

# Workplace Exposure to Bioaerosols in Podiatry Clinics

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**Objectives:** The aim of this study was to design and execute a pilot study to collect information on the personal exposure levels of podiatrists to microbial hazards in podiatry clinics and also to assess health and safety knowledge within the sector using a questionnaire survey.

**Methods:** A self-report quantitative questionnaire dealing with health and safety/health issues was issued to 250 podiatrist clinics. Fifteen podiatry clinics were randomly recruited to participate in the exposure study. Concentrations of airborne bacteria, fungi, yeasts, and moulds were assessed using a six-stage viable microbial cascade impactor. Personal samples of total inhalable dust and endotoxin were measured in the breathing zone of the podiatrist.

**Results:** A questionnaire response rate of 42% ( $N = 101$ ) was achieved. Thirty-two per cent of respondents indicated that they had a respiratory condition; asthma was the most prevalent condition reported. The most frequently employed control measures reported were use of disposable gloves during patient treatments (73.3%), use of respiratory protective equipment (34.6%), use of protective aprons (16.8%), and eye protection (15.8%). A total of 15.8% of respondents used mechanical room ventilation, 47.5% used nail drills with local exhaust ventilation systems, and 11% used nail drills with water spray dust suppression. The geometric mean concentrations of bacteria, Staphylococci, fungi, and yeasts/moulds were 590, 190, 422, and 59 CFU m<sup>-3</sup>, respectively. The geometric mean endotoxin exposure was 9.6 EU m<sup>-3</sup>. A significant percentage of all the bioaerosols that were in the respirable fraction was representative of yeasts and moulds (65%) and Fungi (87%).

**Conclusions:** Even if statistical analysis of data is limited by low sample numbers, this study showed that the frequency of cleaning and use of RPE varied between clinics sampled, and it is likely that refresher health and safety training focusing on health and safety hazards inherent in podiatry work and practical control measures is warranted.

**Keywords:** Bioaerosol; endotoxin; podiatry

## INTRODUCTION

Many studies have shown that occupational exposure to bioaerosols and organic dusts can cause adverse

health effects, such as infectious and respiratory diseases and cancer (Donham *et al.*, 1986; Lacey and Crook, 1988; Blair *et al.*, 1992; Sigsgaard *et al.*, 1994; Douwes *et al.*, 2003; Thorne and Duchaine, 2007). The medical and health sectors have been identified as having an increased risk of contracting occupational infectious diseases due to the potential for bioaerosol exposure within their work environment

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(Douwes *et al.*, 2003; Matheson *et al.*, 2005). However, within the health sector, occupational exposures in podiatry practice have received little attention (Burrows and McLarnon, 2006; Rees, 2008).

Podiatry is a healthcare profession that specializes in the management of disease and disorders of the lower limb and foot. Podiatric treatments such as the reduction of thickened toenails, onychomycotic nails, foot calluses, or corns have the potential to generate substantial concentrations of organic dusts, which could pose an occupational hazard to those exposed. It is estimated that up to 3 g of toenail dust may be generated per day in a podiatry practice (Davies and Ganderton, 1975). Studies of the morphology and particle size of toenail dust generated from podiatric nail drills show that toenail dust particles are plate like in shape allowing them to remain airborne for long periods. Particles are largely respirable, with >80% of the particles within a 0.8–1.6 µm particle size range, thus once inhaled these particles are capable of penetrating the lower lung (Abramson and Wilton, 1985a; Donaldson *et al.*, 2003). Toenail dust has been shown to be a Type I Allergen (Davies, 1984) rich in endotoxin and fungi species. Endotoxin is an amphiphilic component of the outer cell wall of Gram negative bacteria, has strong innate immune and pro-inflammatory properties, and has been shown to be an important factor in the aetiology of lung diseases, such as chronic obstructive pulmonary diseases and non-allergic asthma (Douwes *et al.*, 2003; Hadina *et al.*, 2008). Toenail dust generated from the treatment of onychomycotic nails is rich in fungi species, such as *Trichophyton mentagrophytes* and *Trichophyton rubrum* (English, 1972; Donaldson *et al.*, 2003).

Previous research carried out by Millar (2000) among podiatrists in the UK found the prevalence of asthma among podiatrists to be four times higher than the UK's national average, and a high prevalence of eye irritation and respiratory complaints has been reported in this occupational group. Podiatrists have also been shown to have a higher prevalence of precipitating antibodies for *T. rubrum* compared to the general public (Abramson and Wilton, 1985b; Davies, 1984). However the health implications of inhaling toe nail dusts are inconclusive (Gately, 1991).

