PERSONAL EXPOSURE TO PARTICULATE MATTER DURING GRINDING OF DENTAL NANOCOMPOSITE

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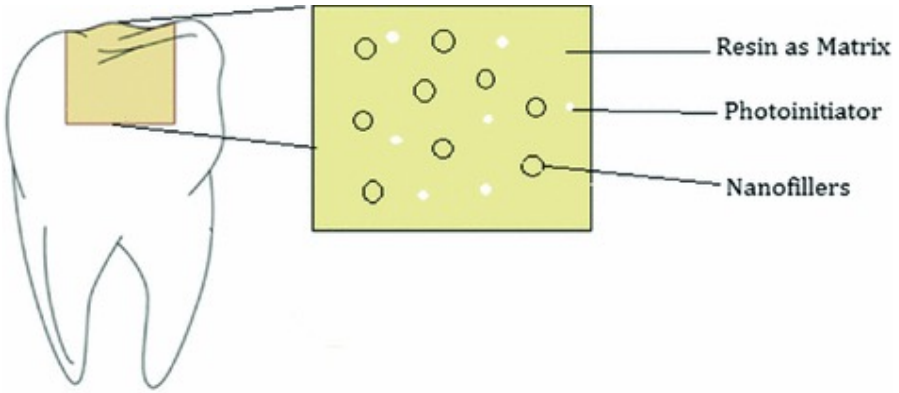
DENTAL COMPOSITES

- Restorative materials
- Organic polymer matrix with inorganic filler particles with different sizes
- High mechanical and wear resistance, improved polishability, and longlasting gloss
- There are possible health risks caused by particles released during finishing and grinding



Ref.: Chaughule, R. et al. (2018). Nanocomposites and Their Use in Dentistry. In: Chaughule, R. (eds) Dental Applications of Nanotechnology. Springer, Cham.

A PILOT STUDY

- Particle size analysis of aerosol generated during grinding of composite materials
  - 2 nanocomposites
  - Microcomposite
  - Unfilled resin

- Significantly increased nanoparticle (< 100 nm) concentrations were recorded for all used materials
- Nanoparticles may originate from thermal decomposition of composite polymeric matrix due to friction heat

Ref.: Bradna, P. et al. (2017). Detection of nanoparticles released at finishing of dental composite materials. Monatshefte fur Chemie, 148, 531-537.

QUESTIONS

1. How does the grinding of dental nanocomposite influence the indoor air quality?
2. Is personal exposure comparable with static indoor monitoring results?
3. What is the relationship between personal exposure and amount of grinded nanocomposite material?

METHODOLOGY

NANOCOMPOSITE MATERIAL

Composite material Filtek Ultimate A2 body, 3M-ESPE (Germany)

- Matrix formed from high molecular weight monomers (bis-GMA, UDMA, TEGMA, bis-EMA6)
- Filled with 78.5 wt. % of primary 20 nm SiO_2 and 4-11 nm ZrO_2 particles and their agglomerates

NANOCOMPOSITE SAMPLES PREPARATION

- Samples of approx. 1.7-2.0 g were prepared
- Polymerized in 2-mm supplement for 20 s each with a Valo polymerization lamp (Ultradent Products, USA) at the radiant exitance 1000 mW/cm^2
- Samples were adjusted in stainless steel ring holders
- Stored for 4 weeks at 37°C in the air to post-cure

GRINDING

- The sample surface was ground with a round medium diamond bur (Edenta, Switzerland) at 100,000 rpm without water cooling
- The burs were fixed to a 1:5 handpiece (Kavo Dental, Germany) attached to an electrical micromotor LA-3 E supplied by a Perfecta 900 (W&H Dentalwerk, Austria)

GRINDING ROUNDS

- 4 rounds in a 135 m^3 room
- 6 participants per round (24 different participants in total – middle-aged females)
- Each participant ground a test sample for 10 min
- The participant remained in the room during the next 50 minutes when the other 5 participants ground their samples
- The room was ventilated by open windows after the round

PARTICLE MEASUREMENTS

Personal Nanoparticle Sampler (PENS)

Ref.: Tsai, C.-J. et al. (2012) Novel active personal nanoparticle sampler for the exposure assessment of nanoparticles in workplaces. Environ. Sci. Technol. 46, 4546-4552.

