STRATEGIC RESEARCH AND PERSPECTIVES SERIES

Pesticide Exposure and Respiratory and Neurological Health in Rural California

Evidence from agricultural communities and priorities for prevention and longitudinal surveillance

Jayne J. Smith, MSN · MBA · RN

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POSITION

California's longitudinal evidence justifies proportionate, precautionary action to protect pregnant women, children, and agricultural workers from specific pesticide exposures. The state should pair source-level exposure reduction with community-governed surveillance that links application records to clinical outcomes, while keeping public claims as precise as the science.

Strategic imperatives

- **Act on chemical-specific evidence.** The strongest findings concern organophosphate insecticides and paraquat, not all pesticides or all rural residents.
- **Protect the most susceptible windows first.** Pregnancy and early childhood carry the clearest signals for respiratory and neurodevelopmental effects.
- **Reduce exposure at the source.** Education is necessary but should never place sole responsibility on families with limited housing or employment choices.
- **Close the surveillance gap.** Notification and monitoring tools exist, but they are not yet connected to health outcomes in a way that can show whether protections work.

Executive perspective

California research supports concern about agricultural pesticide exposure and respiratory and neurological outcomes. The evidence is specific to chemical classes, exposure windows, and measured endpoints. It does not establish that all pesticides have the same effects or that rural residence alone determines risk. Prevention should combine exposure reduction, accessible clinical assessment, and better local monitoring.

Two research programs are particularly relevant. CHAMACOS follows families in the Salinas Valley and has examined early-life exposure, childhood respiratory symptoms, lung function, and cognition. The Parkinson's Environment and Genes study evaluates agricultural exposure and Parkinson's disease in the Central Valley. Their complementary findings support action, while their different designs require different causal interpretations. [1-4]

This paper focuses on agricultural communities, including workers and nearby families. Findings from those settings should not be generalized automatically to every rural California county. The strategic recommendation is a community-based surveillance program that connects exposure records with clinical outcomes without making unsupported individual diagnoses.

Exposure and the importance of chemical specificity

Herbicides control unwanted plants; insecticides and fungicides address different organisms. Grouping these products under one label hides substantial differences in toxicity, persistence, use, and exposure. The research below concerns organophosphate insecticides and specific herbicides or fungicides rather than the entire agricultural chemical inventory.

Exposure assessment should distinguish direct occupational handling from ambient exposure near applications and other pathways. California pesticide-use records can help reconstruct where chemicals were applied, but proximity estimates do not measure the dose absorbed by each person. Urinary metabolites indicate recent exposure, yet some represent multiple parent compounds and can include preformed breakdown products. These limitations affect both clinical interpretation and research. [1,3,4]

Longitudinal respiratory findings

Raanan and colleagues examined 359 mother-child pairs in CHAMACOS, measuring maternal and childhood urinary organophosphate metabolites and assessing respiratory symptoms at ages five and seven. Higher childhood metabolite concentrations were associated with respiratory symptoms and exercise-related coughing. The adjusted odds ratio for respiratory symptoms per tenfold increase in childhood total metabolites was 2.53 (95 percent confidence interval 1.32 to 4.86). The authors described symptoms consistent with possible asthma rather than a confirmed diagnosis in every child. [1]

A separate CHAMACOS analysis assessed lung function in 279 seven-year-olds. Higher early-childhood organophosphate metabolite concentrations were associated with lower measured lung function. Objective testing strengthens the respiratory concern, but the observational

design still allows exposure misclassification and residual confounding. Neither study establishes the statewide fraction of asthma caused by pesticides. [2]

These results support including agricultural work and nearby applications in the history of a child with persistent respiratory symptoms, while also considering smoke, dust, infections, housing conditions, and other explanations. Routine respiratory care and exposure prevention should proceed together.

Neurodevelopment and adult neurological disease

Bouchard and colleagues assessed cognition in 329 seven-year-old CHAMACOS children. Higher maternal organophosphate metabolite concentrations during pregnancy were associated with poorer cognitive scores; children in the highest maternal exposure quintile averaged seven IQ points below those in the lowest. This is a group-level observational finding after adjustment, not a forecast of an individual child's intelligence or proof that all pesticides reduce IQ by seven points. [3]

Paul and colleagues studied 829 people with Parkinson's disease and 824 community controls, estimating historical paraquat exposure from residential and workplace proximity to agricultural applications in three Central Valley counties. Ambient paraquat exposure was associated with Parkinson's disease across several measures. The case-control design supports an association; it cannot by itself demonstrate individual causation or provide a prospective disease rate for exposed residents. [4]

Earlier California research evaluated combinations involving paraquat, maneb, and ziram, suggesting that assessing one compound in isolation may miss the importance of correlated or combined exposures. Mixture estimates remain difficult to interpret when chemicals are applied in the same locations and occupational histories are incomplete. [5]

Evidence	Population and design	Decision relevance	Main limitation
Respiratory symptoms [1]	CHAMACOS birth cohort followed to ages five and seven	Include exposure history in respiratory assessment	Reported symptoms and imperfect exposure specificity
Lung function [2]	CHAMACOS children tested at age seven	Add objective testing when clinically indicated	Observational rather than an exposure trial
Cognition [3]	Prenatal measures and age-seven testing	Prioritize pregnancy and childhood prevention	Cohort-specific estimates and residual confounding

