

Aligning Exposure, Mechanism, and Disease. Pesticides, Liver and Stomach Cancers in Moldova

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Problem and significance

Background. Moldova has unusually high rates of liver and stomach cancers for Europe. Both rank among the top six for new cases and deaths. Radon mainly causes lung cancer, and high cancer areas are not the same as high radon areas. Legacy pesticides that persist in soil and water may better explain the pattern.

Hypothesis

- Pesticide exposure is one of the major cancer risk factors in Moldova.
- Pesticides used and still stored in Moldova could lead to liver and stomach cancers.

Methods

Narrative review of peer reviewed studies and reports from IARC, EPA, EFSA, and GLOBOCAN through April 26, 2025, plus comparison of cancer patterns with radon data and evidence of legacy contamination from sediment studies.

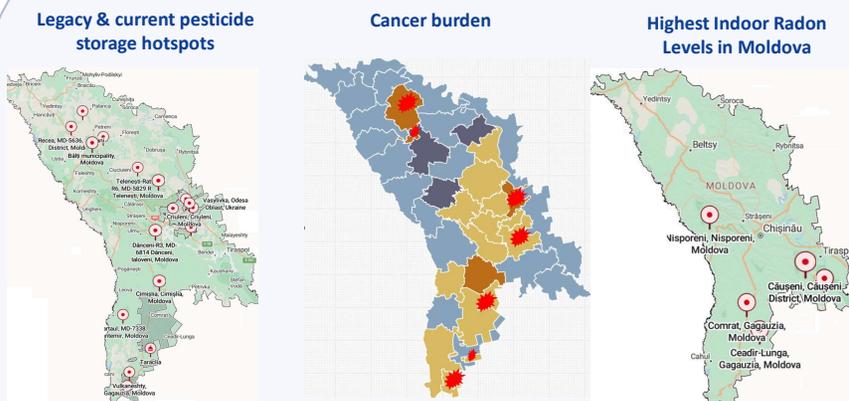
Mechanism

Pesticide	Key mechanism (1-line)	Carcinogen class (authority)	Human evidence (short)	Use in Moldova + region signal
TMTD (thiram)	Stomach nitrosation → NDMA → O6-methylguanine DNA adducts	IARC Group3 (not classifiable)	No	Seeds, orchard, vineyard fungicide → country-wide
DDT	CAR/PXR → ROS stress Estrogen like signaling Immune suppression Epigenetics	IARC Group 2A (probably carcinogenic)	Limited; liver	Legacy insecticide → Central & South hotspots, detections nationwide
Isoxaflutole	DKN → CAR/PXR → ROS stress. Estrogen like signaling Immune suppression Epigenetics	IARC not evaluated	No	Maize herbicide → North/Center maize areas
Lindane (γ-HCH)	Immune suppression Epigenetics ROS stress	IARC Group1 (for NHL)	Strong for NHL; limited in liver/stomach	Seed treatment → hotspots in Central/South , plus North sites

References

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- Global Cancer Observatory (GLOBOCAN 2022). Republic of Moldova – Fact sheet (2024 update).
- UN Moldova / NATO-NSPA (2013–2018). Obsolete pesticide removal operations (e.g., Dănceni, Pașcani)
- Ivanova A., Wiberg K., Ahrens L., Zubcov E., Dahlberg A.-K. Spatial distribution of legacy pesticides in river sediment from the Republic

Results



Legend: Pesticide Storage/Legacy Hotspots

Legend (incidence): High (top 20%)
Legend (prevalence): Very high (top 20%)
High
Low
Very low (bottom 20%)

Legend: Radon ≥ 300 Bq/m³ (reference: action level)

Locations approximate; based on national inventories and technical reports. Values are district-level; some figures may not be age-standardized. Ecological patterns support prioritizing pesticide related hypotheses for non lung cancers, especially gastrointestinal cancers, in regions with legacy agricultural use and pesticide storage.

cross-referenced district incidence and prevalence to confirm consistency.

ANSP (2024). Raport final de proiect, 2020–2023 [Project final report; methods/data pipeline for oncology incidence & prevalence 2012–2022 by region/district.