To the authors' knowledge, there have been few studies which have characterized the personal exposures of podiatrists and few that have evaluated the use of exposure controls and assessed the level of knowledge of occupational exposure hazards among podiatrists. This information is required to adequately estimate the health risks of this work, to aid the selection of appropriate exposure controls,

and to develop appropriately tailored hazard communication programmes for inclusion in educational podiatry programmes.

The aim of the present study was to design and execute a pilot study to evaluate the personal exposure of podiatrists to microbial hazards in podiatry clinics, namely airborne bacteria, fungi, yeasts, and endotoxin. A further aim of this study is to conduct a national survey of podiatrists working in private practice in Ireland to assess health and safety knowledge and to evaluate the use of exposure controls within the sector. It is anticipated that the results from this study will perform the basis for a larger study on occupational exposures in podiatry.

## METHODOLOGY

### *Questionnaire survey*

A self-report quantitative questionnaire was employed in this study, and no medical assessments were undertaken. The questionnaire consisted of 24 closed questions and 1 qualitative open-ended question designed to elicit information on the practice of occupational health and safety in podiatry. The subscales contained within the questionnaire were deemed appropriate for the objectives of this study.

As there is no single professional body/regulatory agency for podiatrists in Ireland, the only direct method of identifying potential participants was through the National telephone directory and School of Podiatry at National University of Ireland, Galway (NUI, Galway). A list of 250 podiatrists practicing in Ireland was compiled utilizing an online telephone listing website. Additional podiatrists were identified by a staff member in the School of Podiatry in NUI Galway. Only podiatrists in private practice were included in this study. As this research is exploratory, it was decided to conduct a full population survey. The questionnaire was posted with an explanatory cover letter to all identified podiatrists and reminder phone calls were used to follow-up with all non-responders.

### *Sampling methodology*

Fifteen podiatry clinics with between one and three podiatricians were randomly recruited to participate in the exposure study. Exposure sampling was conducted over the Summer Autumn period June to November 2010. All exposure sampling was completed by a trained Occupational Hygiene research student, who stayed at the podiatry clinic for the duration of the monitoring period. Prior to the survey, each podiatrist was asked to complete

a short questionnaire which asked questions regarding their podiatry treatment room, for example, presence of exposure controls, room ventilation, cleaning regime, etc. Podiatrists were asked to complete a work diary at 30-min intervals and asked to indicate whether predefined activities likely to generate toenail dust were performed. They were also asked to indicate the number of patients treated over the sampling period.

Airborne microorganisms were sampled by means of a six-stage viable microbial cascade impactor (TE-10-800; Tisch Environmental, Inc., USA), which was placed on the podiatrists clinical unit in between the podiatrist and the patient. The aerodynamic diameter range for each stage was as follows: Stage 1,  $>7 \mu\text{m}$ , Stage 2, 4.7–7.0  $\mu\text{m}$ , Stage 3, 3.3–4.7  $\mu\text{m}$ , Stage 4, 2.1–3.3  $\mu\text{m}$ , Stage 5, 1.1–2.1  $\mu\text{m}$ , and Stage 6, 0.65–1.1  $\mu\text{m}$ . Air ( $28.3 \text{ l min}^{-1}$ ) was impacted for 3 min onto the agar plates. These contained supplier-validated non-selective (for total viable aerobic microorganisms) or selective media the latter of which subsequent to incubation supported the growth of staphylococci and fungi (including moulds and yeasts). Each of the 15 participating clinics were sampled for 1 day and samples were taken in the morning before the first patient was admitted to the clinic and again after the last patient had left. Duplicate samples were taken for each of the six size fractions and  $<8$  min elapsed between taking the second sample. The mean of the two samples was used for further analysis; 90 samples were collected in total, and 30 samples analysed for total bacteria, 30 samples analysed for staphylococci, and 30 analysed for fungi (including moulds and yeasts). It was only possible to use the results from 72 samples, the remaining 18 samples were discarded as the sample plates were either aseptically compromised during transport to the laboratory, were statistically uncountable due to the proliferation of 'spreading microorganism' or because of excessive medium drying during incubation.

