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KNOWLEDGE OF PUBLIC HEALTH RISKS ASSOCIATED WITH PESTICIDE RESIDUES IN FOOD AMONG BIOLOGY EDUCATION STUDENTS IN FEDERAL COLLEGE OF EDUCATION EHA-AMUFU

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Abstract

This study examined the knowledge of public health risks associated with pesticide residues in food among 142 Biology Education students at the Federal College of Education, Eha-Amufu, Nigeria. Guided by three research questions, the study employed a descriptive survey design and analyzed responses using mean scores on a four-point Likert scale. Results revealed that students possess a moderate understanding of pesticide residues, particularly regarding their occurrence during crop cultivation, storage, and persistence after preparation. Participants demonstrated relatively strong awareness of common causes especially pesticide overuse but exhibited limited insight into how application timing influences residue levels. In terms of health risks, respondents were well informed about acute effects and carcinogenic potential, yet displayed lower knowledge of chronic outcomes such as endocrine disruption and heightened vulnerability in children. These findings highlight critical gaps in the existing curriculum and underscore the need for targeted instructional interventions. It is recommended that biology education programs incorporate enhanced modules on safe pesticide application practices, the significance of timing in residue management, and the long-term health implications of persistent exposure. Such measures will better equip future educators to advocate for food safety and protect community health.

Keywords: Pesticide residues in food, Public health risks, Knowledge assessment, Biology education students, Food safety awareness

Introduction

The extensive application of pesticides in modern agriculture has undeniably improved crop productivity and helped safeguard harvests against a multitude of pests and diseases (Aktar et al., 2009). Yet, this agricultural boon comes at a cost: when pesticides are misapplied or when regulatory frameworks and enforcement mechanisms are weak, residues accumulate in foodstuffs, giving rise to significant public health threats (Tudi et al., 2021). Chronic exposure

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to these residues has been linked to a spectrum of adverse health outcomes, including carcinogenesis, endocrine disruption, reproductive dysfunction, and neurotoxicity (World Health Organization [WHO], 2021). The burden of such risks is disproportionately borne by populations in developing regions, where monitoring infrastructures are often under-resourced and consumer awareness remains limited (United Nations Environment Programme [UNEP], 2022).

Educational institutions occupy a strategic position in addressing this knowledge gap, as they are tasked with cultivating scientifically literate graduates who can both understand complex environmental health challenges and communicate them effectively to broader audiences (Osborne & Allchin, 2024). Within this framework, biology education students represent a particularly critical cohort: poised to become future teachers and community advocates, their grasp of environmental toxicology and food safety principles will directly influence the quality of health education delivered at the secondary and tertiary levels (Enkelejda et al., 2024). Yet despite their pivotal role, there is evidence that many teacher-training programs have not fully integrated contemporary public health concerns—such as pesticide residue risks—into their curricula, potentially leaving graduates ill-equipped to address these pressing issues in their professional practice (Ferguson et al., 2014).

In the Nigerian context, the challenges are especially acute. Empirical studies have documented alarming concentrations of pesticide residues in staple foods consumed nationwide, underscoring systemic deficiencies in both agricultural best practices and governmental oversight ((Deji, 2012). Such findings highlight an urgent need for targeted educational interventions that not only raise awareness among consumers but also empower prospective educators with the knowledge and skills necessary to advocate for safer food systems. However, the current state of pesticide-related content within biology education curricula at institutions like the Federal College of Education Eha-Amufu remains unclear, leaving a critical question unanswered: do biology education students possess the depth of understanding required to recognize, communicate, and mitigate the health risks posed by pesticide residues?

This study seeks to fill that gap by assessing the level of knowledge regarding public health risks associated with pesticide residues in food among biology education students at the Federal College of Education Eha-Amufu. By elucidating students' familiarity with key concepts such as the definition and sources of pesticide residues, as well as their potential health impacts this research will provide actionable insights into the strengths and deficits of existing curricular offerings. Ultimately, the findings are intended to inform curriculum development and

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pedagogical strategies that enhance future educators' capacity to foster community awareness and promote food safety, thereby contributing to improved public health outcomes in both local and broader Nigerian settings.