Coretchi, L., Overenco, A., Ababii, A., & Bogdan, M. (2024, October). Study of the cancer morbidity structure in the population of the Republic of Moldova and risk groups exposed to ionizing radiation. In Proceedings of the Romanian Society of Radioprotection National Conference (pp. 237–245). Bucharest, Romania.

ANSP (2024). Raport științific — Etapa 2023 [ANSP scientific annual report, project stage 2023; incidence/prevalence 2012–2022 by district].

Regional Representation and Distribution of Alcohol Use and Hepatitis B Among Hospitalized Liver Cancer Patients, Moldova, 2014 to 2017

Region	Share of HCC patients (study)	~Share of population (2014)	Cases ~ Pop. (representation)	ALCOHOL USE Percentage of patients with HCC from this region self-reported as drinkers	HBV Percentage of patients with HCC from this region with HBV
North	23.00%	~28.6%	0.81x Under-represented	No information	No information
Center	58.80%	43%	1.32x Clearly over-represented	~49% Only half of liver cancer patients from Center had HBV	~39% Majority of liver cancer patients from Center had HBV
South	17.20%	~14.8%	1.16x Slightly over-represented	72% Majority of liver cancer patients from South were drinkers	82% Majority of liver cancer patients from South had HBV

Key message

Central districts are over represented among treated HCC cases. In the same case series alcohol use and hepatitis B were more common among southern patients.

Moldova



Lung Cancer Share of Top-10 Incident Cancers by Region — Moldova, 2017

Shares are site cases divided by each region's sum of the top-10 incident cancers (2017). Values are not age-standardized and may reflect referral patterns.

Region	Sum of top-10 cases	Lung cases (2017)	Lung share of top-10	Other (not lung) share	Vineyards intensity
North	1807	287	15.90%	84.10%	Low
Center	3895	417	10.70%	89.30%	High
South	952	113	11.90%	88.10%	Moderate

Key message

Lung cancer's share is highest in the North (15.9%) where vineyard intensity is low, and lowest in the Center (10.7%) where vineyards are most intensive. This ecological pattern supports prioritizing the hypothesis that vineyard-related pesticide exposures may contribute more to non-lung cancers than to lung cancer

Source: Turcanu, A., Pitel, E., Dumbrava, V.-T., Tcaciu, (2019). Profile of hepatocellular carcinoma in the Republic of Moldova: first-hand information on the presentation, distribution and etiologies. RIM, 57(1), 37-46. Hospital-treated series; not population rates.

Source: IMSP Institutul Oncologic (2019). Managementul activității... 2018, Table "Incidența celor mai frecvente localizări...". Proportions computed from 2017 regional counts (top-10 sites only; not age-standardized).

Ethical significance

- An unintended population scale exposure occurred, not by design and not by choice.
- A prospective study of this magnitude would be impossible to fund and ethically unacceptable.
- Not using it would harm current and future generations and waste a unique opportunity for environmental and mutagenesis research.

Public health implications

Global support beyond pilots, complete remediation of legacy depots and soils, stronger data systems and open reports, immediate health actions for high signal districts, and policy reform to phase out highest risk pesticides and enforce residue and water standards.

Acknowledgments

I acknowledge my hardworking teachers at Leigh High School for introducing students to science and encouraging active engagement, especially Ms. Morfin and Ms. Diordieva. I honor my grandmother, Margarita Pinskaya, who worked at the Oncology Institute in Moldova during very difficult times for the country. I also dedicate this work to the many men and women who farmed the land and suffered ecological trauma, and to their children who remain at risk.

Conclusions

- The regions with the highest cancer incidence and prevalence do not correspond to radon distribution. Their overlap with legacy pesticide storage sites.
- Non-lung cancers align more closely with districts of intensive vineyards and associated vineyard-pesticide exposure.
- Treated HCC cases are overrepresented in the central portion of Moldova, while alcohol use and HBV are more common among southern patients. This mismatch suggests additional contributors and pesticide exposure is a plausible factor in liver cancer risk
- These studies are not population-based evidence, but it signals an exposure pattern worth testing. Together, these observations justify focused evaluation of past and current pesticide exposures including legacy organochlorines and vineyard fungicides as plausible contributors to Moldova's overall—and especially gastrointestinal—cancer burden.

