Plastics in dental care clinics and growing concerns about the environmental impact

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Anne Margrete Gussgard
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Background

- Oral care professionals use large quantities of polymers in the dental clinic for multiple purposes. There is a growing concern about the environmental impact, while estimates og waste and ecological pollution remain scarce.

..all in a day's work

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  - personal protective devices containing polymer
  - items containing polymers in clinical care
  - polymer-based materials in restorative care
    - manufacturing
    - clinical handling
    - degradation

Methods

- A Systematic Review was registered in PROSPERO – CRD42023472616 - *Polymer use in oral health care settings and impacts on human and planetary health*

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(dentist OR "dental health services"[mesh] OR "oral health care" OR "Dentistry"[mesh]) AND ("Polymers"[mesh] OR "Organic Chemicals"[mesh] OR "plastic*"[tw] OR "polymer*"[tw] OR "Resin*"[tw] OR "acryl*"[tw]) AND ("Environmental Pollution"[MESH] OR "waste management"[MESH] OR "ecology"[MESH] OR "environment*"[tw] OR "waste*"[tw] OR "pollut*"[tw] OR "ecolog*"[tw]) n=1911

(dentist OR "dental health services"[mesh] OR "oral health care" OR "Dentistry"[mesh]) AND ("Protective devices"[mesh] OR "surgical equipment"[MESH]) AND ("Environmental Pollution"[MESH] OR "waste management"[MESH] OR "ecology"[MESH] OR "environment*"[tw] OR "waste*"[tw] OR "pollut*"[tw] OR "ecolog*"[tw]) n=354

(dentist OR "dental health services"[mesh] OR "oral health care" OR "Dentistry"[mesh]) AND "Conservation of Natural Resources"[Mesh] n=260

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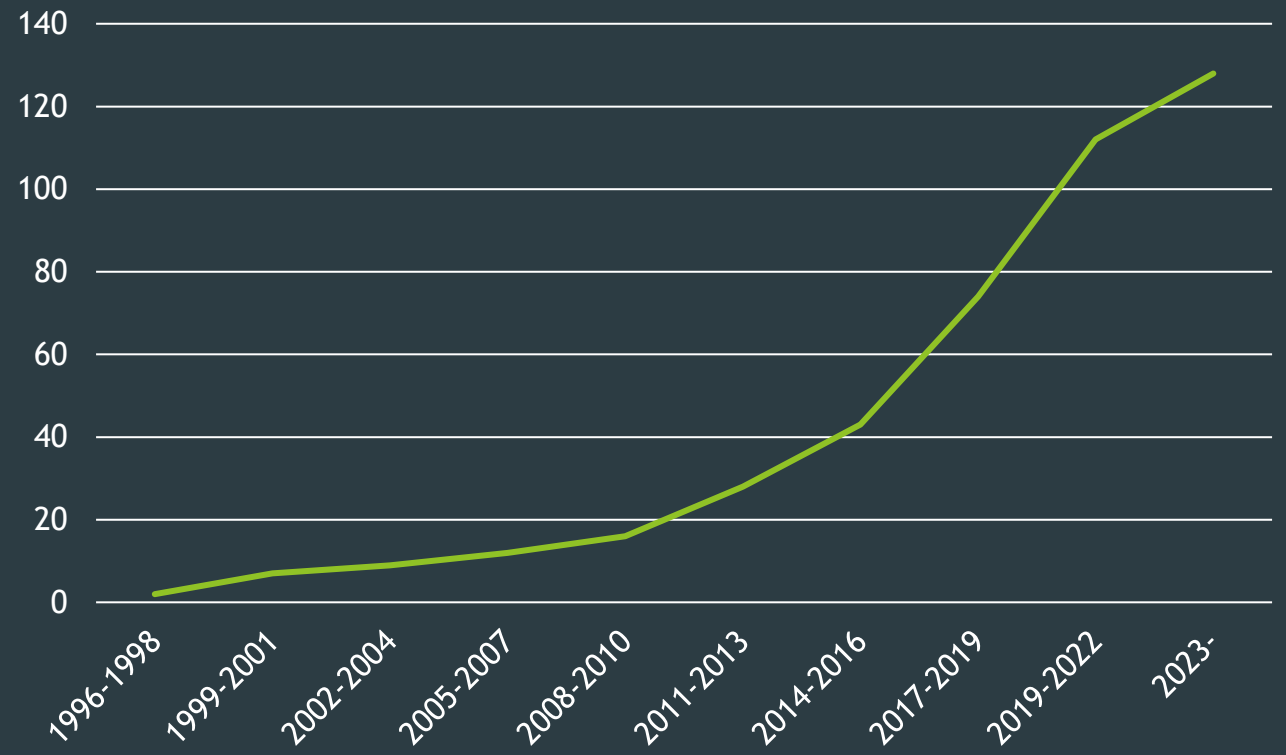
Methods