Personal samples of total inhalable dust and endotoxin were collected in the breathing zone of the podiatrist (sample cassettes were clipped onto the podiatrist's lapel). Sampling commenced in the morning before the podiatrist started work and continued for the full working day and the samples were collected at the end of the working day. Samples were collected on to 25-mm glass fibre filters (Pall Gelman Sciences) loaded into IOM inhalable dust sampler cassettes (Institute of Occupational Medicine, Edinburgh, UK). Filters were pretreated by heating at  $2000^\circ\text{C}$  for 4 h; cassettes and holders were washed with E-Toxa clean (soaked in 1% E-Toxa clean overnight, rinsed 10 times with tap water, five times

with DI water, one time with nanopure water, and dried on room temperature). Personal air sampling pumps (SKC Inc.), with the volumetric flow rate constant at  $2 \text{ l min}^{-1}$ , were used to draw air through the filters. Flow rates were checked before and after sampling using a Primary Air Flow Calibrator. Three podiatrists refused to participate in the personal sampling. In total, 12 personal measurements were collected sampling times ranged from 210 to 420 min.

### Sample analysis

All samples were transported back to the laboratory in a chilled box at  $4^\circ\text{C}$ , where possible within 1 h after sampling. Samples of total bacteria [total viable aerobic count (TVC)] were collected and enumerated using nutrient agar (Oxoid, UK) incubated at  $30^\circ\text{C}$  for 3 days. Samples of fungi (including moulds and yeasts) were collected and enumerated using lactic acid-adjusted malt extract agar (Oxoid, UK) incubated at  $22^\circ\text{C}$  for 5 days. Samples of Staphylococci were collected and enumerated using egg-yolk tellurite emulsion supplemented Bair-Parker medium (Oxoid, UK) which were incubated at  $37^\circ\text{C}$  for 2 days. Samples of dermatophyte fungi were collected using the settle plate technique on Dermasol Agar (Oxoid, UK) and incubated at  $22^\circ\text{C}$  for 2–4 weeks. Dermasol agar plates were monitored over the 4-week period and microscopy was used to identify the presence of *T. rubrum* or other dermatophytes grown on the agar, results were expressed as presence or absence of dermatophytes. Using positive hole correction tables (Macher, 1989), the concentrations of total bacteria, fungi, yeasts, and moulds were calculated and expressed as colony-forming units per cubic metre of air ( $\text{CFU m}^{-3}$ ).

Personal inhalable air samples were analysed for endotoxin as previously described (Thorne, 2000; Thorne *et al.*, 2010). Briefly, sampling filters were extracted into 10 ml of pyrogen-free Limulus amoebocyte lysate (LAL) grade water (Lonza, Inc.) plus 0.05% Tween-20 (Fisher Scientific), shaken for 60 min, and centrifuged for 15 min at 600 g and decanted. Extracts were assayed for endotoxin activity using a modification of the kinetic chromogenic LAL assay with a 12-point standard curve ( $r^2 > 0.995$ ) ranging from 0.0249 to 50  $\text{EU ml}^{-1}$ . Extracts were assayed at four dilutions in LAL water using a  $37^\circ\text{C}$  microplate reader (SpectroMax 340; Molecular Devices) at 405 nm with readings taken every 30 s for 90 min. Four microplate wells served as assay blanks.

### Statistical analysis

All statistical analysis was performed using SPSS (Version 18) and Minitab. The normality of

distribution of the bioaerosol concentrations data was checked using the Shapiro–Wilk test. The distributions were lognormal distributed and so the data are presented as geometric means and geometric standard deviation (Table 3). Independent student *t*-tests were used to compare concentrations of bioaerosols collected before the first patient treatment with samples collected after the last patient treatment. Agreement between bioaerosol concentrations and each of the following, the number of patients treated, the number of onychomycotic nails treated (Fungi only), the total time using a toenail drill/grinder/nail file and endotoxin concentrations (Bacteria only), was assessed by testing the significance of the Pearson correlation coefficient.

## RESULTS

### Questionnaire survey results

A response rate of 42% ( $N = 101$ ) was achieved to the questionnaire survey. The majority of the survey respondents were female 87% ( $n = 88$ ) and 13% ( $n = 13$ ) were male. Most respondents had been working in podiatry for a number of years, with 42% having worked between 20 and 40 years, another 44% having worked in excess of 10 years and the minority (15%) had worked for <10 years.

