Association between Occupational Exposures to Informal Sector E-Waste and DNA Damage: A Systematic Review

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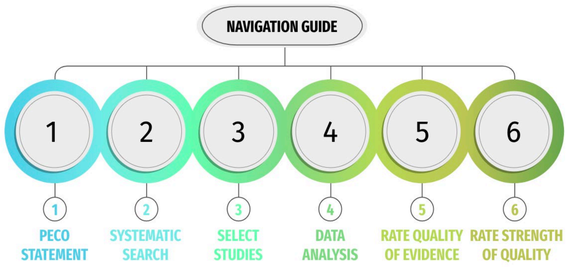
INTRODUCTION

- E-waste is one of the fastest growing streams of waste. In 2016, over 44.7 million tons of e-waste were generated globally(Balde, 2017).
- E-waste is especially harmful because over 70% by mass contains hazardous waste.
- Informal e-waste recycling is on the rise due to its low cost and lack of regulation required, but it poses several threats to worker safety and the environment(Balde, 2017).
- Due to the informal nature of these recycling operations, toxic e-waste dumpsites may concurrently serve as residential, commercial, and industrial centers meaning a large portion of the population has exposure to harmful chemicals(Heacock, 2016).
- Elevated levels of pollutants from e-waste contribute to significant morbidity in nearby communities with workers being an especially vulnerable population. (Heacock, 2016)

STUDY OBJECTIVE

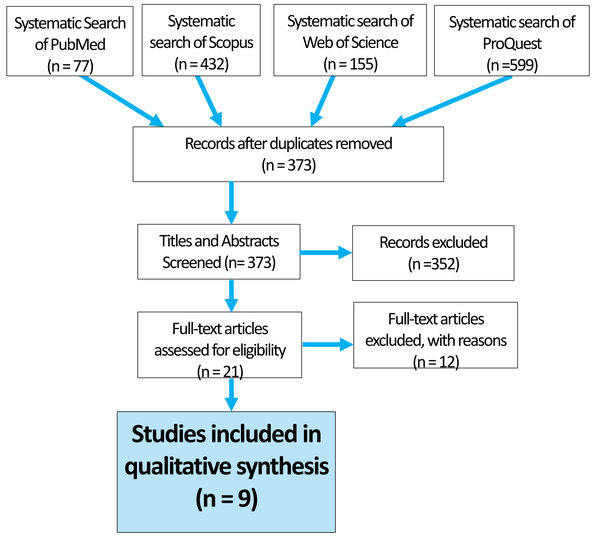
The objective of this systematic review was to explore the association between occupational exposure to informal sector e-waste and outcomes of DNA damage and oxidative stress utilizing the methodology described in the Navigation Guide.



Population: Workers in Lower-and-Middle income countries (LMICs)
Exposure: E-waste Exposure
Comparator: Workers with little to no informal sector occupational e-waste exposure
Outcome: Markers of DNA damage and oxidative stress

METHOD

Study Selection



Search Terms

	PubMed	Scopus	Web of Science	Proquest Environmental Science Collection
Search Strategy	#1 AND #2 AND #3	#1 AND #2 AND #3	#1 AND #2 AND #3	#1 AND #2 AND #3
#1 Exposure	("Electronic Waste"[Mesh] OR "Electronics"[Mesh] OR "Computers"[Mesh] OR "E-waste"[all fields] OR "EEE" OR "WEEE")	TITLE-ABS-KEY("Electronic Waste" OR Electronics OR Computers OR E-waste OR EEE OR WEEE OR "Electrical Waste")	TS=("Electronic Waste" OR Electronics OR Computers OR E-waste OR EEE OR WEEE OR "Electrical Waste")	("Electronic Waste" OR Electronics OR Computers OR E-waste OR "Electrical Waste" OR EEE OR WEE)
#2 Exposure Source	("Environmental Pollution"[Mesh] OR "Environmental Exposure"[Mesh] OR "Industrial Waste"[Mesh] OR "Hazardous Waste"[Mesh] OR "Waste Management"[Mesh] OR "Soil Pollutants"[Mesh] OR "Recycling"[Mesh] OR "Refuse Disposal"[Mesh] OR "recycle"[all fields])	TITLE-ABS-KEY("Environmental Pollution" OR "Environmental Exposure" OR "Industrial Waste" OR "Hazardous Waste" OR "Waste Management" OR "Soil Pollutants" OR Recycling OR "Refuse Disposal")	TS=("Environmental Pollution" OR "Environmental Exposure" OR "Industrial Waste" OR "Hazardous Waste" OR "Waste Management" OR "Soil Pollutants" OR Recycling OR "Refuse Disposal")	("Environmental Pollution" OR "Environmental Exposure" OR "Industrial Waste" OR "Hazardous Waste" OR "Waste Management" OR "Soil Pollutants" OR Recycling OR "Refuse Disposal")
#3 Outcome	("DNA Damage"[Mesh] OR "Oxidative Stress"[Mesh] OR "Genomic Instability"[Mesh] OR "DNA"[all fields])	TITLE-ABS-KEY("DNA Damage" OR "Oxidative Stress" OR "Genomic Instability" OR DNA OR Genes OR "Genetic Damage OR Chromosome)	TS=("DNA Damage" OR "Oxidative Stress" OR "Genomic Instability" OR DNA OR Genes OR "Genetic Damage OR Chromosome)	("DNA Damage" OR "Oxidative Stress" OR "Genomic Instability" OR DNA OR Chromosome OR "Genetic Damage" OR Genes)
Limit source Type:	Scholarly Journals; Subject: DNA			