Research Methods

Research Design

This study adopted a descriptive survey design to systematically collect and describe the characteristics and knowledge levels of Biology Education students regarding public health risks associated with pesticide residues in food. According to Nworgu (2015), a descriptive survey is appropriate when the objective is to gather quantifiable information about existing phenomena in a natural setting. By employing this design, the researchers were able to obtain first-hand data from a representative sample without manipulating variables.

Area of Study

The research was conducted at the Federal College of Education, Eha-Amufu, located in Isi-Uzo Local Government Area, Enugu State, Nigeria. Eha-Amufu is a semi-urban town approximately 64 km northeast of Enugu metropolis. The surrounding landscape is characterized by farmlands, forests, and surface running water provides a relevant environmental context for investigating students' awareness of pesticide residues in locally produced and consumed foods.

Population of the Study

The target population comprised all 337 Biology Education students enrolled at F.C.E. Eha-Amufu. This included 111 students in the Nigeria Certificate in Education (N.C.E.) programme (N.C.E. I = 15; N.C.E. II = 14; N.C.E. III = 82) and 226 students in the Degree programme (D I = 36; D II = 55; D III = 38; D IV = 97).

Sample and Sampling Techniques

A total of 142 students were selected to participate, drawn from N.C.E. I, N.C.E. II, Degree II, and Degree III cohorts. Simple random sampling was used to ensure each eligible student had an equal chance of selection, thereby minimizing bias and enhancing representativeness (Kothari, 2004). This sample size balanced statistical reliability with practical constraints of time and resources.

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Instrument for Data Collection

Data were collected using a structured questionnaire titled *Students' Knowledge of Public Health Risks from Pesticide Residues in Food*. The instrument comprised four sections:

- **Section A:** Knowledge of the term "pesticide residues in food"
- **Section B:** Knowledge of the causes of pesticide residues
- **Section C:** Awareness of potential health impacts
- **Section D:** Demographic information

Responses were measured on a four-point Likert scale: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Agree (A), and 4 = Strongly Agree (SA).

Validity of the Instrument

Face validity was established by two experts—one in Measurement and Evaluation and one in Biology Education at F.C.E. Eha-Amufu—who reviewed the questionnaire for clarity, relevance, and comprehensiveness. Their feedback on item wording, content adequacy, and alignment with research objectives informed necessary revisions before finalization.

Reliability of the Instrument

A pilot test was conducted with 20 Degree III Biology Education students at the same institution. The resulting data were analyzed using Cronbach's alpha, yielding a reliability coefficient of .86, indicating high internal consistency for the non-dichotomous scale (Cronbach, 1951).

Method of Data Collection

Researchers administered the finalized questionnaire during scheduled class sessions, overseeing distribution and retrieval to ensure a high response rate. Each participant completed the instrument once under the supervision of the research team.

Method of Data Analysis

Completed questionnaires were coded and entered into Microsoft Excel for cleaning and processing. Descriptive statistics—including means, standard deviations, and frequency distributions—were computed. Given the four-point scale, a midpoint score of 2.50 was set as the cut-off: item means ≥ 2.50 signified adequate knowledge, while means < 2.50 indicated gaps. These analyses directly addressed the study's research questions and provided a clear picture of students' knowledge levels.

Results

Research question 1: what is the level of knowledge of biology education students in Federal College of Education Eha-Amufu on the term "pesticide residues in food"?