As respiratory illness is the health outcome of most interest in this study, participants in the questionnaire study were asked to indicate whether or not they had a work-related respiratory illness as diagnosed by their doctor. The questionnaire allowed respondents to select more than one illness, and 32 of the 101 survey participants indicated that they had a respiratory condition (Table 1). Asthma was the most prevalent condition, with eight podiatrists reporting this condition, followed by sinusitis ( $n = 8$ ), repeated chest infections ( $n = 6$ ), persistent cough ( $n = 5$ ), nasal irritation ( $n = 4$ ), and bronchitis ( $n = 2$ ). The data were analysed to assess the numbers of podiatrists suffering from individual conditions only.

Table 1. Diagnosed respiratory conditions, diagnosed by a medical practitioner, as reported by respondents ( $n = 32$ ).

Respiratory condition	Frequency
Asthma	$n = 8$ (8%)
Sinusitis	$n = 7$ (7%)
Repeated chest infections	$n = 6$ (6%)
Persistent cough	$n = 5$ (5%)
Nasal irritation	$n = 4$ (4%)
Bronchitis	$n = 2$ (2%)

The questionnaire survey also investigated the use of exposure controls and protective equipment in podiatry practice. Participants identified the frequency with which they employed various control measures. From the self-reported data, it was found that the most frequently employed control measures were always wearing of disposable gloves during patient treatments (73.3%) and use of respiratory protective equipment (RPE) (34.6%) was at a lower level; while consistent use of protective aprons (16.8%) and eye protection (15.8%) were employed to a lesser degree (Table 2). The questionnaire did not require respondents to provide detail regarding the protection factor of the RPE used.

The use of room mechanical ventilation systems, local exhaust ventilation, and dust suppression systems was also investigated in the questionnaire survey. Use of room mechanical ventilation systems was very low (15.8% of respondents used mechanical ventilation). Almost half (47.5%) of the respondents used nail drills with local exhaust ventilation systems. However, the use of nail drills with water spray dust suppression was far less common, with only 11% of respondents always using this equipment.

### Exposure assessment results

The concentrations of airborne bacteria, fungi (including moulds) yeasts, Staphylococci, and personal endotoxin exposures measured in podiatry clinics are presented in Table 3. The geometric mean concentrations of bacteria, Staphylococci, fungi (including moulds), and yeasts were 590, 190, 422, and 59 CFU  $m^{-3}$ , respectively. The geometric mean endotoxin exposure was 9.6 EU  $m^{-3}$ . The concentrations of bacteria were much higher than the concentrations of fungi. Bioaerosol concentration data are presented as CFU  $m^{-3}$  in Table 4 (Supplementary data are available at *Annals of Occupational Hygiene* online) and the size distribution is plotted in Figures 1 and 2 as bacteria CFU  $m^{-3}/d\text{Log } D_p$  staphylococci CFU  $m^{-3}/d\text{Log } D_p$ , fungi CFU  $m^{-3}/d\text{Log } D_p$ , and yeasts and moulds CFU  $m^{-3}/d\text{Log } D_p$ .  $d\text{Log } D_p$  is the logarithmic width of the impactor stage, presenting the concentration data as CFU  $m^{-3}/d\text{Log } D_p$ , allows direct comparison between the concentrations of different stages.

The highest concentration of bacteria and fungi (including moulds) occurred in Stage 5 (1.1–2.1  $\mu\text{m}$ ), followed by Stage 4 (2.1–3.3  $\mu\text{m}$ ). Highest concentrations of yeasts occurred in Stage 2 (4.7–7.0  $\mu\text{m}$ ) followed by Stage 4 (2.1–3.3  $\mu\text{m}$ ). A significant percentage of all the bioaerosols was in the respirable fraction, ranging from 65% (yeasts and moulds)

Table 2. Frequency of use of exposure control measures reported by respondents ( $n = 42$ ).

	Always	Often	Sometimes	Seldom	Never
Disposable gloves	$n = 74$ (73%)	$n = 10$ (10%)	$n = 12$ (12%)	$n = 2$ (2%)	$n = 3$ (3%)
Dust mask	$n = 35$ (35%)	$n = 21$ (21%)	$n = 20$ (20%)	$n = 11$ (10%)	$n = 14$ (14%)
Eye protection	$n = 16$ (16%)	$n = 9$ (9%)	$n = 18$ (18%)	$n = 12$ (11%)	$n = 46$ (46%)
Disposable plastic apron	$n = 17$ (17%)	$n = 10$ (10%)	$n = 18$ (18%)	$n = 21$ (20%)	$n = 35$ (35%)
Sterilization unit	$n = 88$ (87%)	$n = 4$ (4%)	$n = 3$ (3%)	$n = 3$ (3%)	$n = 3$ (3%)
Mechanical ventilation system	$n = 16$ (16%)	$n = 1$ (1%)	$n = 8$ (8%)	$n = 5$ (5%)	$n = 71$ (70%)
Water spray nail drill	$n = 11$ (11%)	$n = 5$ (5%)	$n = 6$ (6%)	$n = 2$ (2%)	$n = 77$ (76%)
Nail drill with dust extraction	$n = 48$ (47%)	$n = 11$ (11%)	$n = 8$ (8%)	$n = 8$ (8%)	$n = 26$ (26%)