Personal

- Personal Nanoparticle Sampler (PENS)
  - Respirable fraction (PM4-0.1)
  - Nanoparticles (PM0.1)

Static

- Number size distribution
  - Scanning Mobility Particle Sizer (SMPS, 10 – 700 nm)
  - Aerodynamic Particle Sizer (APS, 0.5 - 20 µm)
- Mass size distribution
  - Berner low-pressure impactor *(*BLPI, 10 fractions, 26 nm – 10 µm)
- PM2.5 concentration
  - LVS-PM2.5 sampler (quartz fiber filters)

RESULTS

QUESTIONS

1. **How does the grinding of dental nanocomposite influence the indoor air quality?**
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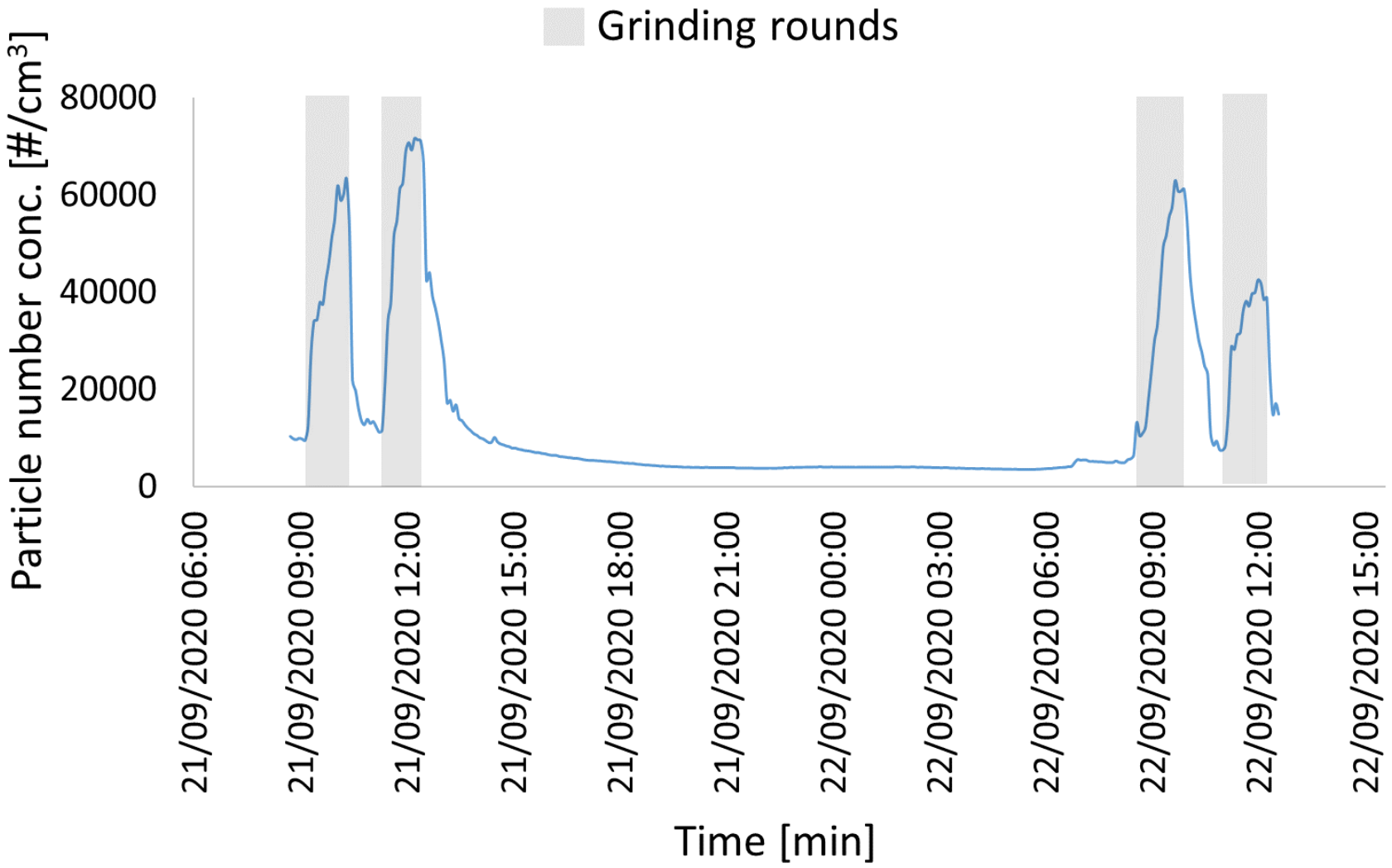
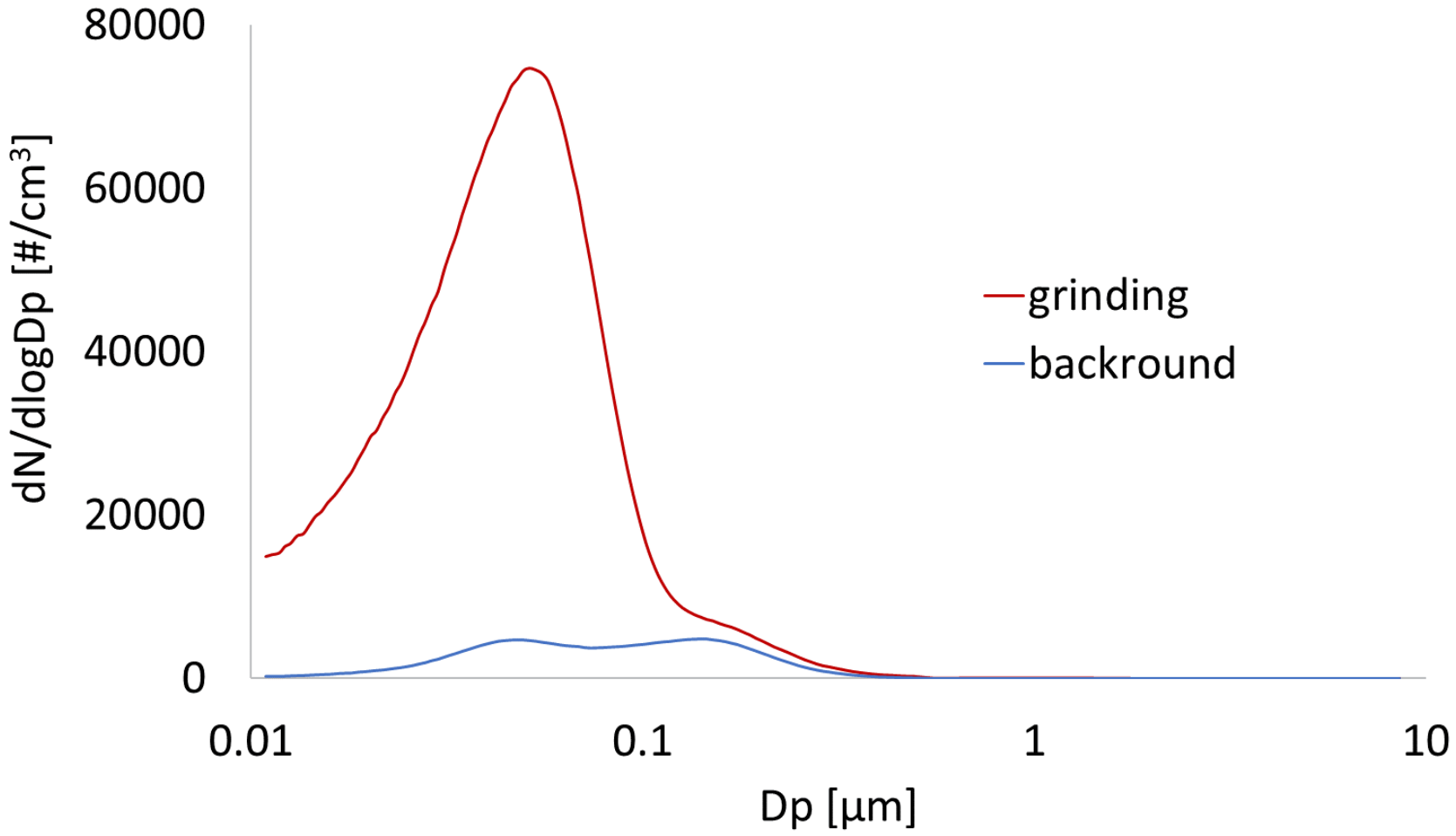
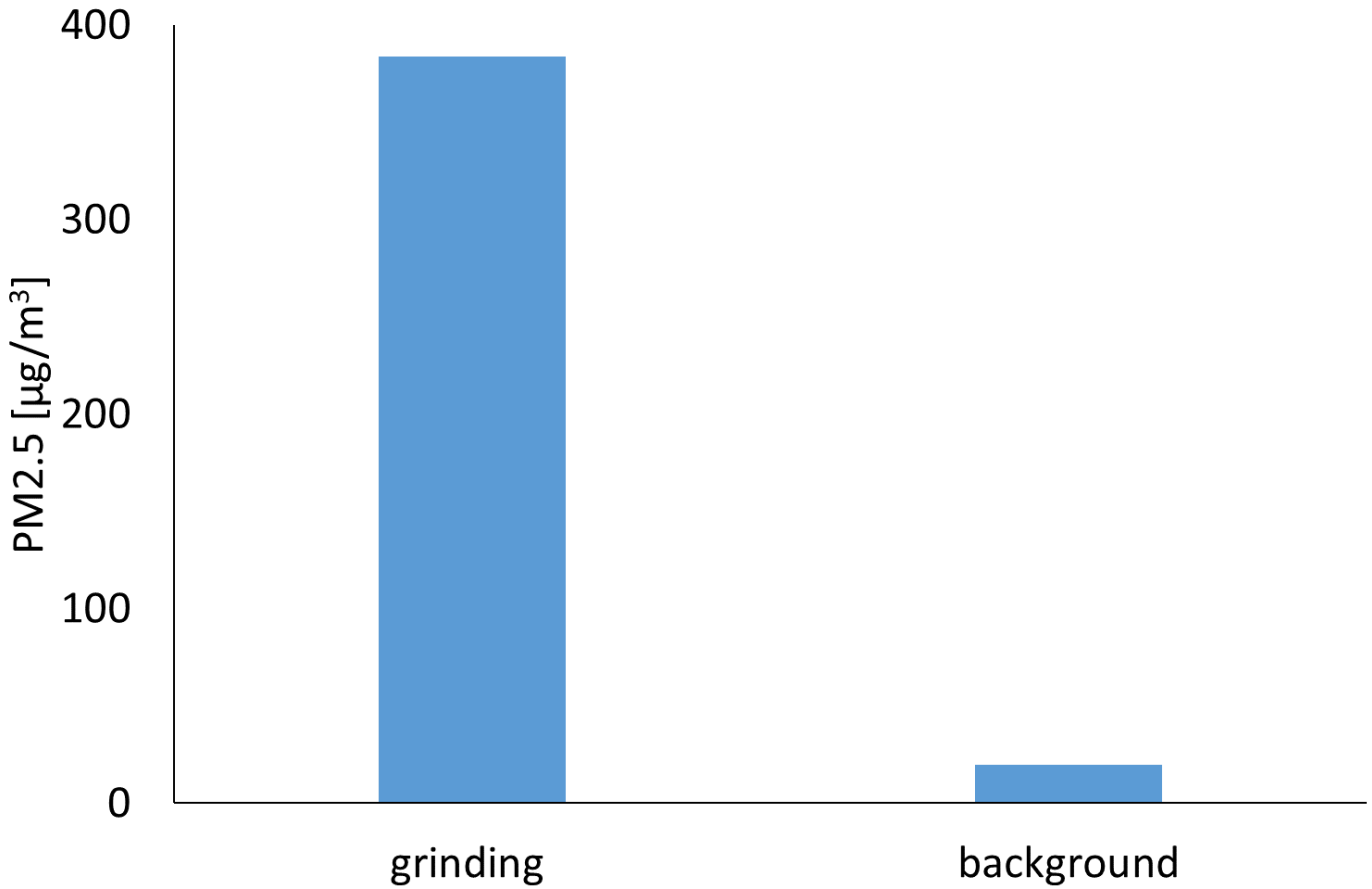
10 nm – 10 µm NUMBER CONCENTRATIONS