- PROSPERO – (CRD42023472616 - *Polymer use in oral health care settings and impacts on human and planetary health*
- Boolean search strategies adapted to different bibliometric databases and the grey literature. Export to Endnote, duplicates removed and export to a relation database (Microsoft Access).
- Per AMSTAR-2 & PRISMA, Two independent investigators scrutinised the identified publications to determine whether the contents contained estimates of waste or material component loss. Papers were critically appraised for bias and methodology using validated checklists adapted for different study designs.
- Data were subjected to meta-analyses suitable to the type of statistical data.

Results

- Search yielded 128 publications in peer-reviewed scientific journals, of which 82 contained data.



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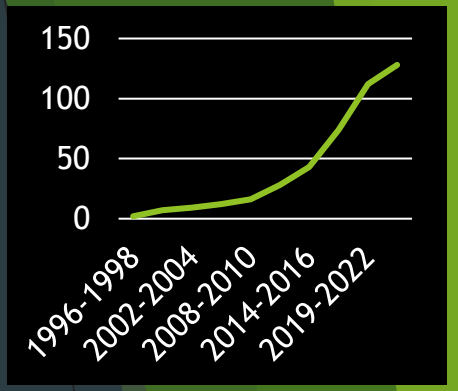
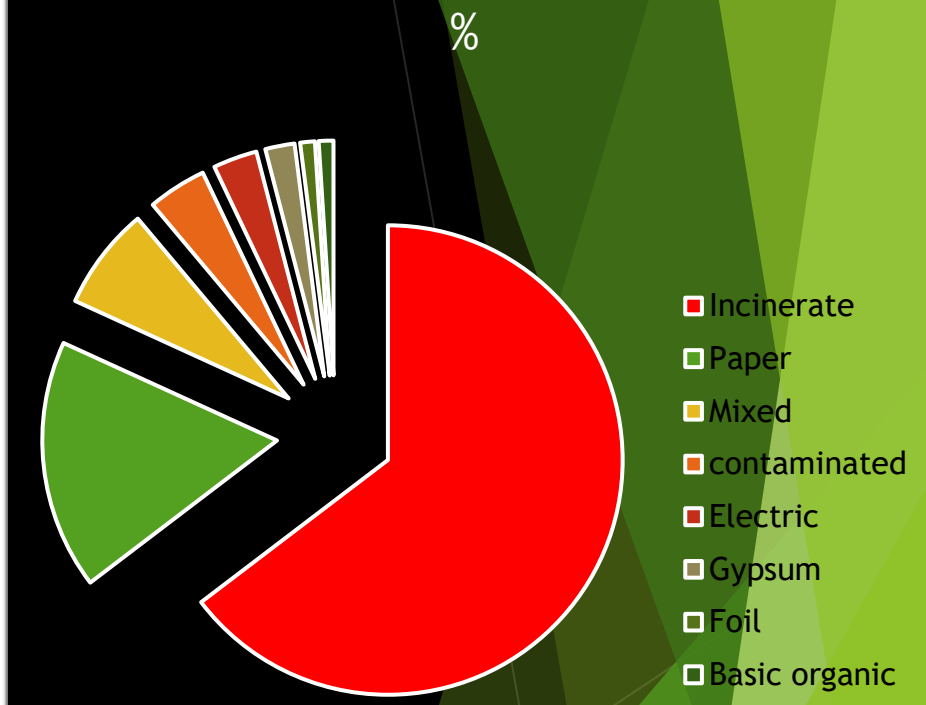
- Effective mitigation strategies to reduce environmental plastic pollution by waste handling and less use of single-use items are limited