Table 3. Geometric mean (GM), geometric standard deviation (GSD), and range of total bacteria (CFU  $m^{-3}$ ), Staphylococci (CFU  $m^{-3}$ ), fungi (CFU  $m^{-3}$ ), yeast and moulds (CFU  $m^{-3}$ ), and endotoxin (8-h TWA, EU  $m^{-3}$ ).

	Total bacteria	Staphylococci	Fungi	Yeasts and moulds	Personal endotoxin
Total GM	590	190	422	58.9	9.6
GSD	1.0	1.1	0.9	0.9	3.5
Range	58.7–8031.7	ND–2982.4	41.1–1914.3	ND–1028.2	0.5–32.6

Endotoxin sampling was performed in 12 podiatry clinics ( $n = 12$ ), and sampling for total bacteria ( $n = 24$ ), staphylococci ( $n = 24$ ), fungi (including yeasts and moulds) ( $n = 24$ ) was performed in 15 podiatry clinics.

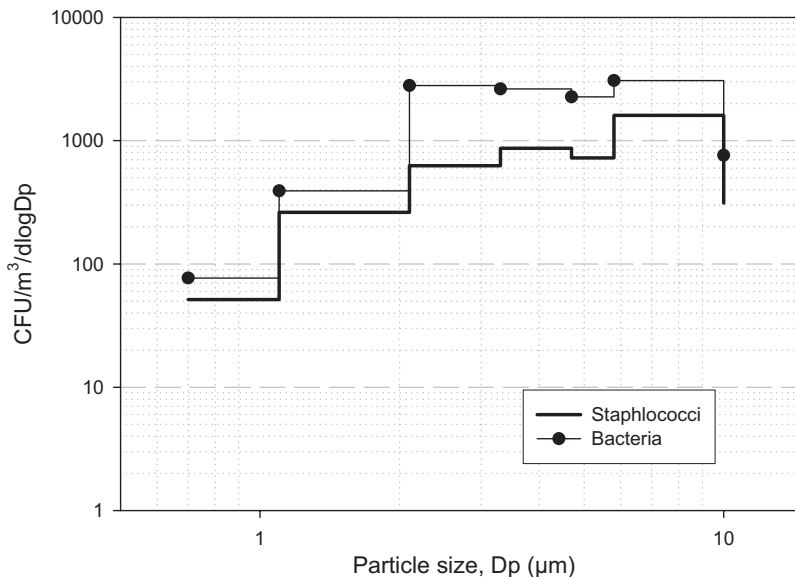


Fig. 1. Size distribution of total bacteria and staphylococci in podiatry clinics ( $n = 47$ ).

to 87% (fungi). There was no significant difference between the concentrations of bioaerosols collected in the morning prior to the first or second patient treatment compared with samples collected in the evening after the last patient treatment.

Correlations between bioaerosol concentrations (bacteria or fungi) and the number of patients treated, total time using a toenail drill/grinder/nail file, were all not significant ( $P > 0.05$ ). Similarly,

there was no correlation found between fungal concentrations and number of onychomycotic nail treatments within the clinics ( $P < 0.05$ ).

