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# Detection of organophosphorus pesticide residues in breast cancer tissue: A translational integrated environmental exposure study.

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## Abstract

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**Background:** Geographic variation in cancer incidence reflects differences in exposure to environmental carcinogens. Pesticides, particularly organophosphorus compounds, are extensively used in agriculture and are known to function as endocrine disruptors, hormone mimics, and chronic inflammatory mediators. While epidemiologic associations between pesticide exposure and breast cancer risk have been reported, direct evidence of pesticide accumulation within human breast cancer tissue remains limited. To explore, we performed tissue-level detection of pesticide residues in breast cancer specimens and peritumoral adipose tissue, coupled with a root cause analysis through assessment of pesticide use practices, awareness, and regulatory checks among farmers. **Methods:** Breast cancer tissue specimens (n=30) were analyzed for pesticide residues using high-resolution mass spectrometry. Analytical accuracy and detection reliability were validated using appropriate positive controls. The presence, diversity, and relative distribution of pesticide residues were assessed separately in tumor tissue and peritumoral adipose tissue to evaluate preferential accumulation patterns within the tumor microenvironment. In parallel, structured interviews were conducted with 50 farmers to assess knowledge on pesticide type, quantity and frequency of use, awareness of potential carcinogenic effects, residue monitoring practices, and familiarity with regulatory guidelines governing pesticide application and food safety. **Results:** A total of 49 distinct pesticide residues were detected across breast cancer tissue samples. Peritumoral adipose tissue demonstrated a higher number and greater relative concentration of pesticide residues compared with tumor tissue, consistent with lipophilic nature of organophosphorus pesticides. Farmer interviews revealed limited awareness of the carcinogenic potential of commonly used pesticides, [illegible] nophosphorus compounds. Selection and quantity of pesticide use were primarily guided by [illegible] local convention, and perceived yield benefits rather than standardized safety guidelines. Routine monitoring of pesticide residue on agricultural produce was uncommon in domestic supply chains, whereas export-

oriented products followed stringent residue control measures from cultivation through post-harvest processing and packaging. **Conclusions:** In addition to detected pesticide at tissue level, root cause analysis demonstrates limited awareness on safe pesticide usage at the grassroots level, underscoring the need for improved education, standardized residue monitoring, and strengthened regulatory enforcement to mitigate long-term cancer risk.

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