University of Bergen - Dental student clinic 2022

		202201 - 202210			
Fraksjon	Fraksjon navn	Omberegnet tonnasje	Antall Tømminger Akk	Snitt pr. tømming	% av totalen
1299	Blandet papir,papp, kartong	6,880	2	3,440	17%
1322	Blandet glassemballasje med me	0,160	1	0,160	0%
1599	Blandet EE-avfall	1,240	3	0,413	3%
1615	Gips	0,860	3	0,287	2%
1712	Folieplast, annen	0,360	12	0,030	1%
1729	Blandet myk og hard plastembal	0,050	1	0,050	0%
1732	Ekspandert og ekstrudert plast	0,071	9	0,008	0%
6003	Smittefarlig avfall	1,657	21	0,079	4%
7024	Oljefiltre	0,004	1	0,004	0%
7055	Spraybokser	0,005	1	0,005	0%
7091	Uorganiske salter og annet fas	0,005	1	0,005	0%
7093	Småbatterier usortert	0,056	1	0,056	0%
7123	Herdere, organiske peroksider	0,030	1	0,030	0%
7132	Baser, uorganiske	0,005	1	0,005	0%
7134	Surt organisk avfall	0,584	1	0,584	1%
7135	Basisk organisk avfall	0,030	1	0,030	0%
7152	Organisk avfall uten halogen	0,150	1	0,150	0%
9912	Blandet næringsavfall til sort	2,980	5	0,596	7%
9913	Utsortert brennbart avfall	26,340	42	0,627	64%
	Sum:	**41,467**	**108**	**0,384**	**100%**



The proportion of plastics?

Adapted from Krage & Hågå, 2023.

