

Paraquat and Parkinson's

Fern Wesson (Researcher)

The BBC recently reported that UK farmers have called for the ban of UK production of the potent weed killer, Paraquat. It has long been known to be **highly toxic** when ingested, but there is a growing body of evidence that suggests **chronic exposure to the chemical could cause Parkinson's Disease (PD)**.¹

The use of Paraquat as a weed killer has been **banned in the UK since 2007**, but the UK still produces the chemical.¹

Documented Paraquat neurotoxicity in lab conditions²

Bypasses blood-brain barrier via amino acid transporters

Induces oxidative stress in dopaminergic neurons

Causes mitochondrial dysfunction and injury

Syngenta, producers of Paraquat

"Paraquat has been the subject of **more than 1,200 safety studies** submitted to, and reviewed by, regulatory authorities around the world."¹

The Paraquat chemical is **structurally similar to the chemical MPTP**, which is used to **induce PD** in experimental animal models. In addition, meta-analyses have identified a higher incidence of PD in areas of Paraquat exposure³ and it is also known to accumulate in the tissues of farm animals⁴.

Does Paraquat cause Parkinson's disease? A review of reviews⁵

Objective

- ❖ To examine whether there is any scientific consensus regarding the relationship between Paraquat exposure and Parkinson's Disease (PD).

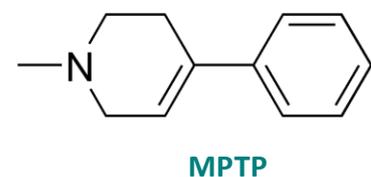
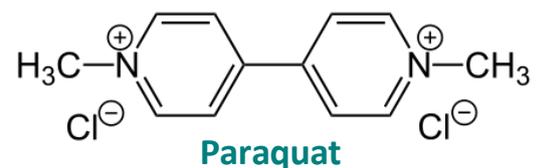
Methods

- A systematic search of scientific databases to identify reviews regarding Paraquat and PD in order to generate a review of reviews.
- Focused on epidemiological studies and reviews of Paraquat and PD, and interpreted through the lens of biological plausibility, i.e. how Paraquat could cause PD at a molecular level.
- The funding of the included studies was also reported.

Results

- ✓ The consensus of the available evidence is that none of the 12 included reviews show that Paraquat can directly cause PD
- ✓ However, several authors conclude that there is an **association** between Paraquat exposure and PD.
- ✓ Future research should focus on identifying **specific pathogenic mechanisms** and improving the **quality** of epidemiological evidence.

Chemical structure of Paraquat vs MPTP



Take home points:

- There is substantial interest in investigating the relationship between Paraquat exposure and PD.
- Current evidence **does not show** a definite causal link between Paraquat exposure and PD
- Epidemiological studies concerning Paraquat and PD have notable limitations, including **lacking objective measurements of Paraquat exposure**, and lacking evidence on **exact biological mechanisms** of action. Animal studies have been criticised for using high doses of Paraquat on young animals, future animal studies should also endeavour to replicate a mature, chronic low-exposure model *in vivo*.
- There are also **external factors** that workers could be exposed to (e.g. well-water consumption, rural living conditions) which could influence the relationship between PD and Paraquat.

1. BBC. Marshall. C & Prior. M. UK farmers call for weedkiller ban over Parkinson's fears. (2022) Available from: <https://www.bbc.co.uk/news/science-environment-60836892>
 2. Wen. S, Aki. T, Unuma. K, Uemura. K. Chemically induced models of Parkinson's Disease: History and perspectives for the involvement of ferroptosis. *Frontiers in cellular neuroscience*. (2020) 14: 581191.
 3. Zhang. X-F, Thompson. M, Xu. Y-H. Multifactorial theory applied to the neurotoxin paraquat and paraquat-induced mechanisms of developing parkinsons disease. *Laboratory investigation*. (2016) 96: 496-507.
 4. Locke KK. Toxicological significance of the following metabolites of paraquat: monoquat, QINA, monopyridone, dipyrindone, and methylamine. *United States Environmental Protection Agency*, 1988 <http://archive.epa.gov/pesticides/chemical/search/chemical/foia/web/pdf/061601/061601-1988-09-02.pdf>
 5. Weed, D. L. Does paraquat cause Parkinson's Disease? A review of reviews. *Neurotoxicology*. (2021) 86: 180-184.