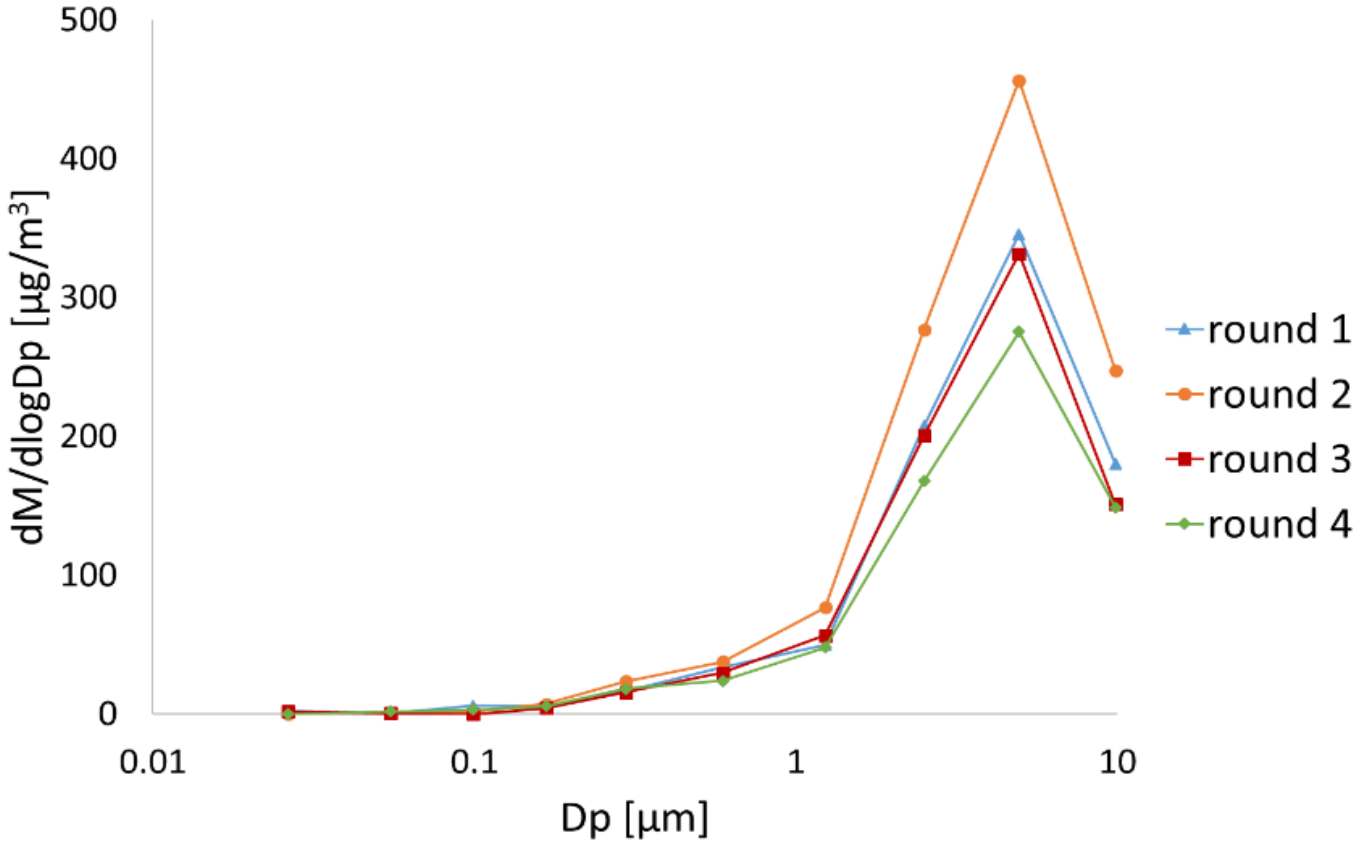
NUMBER SIZE DISTRIBUTIONS



PM2.5 MASS CONCENTRATION



MASS SIZE DISTRIBUTIONS