PLASTAVFALL VED ODONTOLOGISK UNIVERSITETSKLINIKK I ET MILJØPERSPEKTIV

Ragnhild Elisabeth Krage og Margit Hågå

Prosjektoppgave for Integrert masterprogram i odontologi

Institutt for klinisk odontologi

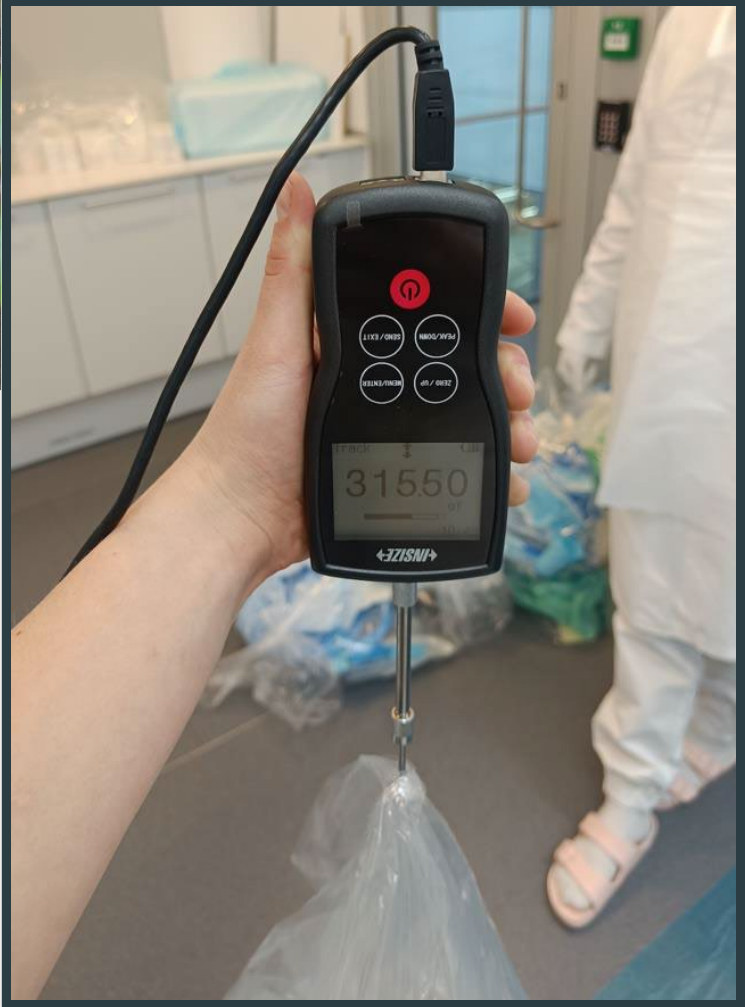
Det medisinske fakultet

Universitetet i Bergen

Våren 2023

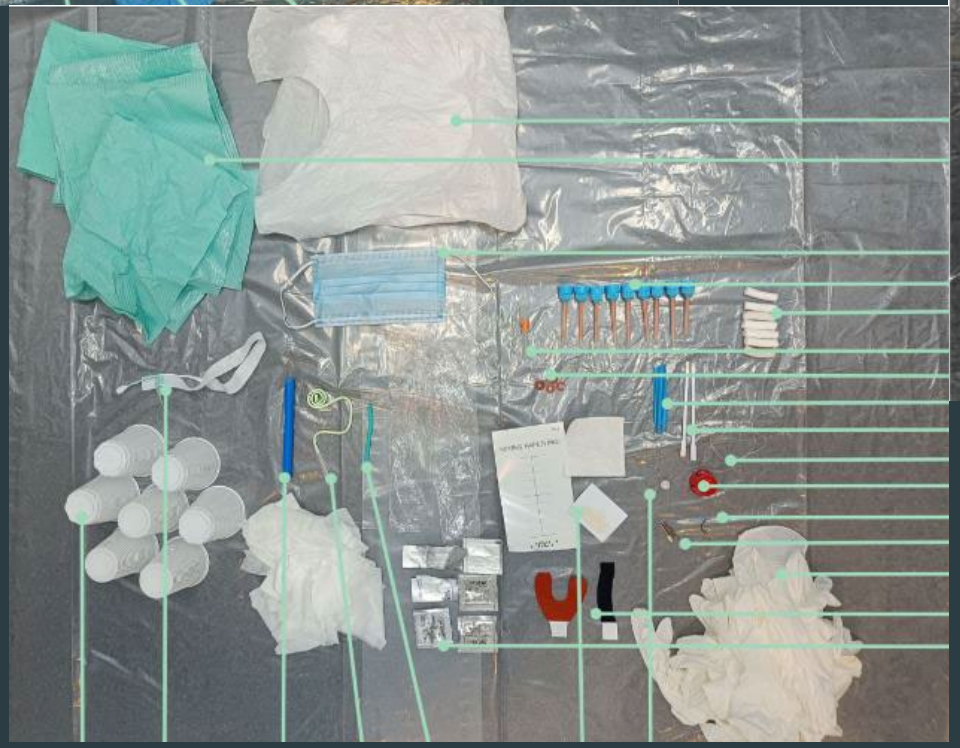
Veiledere: Mihaela-Roxana Cimpan og Nils Roar Gjerdet

UNIVERSITETET I BERGEN
Det medisinske fakultet



Waste production / patient consultation
Quantitative & qualitative
Dental student clinic September 2022

