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Contamination of Indoor Dust with Organophosphate Esters

Sandra Brommer and Stuart Harrad

INTRODUCTION

- Organophosphate esters (OPEs) used extensively as plasticisers and as flame retardants
- In the latter context, concern about increasing use in response to restrictions on BFRs
- Known that indoor dust ingestion is an important human exposure pathway for BFRs, so this presentation is a preliminary report on OPEs in UK indoor dust
- Part of a wider human exposure assessment that will also examine exposure via inhalation and diet and examine relationships to biomarkers of internal exposure

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STUDY DESIGN

- Dust samples taken in the West Midlands from:
- 7 cars, 8 living rooms, and 22 offices
- OPEs measured were:
- tri-*n*-butyl-phosphate (TnBP),
- tris 2-chloroethyl phosphate (TCEP),
- tris (1-chloro-2-propyl) phosphate (TCPP),
- tris-(1,3-dichloro-2-propyl) phosphate (TDCPP),
- tri-cresyl phosphate (TCP), and
- triphenyl phosphate (TPhP)

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METHODS - SAMPLING

- Samples collected using a Nilfisk Sprint Plus 1600W vacuum cleaner or hand-held in cars
- Dust retained within a nylon "sock" fitted within the furniture attachment

- 1 m^2 floor sampled for 2 min if carpeted, 4 m^2 for 4 min if bare floor, and cars as indicated for 2 min

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ANALYSIS

- Samples spiked with d_{27}-TBP and d_{15}-TPhP, extracted with hexane:acetone (3:1) using sonication, followed by SPE and GC-EI MS using VF5ms column
- Method accuracy and precision evaluated by replicate (n=11) analysis of indoor dust reference material SRM2585

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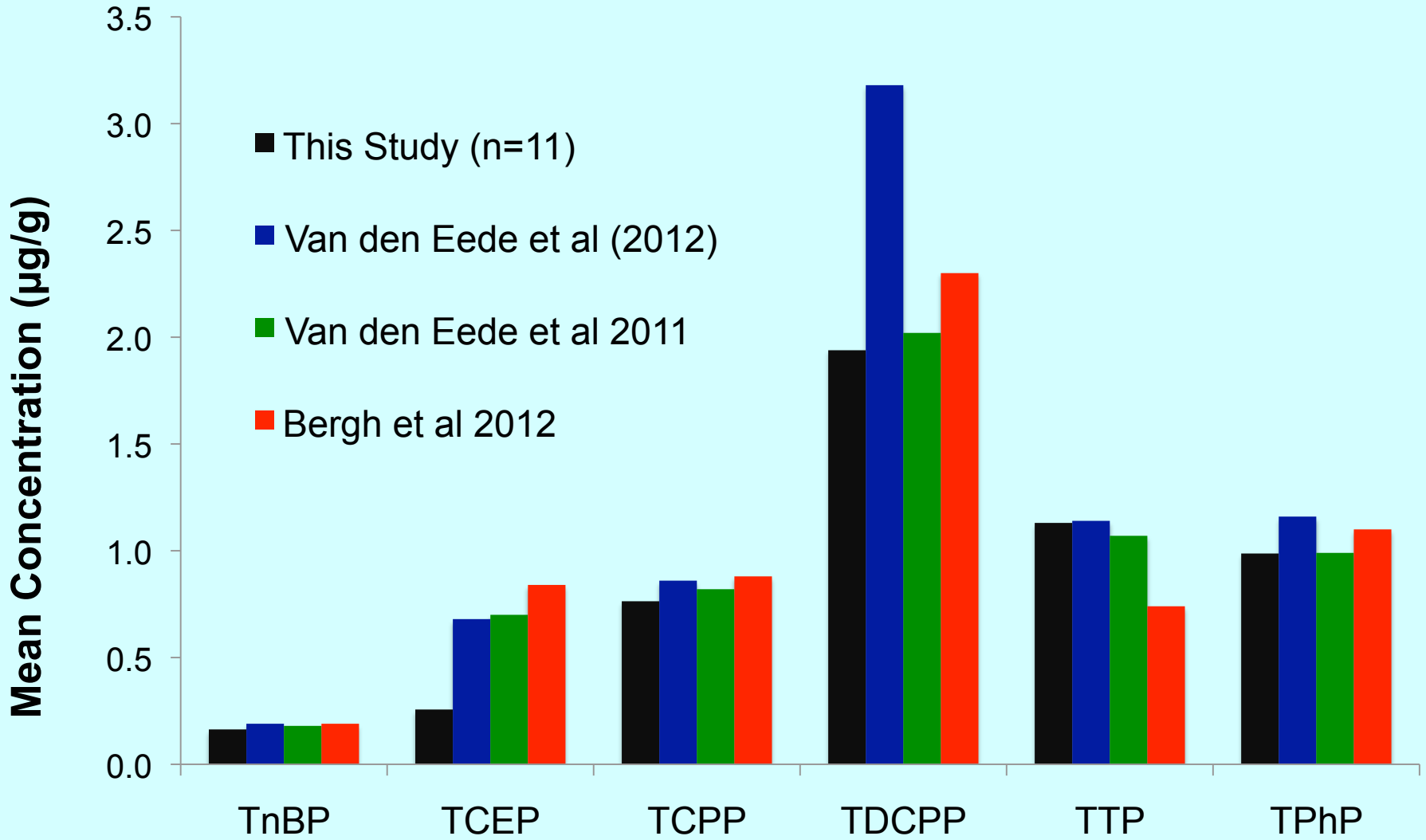
REPLICATE ANALYSES OF SRM2585