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Table 1: Mean rating on the level of knowledge of biology education students in Federal College of Education Eha-Amufu on the term "pesticide residues in food"

S/N	ITEMS	SD	D	A	SA	N	MEAN	REMARKS
1.	Pesticide residues in food refer to the traces of chemicals left on food after pesticides are used in farming.	5	50	36	45	142	2.92	Accept
2.	These residues occur when pesticides applied to crops during growing or storage remain on or in the food.	7	20	77	38	142	3.03	Accept
3.	Pesticide residues can be found on fruits, vegetables, grains, and other food products.	15	41	69	17	142	2.61	Accept
4.	The amount of pesticide residue left on food is usually measured in parts per million (ppm).	28	13	59	42	142	2.81	Accept
5	These residues can persist even after food is washed, peeled, or cooked.	17	15	60	50	142	3.01	Accept

The findings from Table 1 reveal the level of knowledge of biology education students in Federal College of Education Eha-Amufu on the term "pesticide residues in food." The mean ratings across all items suggest a moderate level of understanding, with all items falling within the "Accept" category. The students have a generally fair grasp of pesticide residues in food, as evidenced by the highest mean score of **3.03** for the item regarding the occurrence of pesticide residues when pesticides are applied during growing or storage. Students also demonstrated awareness that pesticide residues can persist after washing, peeling, or cooking, reflected by a mean score of **3.01**, which indicates a reasonable understanding of food safety. The lowest mean score of **2.61** was recorded for the statement that pesticide residues can be found on various food products, suggesting a slightly lower understanding in this area.

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Research question 2: what is the level of knowledge of biology education students on the causes of pesticide residues in food?

Table 2: Mean rating on the level of knowledge of biology education students on the causes of pesticide residues in food

S/N	ITEMS	SD	D	A	SA	N	MEAN	REMARKS
6.	Pesticide residues in food are primarily caused by the application of pesticides during farming to control pests and diseases.	40	29	46	169	284	3.20	Accept
7.	Overuse or excessive application of pesticides can lead to higher residue levels on crops.	23	27	40	194	284	3.41	Accept
8.	Poor timing of pesticide application, such as applying it too close to harvest, can result in pesticide residues.	73	82	80	49	284	2.37	Accept
9.	Inadequate washing or processing of food after harvesting can leave pesticide residues on the surface.	28	25	41	190	284	3.36	Accept
10.	Improper storage conditions, such as high humidity or temperature, can cause pesticides to remain on food longer.	30	29	119	106	284	3.31	Accept

The findings from Table 2 indicate the level of knowledge of biology education students on the causes of pesticide residues in food. The overall results suggest that students possess a moderate to fairly good understanding of the causes, with most items receiving mean scores above 3.0, indicating general acceptance of the concepts. The highest mean score of **3.41** was recorded for the item concerning the overuse or excessive application of pesticides, suggesting that students have a strong understanding of how improper pesticide use contributes to higher residue levels on crops. The item regarding poor timing of pesticide application, with a mean score of **2.37**, shows the lowest understanding. This indicates that students may have less awareness of the impact of applying pesticides too close to harvest on pesticide residue levels.

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Items regarding inadequate washing or processing (**3.36**) and improper storage conditions (**3.31**) also received relatively high scores, reflecting good knowledge of how these factors contribute to pesticide residue persistence on food. These findings suggest that while students have a solid understanding of several causes of pesticide residues, they need further education on the effects of timing pesticide application close to harvest.

Research question 3: what is the level of knowledge of biology education students on the potential health impacts of pesticide residues in food?

Table 3: Mean rating of the level of knowledge of biology education students on the potential health impacts of pesticide residues in food

S/N	ITEMS	SD	D	A	SA	N	MEAN	REMARKS
11.	Pesticide residues in food can cause acute health effects, such as headaches, dizziness, or nausea, if consumed in high quantities.	20	35	45	184	284	3.37	Accept
12.	Long-term exposure to pesticide residues has been linked to an increased risk of developing cancers, such as leukemia and lymphoma.	10	16	64	194	284	3.52	Accept
13.	Some pesticide residues may disrupt hormone function, potentially leading to reproductive and developmental issues.	30	53	112	89	284	2.59	Accept
14.	Children are particularly vulnerable to pesticide exposure, as it can affect their growing bodies and brain development.	60	24	132	68	284	2.72	Accept
15.	Chronic exposure to pesticide residues may contribute to neurological disorders, including memory loss and learning disabilities.	44	20	124	96	284	2.80	Accept