Representative waste bin examples



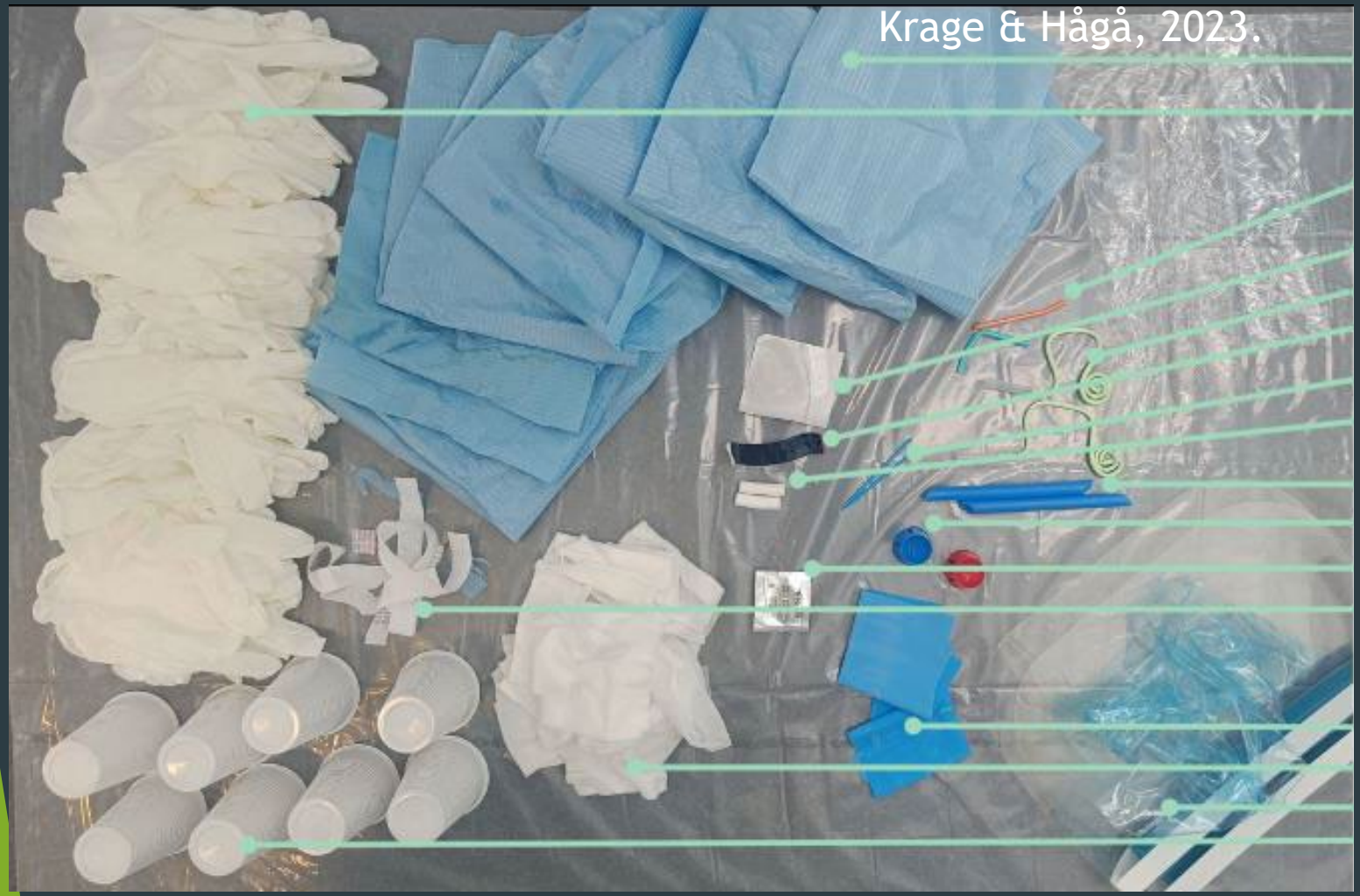
~65-85
single items

Average waste 348 grams / patient visit
Student clinic: 66 kg / day OR 331 kg / week
Per year 10.600 kg

92% containing plastic

Krage & Hågå, 2023.