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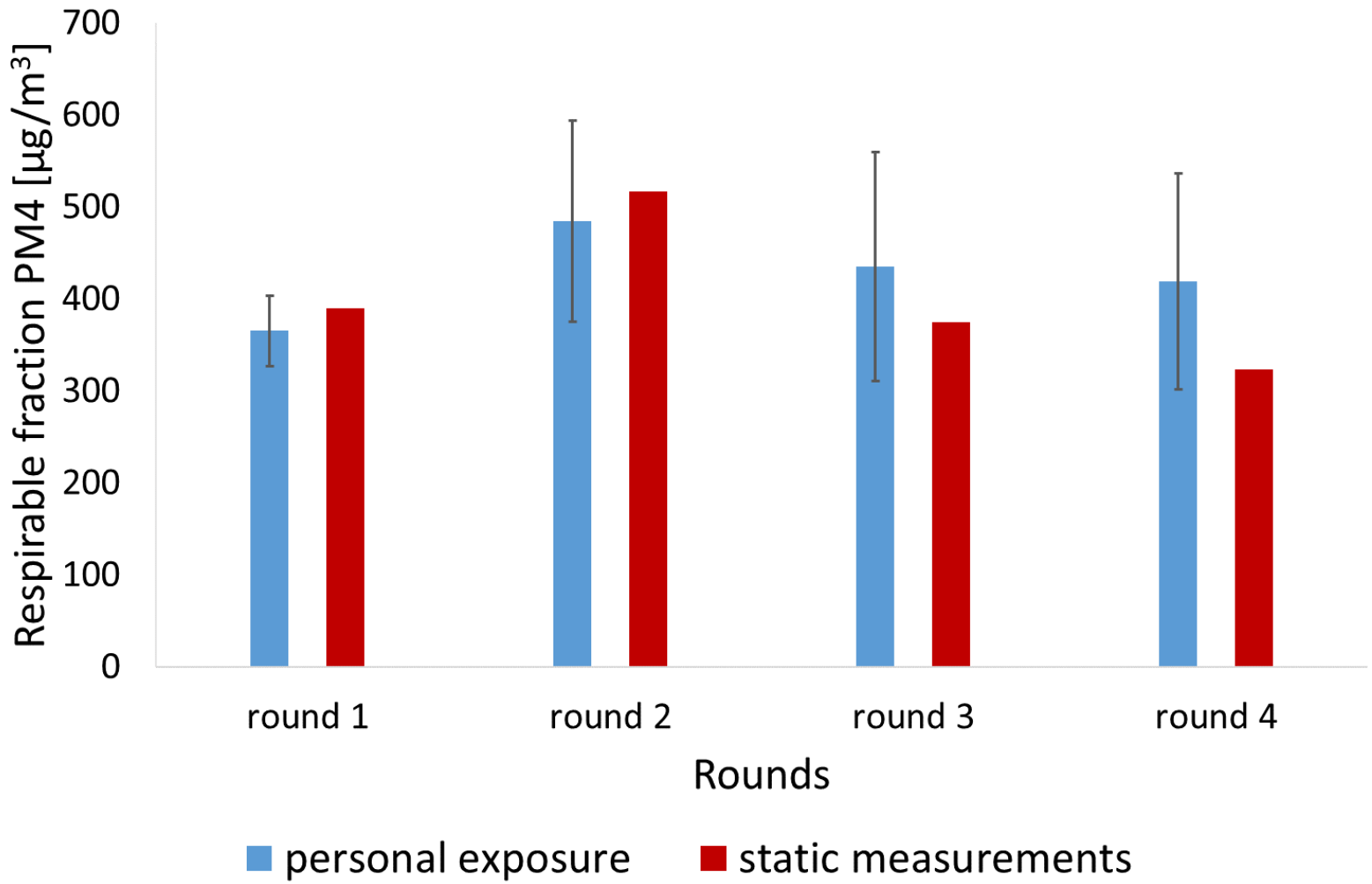
PERSONAL EXPOSURE VS. STATIC MEASUREMENTS