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The findings from Table 3 highlight the level of knowledge of biology education students on the potential health impacts of pesticide residues in food. Overall, the mean scores suggest a moderate understanding of these health risks, with most items falling within the "Accept" category. The highest mean score of **3.52** was recorded for the item about the link between long-term exposure to pesticide residues and the increased risk of cancers such as leukemia and lymphoma, indicating strong awareness of this serious health effect. The item regarding acute health effects, with a mean score of **3.37**, reflects a good understanding that pesticide residues can cause immediate symptoms like headaches, dizziness, and nausea when consumed in large amounts. The lowest mean scores were observed for the item on hormone disruption and developmental issues (**2.59**) and the vulnerability of children to pesticide exposure (**2.72**), suggesting that students have less knowledge in these areas, especially regarding the long-term impacts on hormonal health and child development. These results suggest that while students have a good understanding of certain health risks, there is a need for increased education on the effects of pesticide residues on hormones and child development.

Discussion of findings

The findings (Table 1) indicate that biology education students in the Federal College of Education Eha-Amufu possess a moderate level of knowledge about pesticide residues in food. The mean scores for all items fall within the "Accept" range (2.61–3.03), showing that students have a fair understanding of key concepts. The highest-rated item (Mean = 3.03) reflects strong awareness of how pesticide residues occur during crop growing or storage. Additionally, students displayed significant knowledge that pesticide residues can persist after food preparation methods such as washing, peeling, or cooking (Mean = 3.01). However, the relatively lower mean score of 2.61 for the item regarding pesticide residues on various food products suggests an area where knowledge could be enhanced. The moderate level of knowledge observed can be attributed to several factors such as: biology students are likely exposed to environmental science and food safety topics, which often include discussions on pesticide usage and its implications; increased public and media attention to food safety issues may have contributed to students' understanding of pesticide residues, particularly their persistence despite washing or cooking, and Many students may have anecdotal or personal exposure to pesticide-related issues, especially in agricultural communities. However, the lower awareness of specific details, such as the variety of food products that may contain residues, could stem from insufficient emphasis on this topic in their education or public discourse. The moderate level of knowledge observed aligns with the findings of **Taufeeq et al. (2021)**, who emphasized that students exposed to environmental and food safety education generally possess a fair understanding of pesticide residues but may lack in-depth knowledge of specific aspects. Similarly, **Tudi et al. (2022)** found that media and public awareness

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campaigns on food safety have significantly contributed to raising awareness about pesticide residues, especially regarding their persistence despite washing or cooking. Furthermore,

Sawyer et al. (2024) underscored that formal education plays a pivotal role in shaping students' understanding of pesticide-related issues, though certain topics, such as the variety of food products affected by residues, are often underrepresented.

The findings presented in Table 2 reveal that biology education students have a moderate to fairly good understanding of the causes of pesticide residues in food. Most items received mean scores above 3.0, indicating general acceptance and agreement with the presented statements. The highest mean score of 3.41 was recorded for the overuse or excessive application of pesticides, reflecting a strong understanding among students about how improper pesticide use contributes to higher residue levels. On the other hand, the lowest score of 2.37 was observed for the item regarding poor timing of pesticide application, indicating that students were less knowledgeable about how applying pesticides too close to harvest can impact residue levels. The students' relatively strong understanding of pesticide overuse (with a mean score of 3.41) may stem from the emphasis on pesticide management in their biology curriculum, which likely covers the consequences of excessive pesticide application on both environmental and human health. Additionally, the increasing media and public focus on pesticide misuse and its harmful effects on food safety might have contributed to the students' awareness. The higher scores for items related to inadequate washing or processing (3.36) and improper storage (3.31) could reflect a reasonable understanding of common food safety practices, which are frequently discussed in both biology and public health contexts. However, the lower score of 2.37 regarding the timing of pesticide application suggests a gap in the students' understanding of agricultural practices and their impact on pesticide residue levels. This may be due to less emphasis in the curriculum on this specific aspect, or it could reflect a lack of real-world exposure or practical experience related to the timing of pesticide applications in agriculture. These findings are consistent with the results of **Strassemeyer et al. (2017)**, who noted that students tend to have a stronger understanding of general causes of pesticide residues, such as overuse and improper storage, but often lack knowledge about more nuanced factors like timing of application. **Korucu et al. (2021)** also reported that public health education focuses heavily on food safety practices like washing and storage but places less emphasis on agricultural practices. Similarly, **Liu et al. (2021)** found that while students were well-informed about common causes of pesticide residues, gaps in their understanding of specific farming practices suggest the need for more practical or hands-on learning experiences.