One resin-based composite restoration



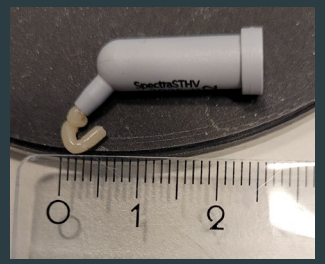
8 patient bibs
25 disposable gloves
Air-water syring tip

Mixing paper
Curly suction
Blue paper
Micro applicators
Cotton rolls
Vacuum suction
Dappen dishes
Rotating bur wrapping
Bib clip

Rubber dam
Disinfection wipes
Visor
8 plastic cups

~85 items

Sealed metal pouch: 4 compules w/ rubber tip



0.25 g Monomer

Bonding agent + LCU polymerisation 50-80% conversion

Restoration
Flash removal
Contouring
Finishing
Polishing

Wastewater

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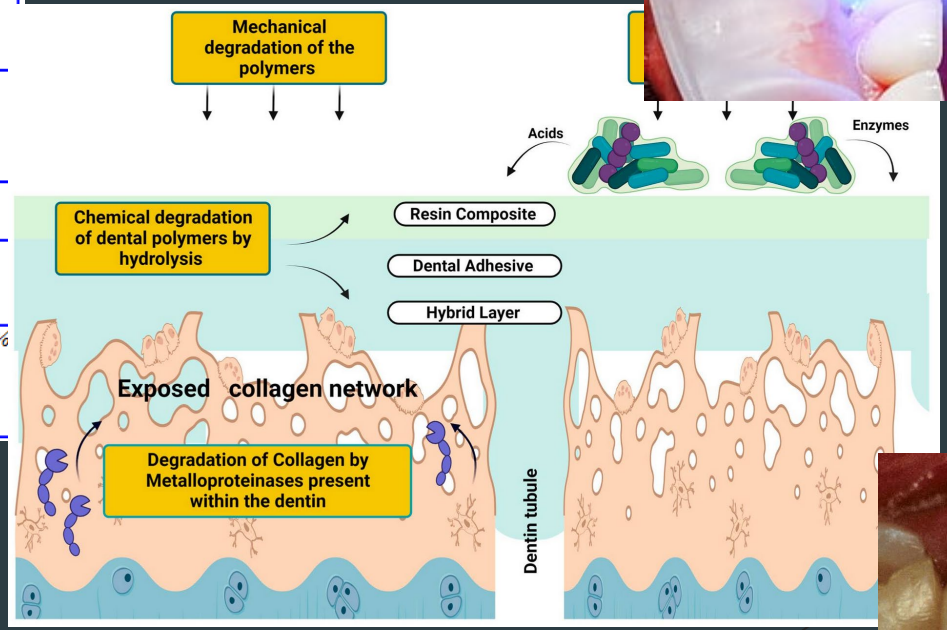
- Dust and aerosols from grinding dental devices made from some polymers remain a hazard principally for dental personnel.
- The amount of estrogenic xenobiotic bisphenol-A residues leakage from RBCs (n=22 papers) in vitro is low
- RBCs show acceptable occupational and patient risk profiles, but environmental aspects remain undocumented.

Resin-based composite materials is unstable in an intra-oral environment

· **3.2 Stoffblandinger**
· **Beskrivelse:** Blanding av nedenstående oppførte stoffer med ufarlige tilsetninger.

· **Farlige innholdsstoffer:**		
CAS: 41637-38-1	Esterification products of 4,4'-isopropylidenediphenol, ethoxylated and 2-methylprop-2-enoic acid Skin Irrit. 2, H315; Eye Irrit. 2, H319; Skin Sens. 1, H317; STOT SE 3, H335; Aquatic Chronic 4, H413	≥ 2,5 – < 10%
CAS: 109-16-0 EINECS: 203-652-6	2,2'-ethylenedioxydiethyl dimethacrylate Skin Sens. 1, H317	≥ 2,5 – < 10%
CAS: 13760-80-0 EINECS: 237-354-2	ytterbium trifluoride Skin Irrit. 2, H315; Eye Irrit. 2, H319; STOT SE 3, H335	≥ 2,5 – < 10%
CAS: 1565-94-2 EINECS: 216-367-7	(1-methylethylidene)bis[4,1-phenyleneoxy(2-hydroxy-3,1-propanediyl)]bismethacrylate Skin Irrit. 2, H315; Eye Irrit. 2, H319; Skin Sens. 1, H317	≥ 0,1 – < 1%
CAS: 10287-53-3	Ethyl-4-dimethylaminobenzoat Repr. 1B, H360; Aquatic Chronic 2, H411	< 0,25%
CAS: 131-57-7 EINECS: 205-031-5	oxybenzone Skin Irrit. 2, H315; Eye Irrit. 2, H319; STOT SE 3, H335	≤ 2,5%
CAS: 128-37-0 EINECS: 204-881-4 Registreringsnummer: 01-2119565113-46-XXXX	2,6-di-tert-butyl-p-cresol Aquatic Acute 1, H400; Aquatic Chronic 1, H410	≥ 0,025 – < 0,25%