QUESTIONS

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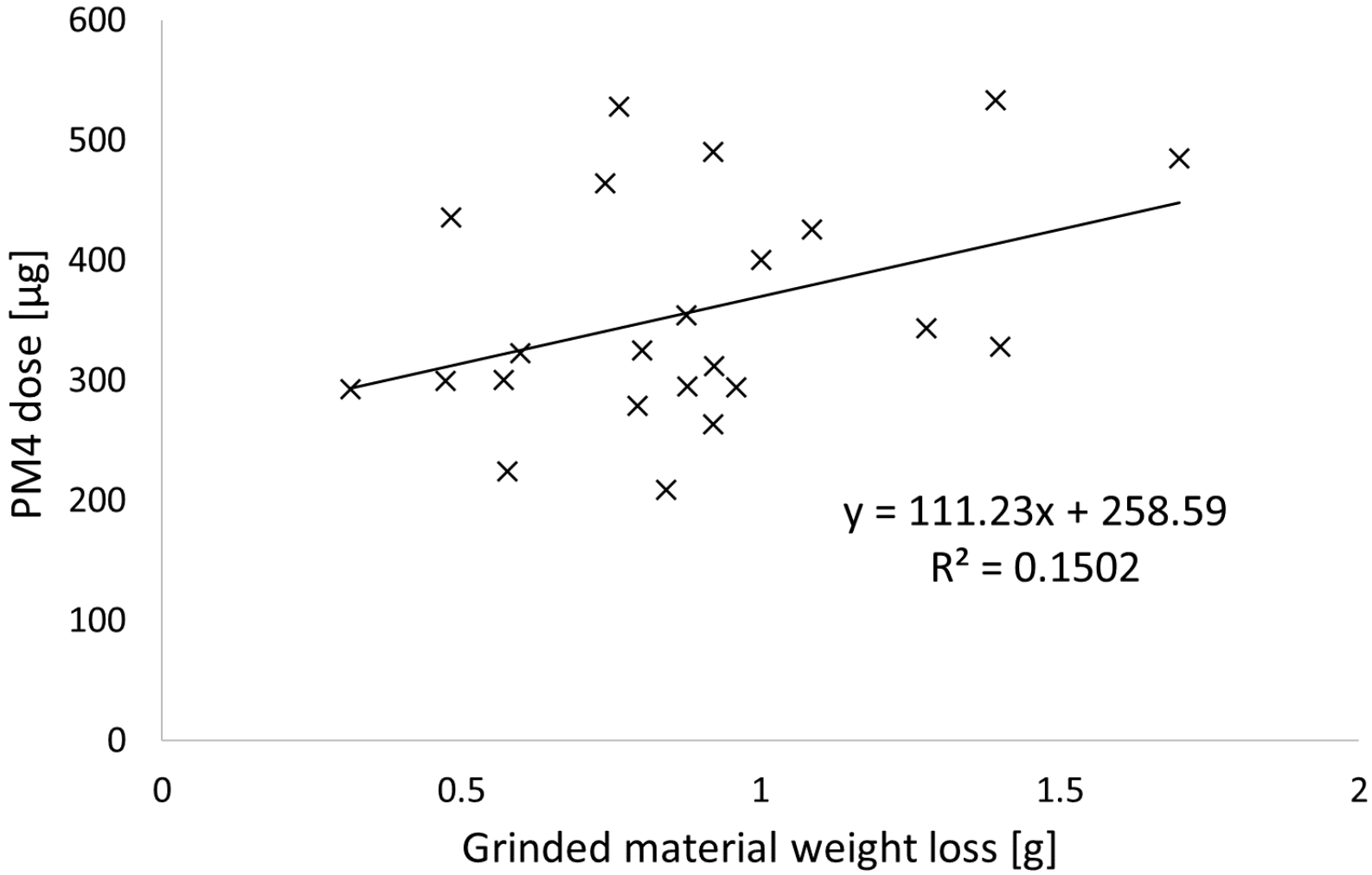
GRINDED MATERIAL VS. PERSONAL EXPOSURE



CONCLUSIONS

- Grinding of nanocomposite material is an important source of nanoparticles in the indoor environment.
- Number concentrations of nanoparticles increased by one order of magnitude compared to background values.
- Personal exposure to respirable particles relatively corresponded with the indoor concentrations.
- The relationship between the weight loss of grinded material by one participant and her personal exposure was relatively weak.
- The exposure to the PM generated during grinding of dental composites cause a healthy risk for dentists who directly work with the materials, other staff and patients.

HEALTH EFFECTS – PARALLEL STUDY

- 24 female volunteers
- Before and after exposure
  - Exhaled breath condensate, blood, and urine samples were collected

HEALTH EFFECTS – PARALLEL STUDY

- Rossnerova, A. et al. (2024) Genetic alteration profiling in middle-aged women acutely exposed during the mechanical processing of dental nanocomposites, Environmental Toxicology and Pharmacology, 108, 104462.
- Simova, Z. et al. (2024) Transcriptome changes in humans acutely exposed to nanoparticles during grinding of dental nanocomposites. Nanomedicine, in press.
- Pelclova, D. et al. (2024) Are there risks from nanocomposite restoration grinding for dentists? International Dental Journal, in press.

ACKNOWLEDGEMENT

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THANK YOU