited, ensuring adherence to academic integrity and ethical research practices.

FINDINGS AND DISCUSSION

Findings

The systematic review of 50 selected articles reveals significant public health risks associated with pesticide use in Bangladesh. The key findings include:

1) Health Impact on Farmers and Communities:

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a) 27% of Bangladeshi farmers experience pesticide-related illnesses annually (Ahmed & Rahman, 2020).
b) A study by Hossain et al. (2020) found that 35% of farmers suffer from acute symptoms such as nausea, headaches, and respiratory distress due to pesticide exposure.
c) Long-term exposure has been linked to cancer, neurological disorders, and endocrine disruption (Kabir et al., 2019).

2) Pesticide Residues in Food and Water:

a) 40% of fresh vegetables and 25% of rice samples exceed FAO/WHO pesticide safety limits (Shammi et al., 2021).
b) The hydrochemistry and weathering processes affecting water quality in the Lower Ganges-Brahmaputra-Meghna Basin, which is relevant for understanding contamination patterns, including pesticide residues. (Hossain. J., 2023).

3) Regulatory and Awareness Gaps:

a) Despite the presence of the Pesticide Act (1985) and Pesticide Rules (1985), weak enforcement and limited monitoring allow excessive pesticide use (BBS, 2022).
b) Over 60% of farmers lack formal training on safe pesticide handling and disposal (Rahman et al., 2021).
c) Counterfeit and unregistered pesticides are widely available, further exacerbating health risks (World Bank, 2022).

DISCUSSION

Supporting International Research

The findings align with global research highlighting pesticide-related health risks. A study in India found that 30% of farmers suffer from pesticide-induced illnesses, similar to Bangladesh (Mohammadi et al., 2019). Research in Vietnam demonstrated that high pesticide exposure led to a 42% increase in respiratory diseases among farmworkers (Nguyen et al., 2022). Studies in Pakistan revealing that pesticide residues are among the major contaminants in both surface and groundwater in Pakistan, leading to waterborne diseases and posing significant health risks. (Fida et al., 2021).

Similarly, a meta-analysis in Sub-Saharan Africa found that farmers lacking protective measures had a 3.2 times higher risk of pesticide poisoning (Jallow et al., 2017). These comparisons indicate that Bangladesh shares similar challenges with other developing countries but has weaker regulatory enforcement and lower adoption of safer alternatives.

Novelty of the Research

Unlike previous studies that focus solely on agricultural or environmental impacts, this study integrates public health perspectives with regulatory analysis and comparative global best practices. The novelty of this research lies in:

1. Comprehensive synthesis of health impacts, environmental contamination, and policy gaps.
2. Comparative analysis with international studies to identify regulatory weaknesses in Bangladesh.
3. Emphasis on policy recommendations, including stricter enforcement, Integrated Pest Management (IPM), and improved farmer education.

Contribution of the Research

This study provides critical insights into pesticide-related health risks in Bangladesh, contributing to:

- Policy Development: Strengthening pesticide regulations and enforcement mechanisms.
- Public Health Awareness: Enhancing farmer training programs on pesticide safety.

- Sustainable Agricultural Practices: Promoting alternative pest management strategies.
- Global Agricultural Health Research: Serving as a reference for similar developing economies.

These findings highlight the urgent need for a multi-sectoral approach involving government agencies, public health officials, and agricultural researchers to reduce pesticide-related risks in Bangladesh.

CONCLUSION

This study systematically reviewed the public health implications of pesticide use in Bangladesh, focusing on health risks, environmental contamination, and regulatory gaps. The findings indicate that 27% of farmers suffer from pesticide-related illnesses annually, with long-term exposure linked to neurological disorders, cancer, and endocrine disruption. Additionally, 40% of fresh vegetables and 25% of rice samples exceed FAO/WHO pesticide safety limits, posing a severe risk to consumers. Weak regulatory enforcement, low farmer awareness, and widespread use of counterfeit pesticides further exacerbate these issues.

The research highlights that, compared to other developing countries, Bangladesh has weaker regulatory mechanisms and a lower adoption rate of Integrated Pest Management (IPM) and other safer alternatives. Addressing these challenges requires urgent policy interventions and stakeholder collaboration.

RECOMMENDATIONS

1. Strengthen Regulations & Enforcement: Ban hazardous pesticides, enhance monitoring, and impose strict penalties for violations.
2. Promote Safer Farming Practices: Expand Integrated Pest Management (IPM), encourage organic alternatives, and provide subsidies for eco-friendly pest control.
3. Enhance Farmer Education: Implement nationwide training on pesticide safety, launch awareness campaigns, and provide mobile-based advisory services.
4. Improve Health & Food Safety Monitoring: Establish a national database on pesticide-related illnesses, increase hospital reporting, and conduct regular food and water testing.
5. Foster Multi-Sectoral Collaboration: Form a task force with government agencies, NGOs, and private sectors to oversee pesticide management and provide protective gear to farmers.

These measures will reduce pesticide-related health risks, enhance food safety, and promote sustainable agricultural practices in Bangladesh.

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