From: Mokeem et al.
doi: 10.3390/biomedicines11051256

LCU polymerisation of monomers: 50-80% conversion

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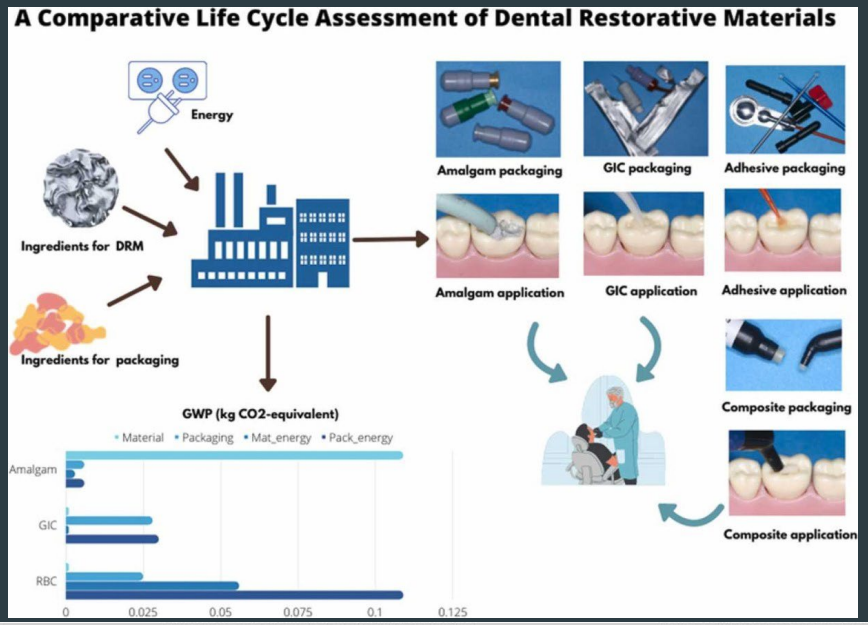
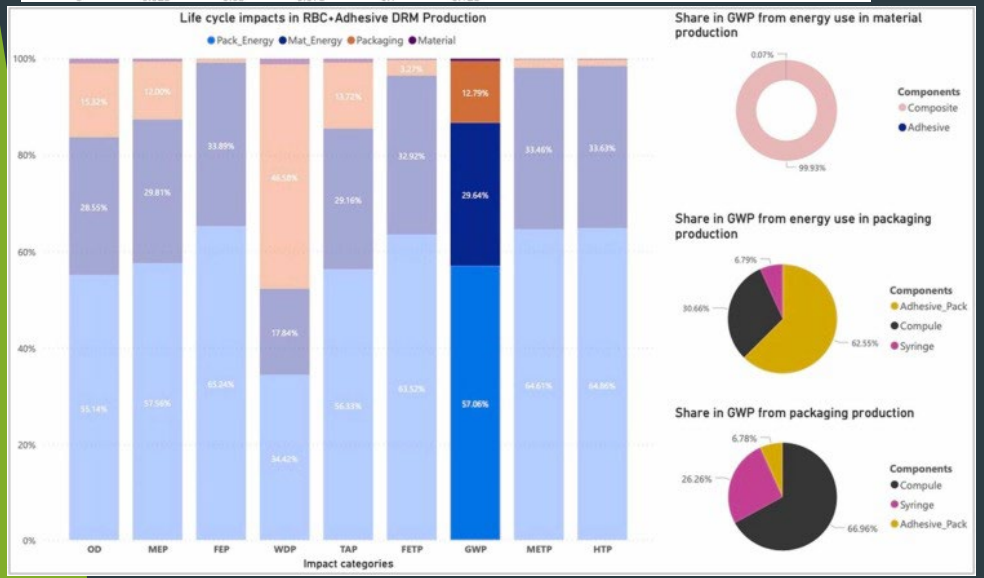
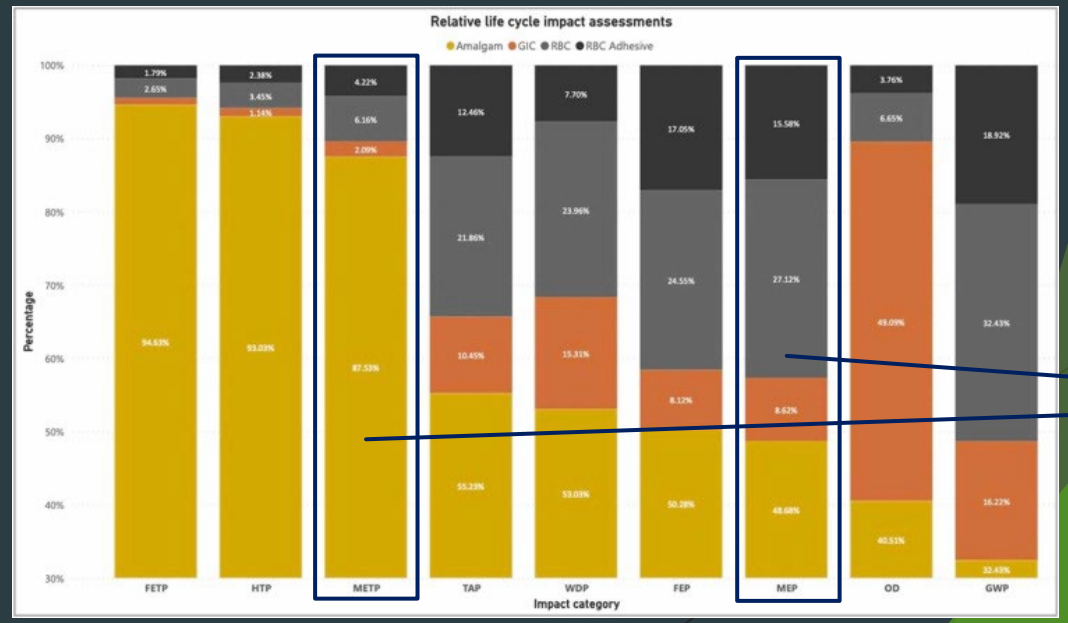
- RBCs show acceptable occupational and patient risk profiles, but environmental aspects remain undocumented.
- Emerging data suggest that using RBCs may have higher global warming potential than alternative restorative materials.

Environmental performance of restorative materials





University of Sheffield
Nine impact categories , highest impacts:
Amalgam: human- / freshwater & marine ecotoxicity,
Resin-bond composite: global warming potential, eutrophication
Glass ionomer cement: ozone depletion



	IMPACT
FEP	Freshwater Eutrophication
FETP	Fresh Water Ecotoxicity
GWP	Global Warming Potential
HTP	Human Toxicity
MDP	Metal Depletion
MEP	Marine Eutrophication
METP	Marine Ecotoxicity
OD	Ozone Depletion
TAP	Terrestrial Acidification
WDP	Water Depletion

Smith et al. doi: 10.1016/j.dental.2022.11.007

Conclusions

- The use of different polymers in dental care clinics is frequent and in large amounts, with a largely unknown environmental impact.
- There is a void of studies on microplastics and monomer release secondary to resin-based composite degradation intraorally and environmentally.
- Mitigation strategies for waste handling and reduction of single-use plastics must address better practices, including reusing devices and recycling.