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RESULTS

- Concentrations summarised overleaf
- TCPP is predominant, with TDCPP also elevated in cars (N.B. two very high indicative TDCPP concentrations in car dust - 290 and 620 µg/g - awaiting confirmation)
- Some recent data for Belgian house dust indicate UK house data to be within range of previous studies, though noticeably higher for TCPP – but more data needed
- Elevated TDCPP in cars reported elsewhere in preliminary studies in Germany & Spain

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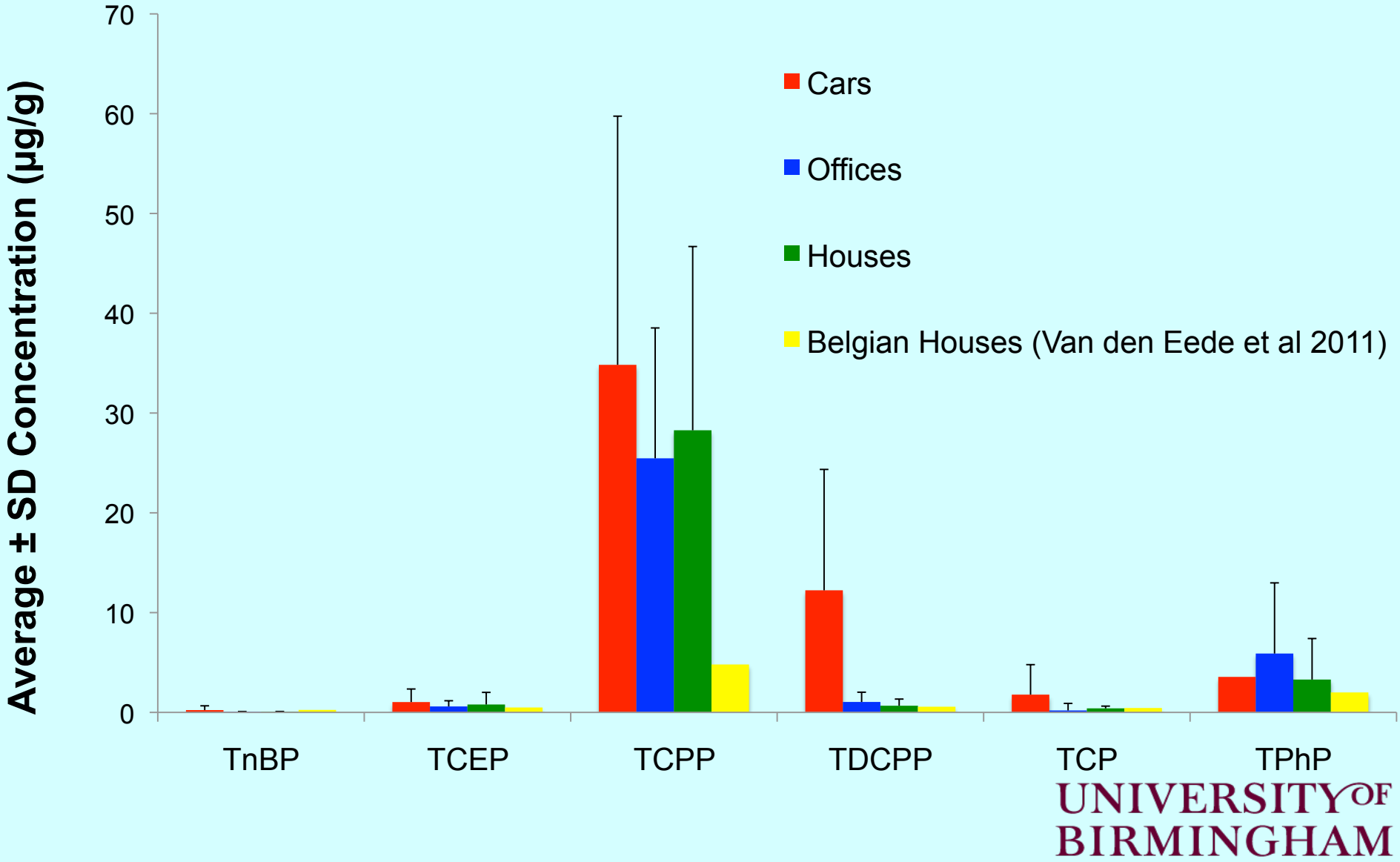
AVERAGE±SD CONCENTRATIONS



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DIFFERENCES BETWEEN MICROENVIRONMENTS

- Data display a log-normal distribution
- ANOVA of log-transformed data reveals the following significant ($p<0.05$) differences in concentrations between microenvironment categories:
- TDCPP in car (median = 7.3 µg/g) exceeds that in office (0.86 µg/g) and house (0.43 µg/g) dust
- TCP in car (0.78 µg/g) and house (0.36 µg/g) both exceed concentrations in office (0.01 µg/g) dust