Evidence	Population and design	Decision relevance	Main limitation
Parkinson's disease [4,5]	Central Valley case-control research	Improve occupational and residential histories	Historical proximity estimates and correlated exposures

Acute events and chronic associations

Acute organophosphate poisoning can involve severe cholinergic effects and respiratory failure. That syndrome differs from the lower-level exposures evaluated in childhood cohort studies. Mechanistic reviews support several respiratory and neurological pathways, but a mechanism does not determine the risk associated with any specific ambient concentration, and chronic association estimates should not be described as acute poisoning rates. [6]

For a suspected exposure with severe breathing difficulty or other serious symptoms, urgent assessment is needed. California DPR advises leaving an active spray exposure, calling 911 for serious symptoms, and reporting suspected pesticide illness to the County Agricultural Commissioner. Incident documentation should preserve time, location, symptoms, and product information when available. [7]

California monitoring and notification

SprayDays provides advance information about planned agricultural use of restricted-material pesticides. DPR's June 2026 explanation states that it displays a one-square-mile location, product and active ingredients, intended timing, and application information. It does not cover every pesticide, and a notice may be rescheduled, cancelled, or applied within the allowed window. An empty map therefore does not establish absence of exposure. Completed applications belong in official pesticide-use records. [7]

California's air-monitoring program characterizes selected chemicals and locations but cannot assign individual dose everywhere. Data version control matters: the 2024 air-monitoring report identifies corrections involving 1,3-dichloropropene and methyl bromide measurements. Researchers should confirm the latest validated dataset before comparing concentrations with benchmarks. [8]

Policy and strategic recommendations

Stakeholder	Recommended action	Measure of success
California DPR and Legislature	Fund linkage of pesticide-use, SprayDays, and air-monitoring data with de-identified health surveillance; prioritize exposure controls near schools and homes	Linked dataset in use; measured change in exposure near sensitive sites
County health and agricultural agencies	Co-design notification education with schools and prenatal services, explaining tool limits	Incident reports with complete follow-up
Employers	Strengthen source controls, protective practices, and take-home exposure prevention	Documented controls and reduced reported incidents
Health systems and clinics	Adopt a brief multilingual exposure history covering occupation, tasks, location, timing, pregnancy, and household contact	Share of respiratory and prenatal visits with completed history
Research funders	Support a prospective regional cohort with repeated exposure measures and validated outcomes	Cohort enrollment and retention across exposure gradients

A positive exposure history should trigger appropriate clinical evaluation and reporting, not an automatic diagnosis of pesticide injury. Quality programs should track respiratory symptom visits, clinically indicated lung-function testing, completed exposure histories, incident follow-up, and referral access. Community advisory groups should help determine what information is collected and how findings are communicated, and public reporting should avoid maps that stigmatize communities or expose individual workers.

Strategic lens

Healthcare improvement. Embedding exposure history into routine pediatric, prenatal, and occupational care is a low-cost change that improves diagnostic reasoning and incident reporting in underserved agricultural communities.

Conservation and environmental health. Precision in chemical policy protects both people and ecosystems; targeting the specific compounds and practices with the strongest evidence supports productive agriculture while reducing avoidable exposure.

Scientific advancement. California's detailed pesticide-use reporting and long-running cohorts are valuable research assets. Linking them to health outcomes could serve as a national model for environmental health surveillance.

Research priorities

A prospective regional cohort should record residential and occupational histories, repeated exposure measures, pregnancy timing, and validated respiratory and neurological endpoints. It should account for wildfire smoke, traffic pollution, dust, smoking, socioeconomic conditions, and other coexposures, and should predefine how individual chemicals and mixtures will be evaluated.

Evaluations of application restrictions or exposure-control changes could compare outcome trends with suitable communities or time periods, after first establishing that exposure actually changed. Parkinson's disease requires far longer follow-up than childhood respiratory symptoms, so a short pilot should measure exposure and service access without promising to prove prevention of a disease that develops over decades.

The recommended policy position is proportionate prevention with precise claims. California's evidence justifies protecting susceptible populations and improving surveillance, while acknowledging where studies cannot identify a specific chemical, establish individual causation, or represent every rural community.

Research approach

This paper is a targeted narrative evidence synthesis for strategic decision-making, with sources reviewed on 1 October 2026. It prioritizes peer-reviewed cohort and case-control research and official California agency material. It is not a systematic review or original empirical study. Study findings are distinguished from the author's recommendations, and observational associations do not establish individual causation. Regulatory programs and monitoring data are updated periodically and should be confirmed with California DPR.

References

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About the author

Jayne J. Smith, MSN, MBA, RN, is a nurse executive with more than 15 years of combined clinical, operational, and financial leadership experience. Her nursing leadership spans multi-site home health, assisted living, memory care, long-term care, hospice, and case management in rural communities, alongside prior multi-state business leadership in strategy, human resources, and operations. She is completing a Doctor of Nursing Practice. Her work focuses on evidence-based strategy at the intersection of healthcare quality, prevention, rural health, and the environmental and supply-chain conditions that shape population health.

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