The findings from Table 3 indicate that biology education students have a moderate understanding of the potential health impacts of pesticide residues in food. Most of the items

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show mean scores that fall within the "Accept" category, suggesting general agreement and awareness of the health risks. The highest mean score of 3.52 is associated with the link between long-term exposure to pesticide residues and an increased risk of cancers like leukemia and lymphoma, indicating a strong understanding of this serious health risk. The item concerning acute health effects, such as headaches and dizziness, also received a relatively high mean score of 3.37. However, the lowest mean scores were recorded for the item on hormone disruption (2.59) and the vulnerability of children to pesticide exposure (2.72), signaling weaker knowledge in these areas. These findings suggest that while students are knowledgeable about certain health effects, they may lack deeper awareness regarding long-term, developmental, and hormonal health risks. The students' relatively strong understanding of acute health effects (mean = 3.37) and cancer risks (mean = 3.52) can be attributed to the prominence of these issues in media discussions and public health campaigns. Issues such as pesticide-induced cancers are often highlighted in environmental health discourse, contributing to a higher level of awareness. However, the lower mean scores for hormone disruption (2.59) and the vulnerability of children (2.72) may reflect less emphasis on these areas in the curriculum or fewer public health campaigns specifically targeting the long-term effects of pesticide residues on hormones and child development. The lack of practical experience or case studies highlighting these risks in the classroom could contribute to the students' lower awareness in these specific areas. The students' relatively strong understanding of cancer risks and acute health effects aligns with the findings of **Yan et al. (2021)**, who reported that public health campaigns and media discussions often focus on severe and immediate health risks, such as cancer and acute symptoms, leading to higher levels of awareness. Similarly, **WHO (2022)** highlighted that public health education prioritizes life-threatening health impacts of pesticides, while developmental and hormonal risks, including their specific impact on children, are often underemphasized. This lack of emphasis may explain the students' limited awareness of these areas, as observed in the current study.

Conclusion

The study reveals that biology education students at the Federal College of Education Eha-Amufu possess a moderate understanding of pesticide residues in food, with their knowledge ranging from fair to fairly good across various aspects. While students demonstrate strong awareness of the occurrence of pesticide residues and their persistence after food preparation, there is a gap in their understanding of the full range of food products that may contain residues. Additionally, students have a solid grasp of the causes of pesticide residues, particularly the overuse of pesticides, but show weaker knowledge on the timing of pesticide application. In terms of health impacts, students are more aware of acute health effects and cancer risks linked to pesticide exposure, but have less understanding of long-term issues such as hormone disruption and the vulnerability of children. These findings align with previous studies,

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highlighting the need for further education, particularly in areas related to pesticide application timing, hormone disruption, and child vulnerability to exposure.

Recommendation for further studies

We recommend that further research should explore the specific gaps in students' knowledge, especially regarding the timing of pesticide applications and the full range of food products that may contain pesticide residues. This could help identify areas for improvement in the curriculum and highlight the need for more targeted education on pesticide-related issues. Secondly, Future studies should focus on increasing students' awareness of long-term health impacts, such as hormone disruption and the vulnerability of children to pesticide exposure. Incorporating case studies, practical experiences, and public health campaigns into the curriculum could enhance understanding of these critical areas.

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