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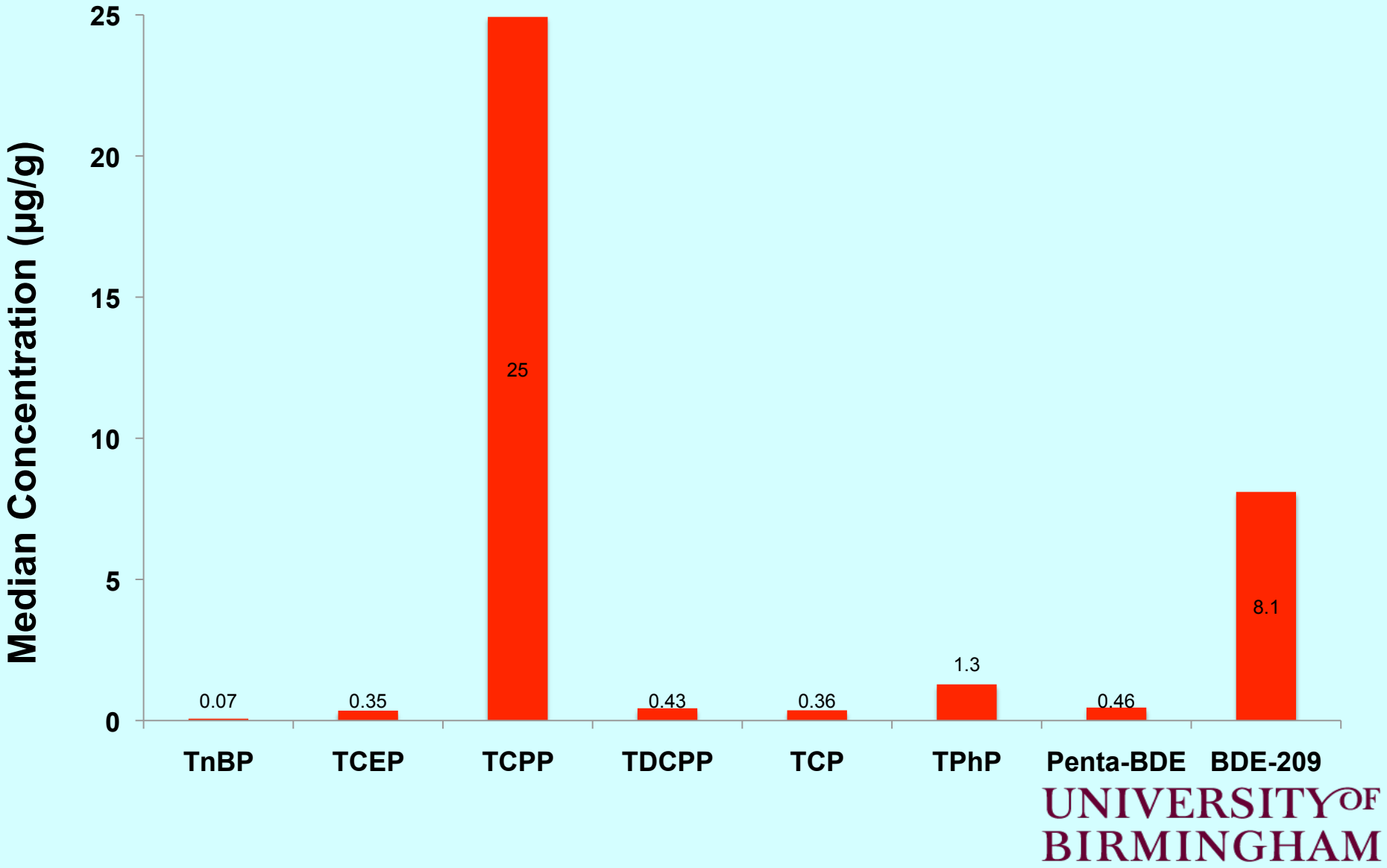
OPEs VERSUS PBDEs IN UK HOUSE DUST