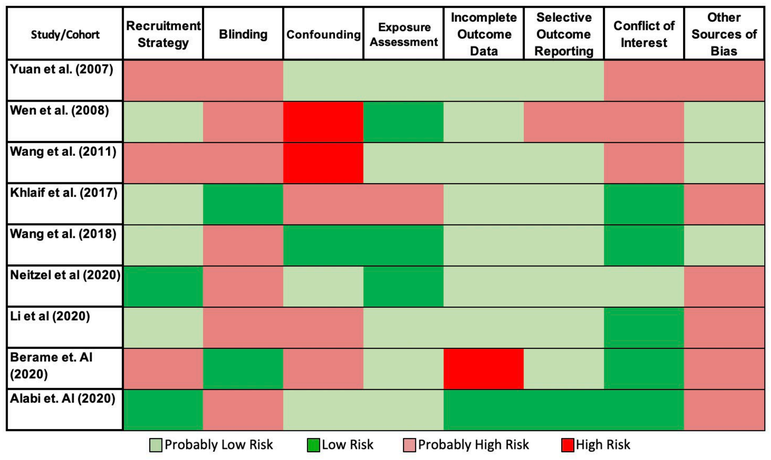
RESULTS

Table of Study Characteristics

	Asia (n=8)	Africa (n=1)
Study Location	China (n=5), the Philippines, Palestine and Thailand	Nigeria
Sample Size	26-146 participants	95 participants
Study Design	Cross-Sectional (n=8)	Cross-Sectional (n=1)
E-waste Exposure	Cd (n=3), Cu (n=3), Pb (n=4), PCBs (n=2), Dioxins (n=2), and General e-waste (n=2),	Cd, Cr, Ni, and Pb
Outcome	DNA Damage (n=5) and Markers of Oxidative stress (n=4)	DNA Damage

Risk of bias was rated **"Probably High Risk"** for the body of evidence. The domains of **confounding** , **recruitment strategy**, and **other sources** had the highest designations of bias due to lack of appropriate choice of confounders, inconsistent recruitment strategy, and risk of recall and selection bias.

- All studies reported a positive association between occupational exposure to e-waste and DNA damage despite much heterogeneity in exposure assessment and outcome measurement.
- Workers with occupational exposure to e-waste had greater rates of DNA damage than both who were residentially exposed or employed in other waste management sectors
- Blood chromium and nickel concentrations most significantly associated with DNA damage
- Several studies reported correlations between length of time in the e-waste industry and increased micronuclei presence and heavy metal presence



CONCLUSION

"Limited" evidence for the association between occupational exposure to e-waste and DNA damage and/or oxidative stress
"Limited" evidence designation given due to lack of statistical power of study designs, small sample size, lack of adjustment for confounders, and potential for exposure misclassification

Currently, several **limitations** exist across the body of literature.

- Although the current body of evidence is indicative of an association, there are no clinical research trials or cohort studies, and current studies lack the statistical power necessary to
- Most studies have been conducted in Asia even though a substantial proportion of e-waste is recycled in Africa and South America
- Studies have vast heterogeneity given that the exact mechanism or pathway between e-waste exposure and DNA damage are unclear.

Takeaway: A collaborative research agenda is necessary to identify the extent of human health effects from e-waste. As e-waste volumes continue to skyrocket, more must be done to protect vulnerable populations .

REFERENCES

Alabi et al. *Biological Trace Element Research. 2020.* 194:24-33.
Balde et al. *The global e-waste monitor-2017*
Berame et al. *Journal of Health and Pollution*. 2020. 10(28):1-10
Heacock et al. *Environmental Health Perspectives.* 2016. 124:550-555.
Khlaif et al.. I*nternational Journal of Environmental Studies*. 2017. 74:66-74.
Lam et al. *Environ Health Perspectives*. 2014. 122(10):1040-1051.
Li et al. *Environment International*. 2020. 140:105769.
Neitzel et al.. *Int J Occup Environ Med*. 2020. 11:72-84.
Wang et al. *Journal of Environmental Science and Health*. 2011. 46:669-676.
Wang et al.. *Environment International*. 2018. 117:69-81.
Wen et al. *Environmental Science & Technology*. 2008. 42:4202-4207.
Yuan et al. *Environ Sci Technol*. 2008. 42:2195-2200.

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