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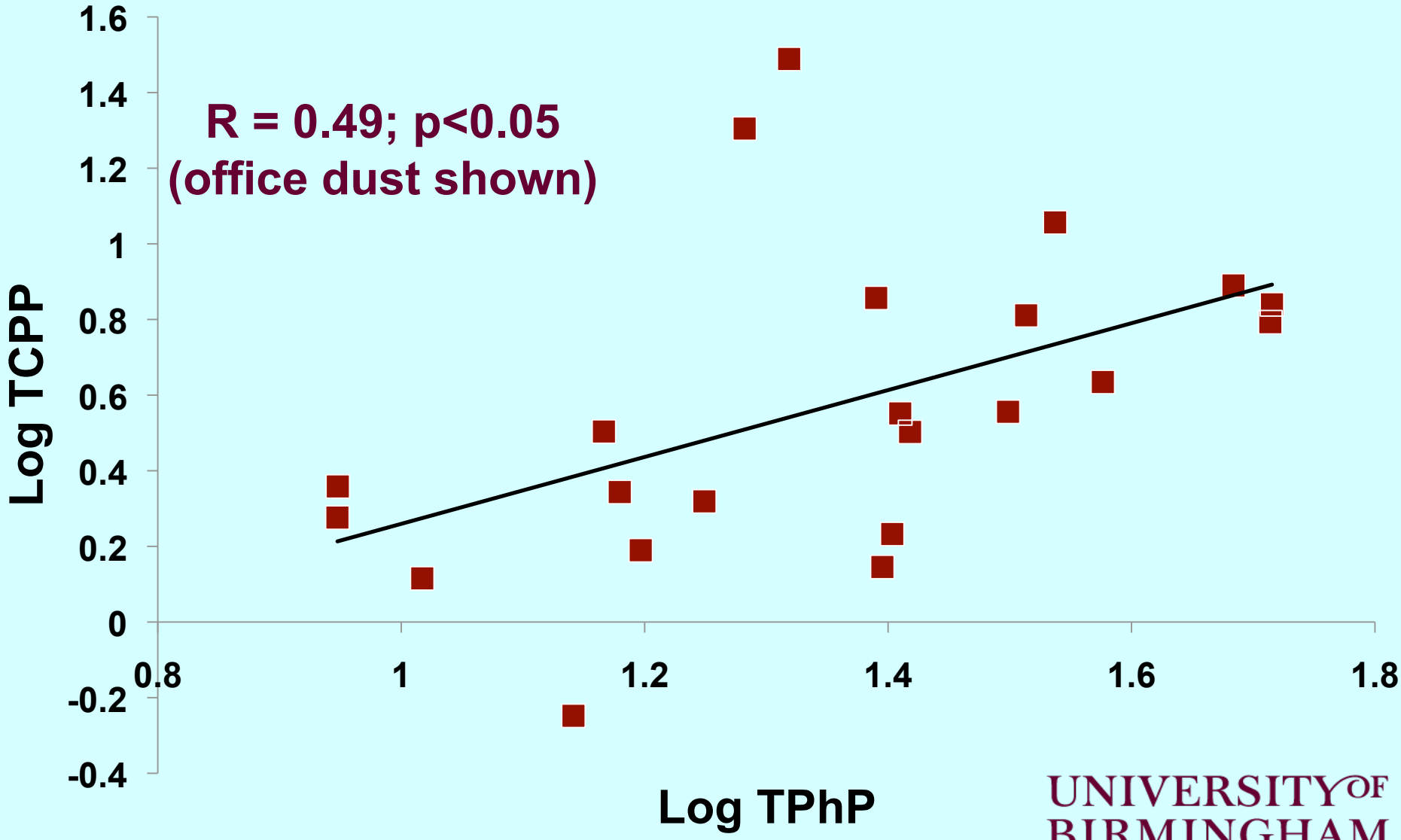
TCPP & TPhP SIGNIFICANTLY CORRELATED



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TDCPP IN CAR DUST

- In our earlier work on German car dust (n=6), where (as in UK samples) TCDPP was the dominating OPE; there was a significant positive correlation ($p<0.05$) between TDCPP concentration and the estimated mileage completed between sampling and the last vacuum cleaning
- We hypothesise this indicates intensive use of a car causes greater abrasion of vehicle upholstery with concomitant enhanced release of flame-retarded upholstery fabric fibres.
- Relevant data from this study not yet analysed
- More work (more samples and forensic microscopy) needed to test this hypothesis

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EXPOSURE VIA DUST INGESTION

- Exposure estimated under low-end, typical, and high-end scenarios
- Notional RfDs for OPEs to assess the margin of safety of exposure derived using reported chronic NOAEL or NOEL values divided by a safety factor of 10,000 (Van den Eede et al, 2011)
- Even under high-end exposure scenarios, MoS (RfD/exposure) at least 30 for most OPEs
- BUT…MoS for toddlers under high-end exposure scenario = 8 for TCPP
- More toxicological and exposure data needed (TDCPP in car dust possibly very high)

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