Endotoxin concentrations [expressed as 8-h time weighted average (TWA)] ranged from 0.5 to 32.6 EU  $m^{-3}$ . The highest endotoxin exposures were recorded in Clinic 7. Correlations between endotoxin concentrations and total bacterial concentrations, total number of patients treated, the total time using



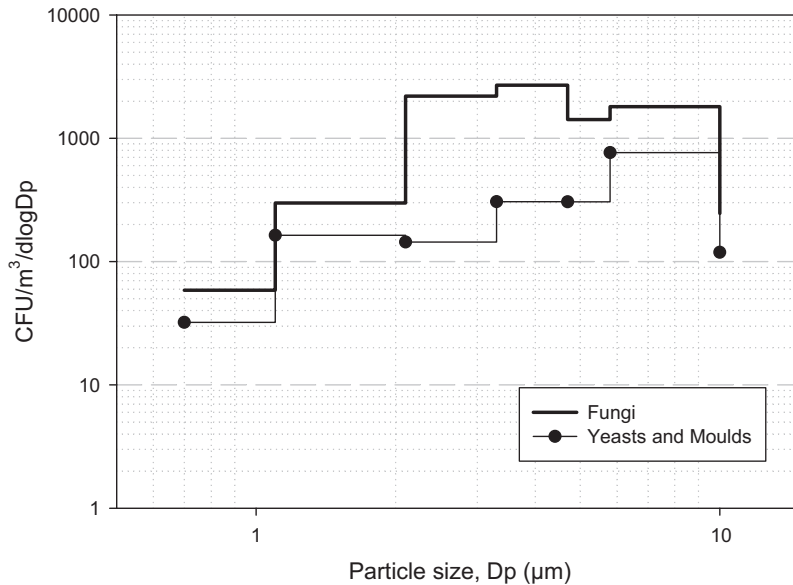


Fig. 2. Size distribution of fungi and yeasts/moulds in podiatry clinics ( $n = 47$ ).

a toenail drill, or the total time using a nail file or pumice stone were not significant ( $P < 0.05$ ).

## DISCUSSION

Concentrations of total viable bacteria, fungi, yeasts/moulds, and personal endotoxin exposures were measured in podiatry clinics. To the authors' knowledge, there have been no other studies reported concerning bioaerosol concentrations and endotoxin exposures in podiatry.

The geometric mean concentrations of bioaerosols reported in this study are higher than values reported for other clinical settings, such as dentistry and hospital environments (Bennett *et al.*, 2000; Monarca *et al.*, 2000; Kim and Kim, 2007) and lower than those reported for residential dwellings (De Koster and Thorne, 1995; Nasir and Colbeck, 2010). In the present study, concentrations of bacteria were highest, followed by fungi (including moulds) and yeasts. There were no visible signs of fungal or mould growth in any of the clinics sampled. The maximum concentrations of all bioaerosols (apart from yeasts and moulds) were isolated from Stage 5 (1.1–2.1 µm) (Figures 1 and 2). The size distributions of bacteria and fungi (72–79%, 87% respirable) are comparable to those reported for residential homes in the UK (Nasir and Colbeck, 2010) and the USA (De Koster and Thorne, 1995) but slightly higher than those reported by Kim and Kim (2007)

for hospitals environments. In this study, the high fraction of respirable bioaerosols could largely be due to microbial laden dust originating from the use of grinding tools used for podiatric treatments within the clinics. Studies of toenail dust particle size and morphology on dust collected from toenail drills have shown that toenail dust is highly respirable (Abramson and Wilton, 1985a; Donaldson *et al.*, 2002). Nine of the clinics sampled in this study used a toenail drill during the survey. Some clinics reported spending up to 1.5 h day<sup>-1</sup> reducing the thickness and distortion of onychomycotic nails using a toenail drill or nail file. Highest concentrations of yeasts were found in Stage 2 (4.7–7 µm).

All personal endotoxin exposures are less than the Dutch exposure standard limit of 90 EU m<sup>-3</sup> for airborne endotoxin DECOS (2010). Concentrations are highly variable (range 0.5–32.68 EU m<sup>-3</sup>), but within the range of exposure concentrations reported for similar clinical settings, such as dentistry (Singh *et al.*, 2010) or for indoor environments such as office buildings and rural households (Thorne and Duchaine, 2007).

One of the most commonly performed treatments at the podiatry clinics during the survey involved the drilling or filing of onychomycotic nails. As onychomycotic nails are caused by dermatophytic fungi, the number of onychomycotic nail treatments performed should be one of the main sources of airborne fungi within the clinic. There was, however, no dermatophytes identified

and there was no significant correlation ( $P > 0.05$ ) between the number of onychomycotic nail treatments or total time using a nail drill and total fungi concentrations. In addition, there was no significant correlation ( $P > 0.05$ ) between bioaerosol or endotoxin concentrations and number of patients treated, even though previous studies have identified building occupancy as a factor influencing bioaerosol concentrations in domestic settings (Nasir and Colbeck, 2010).

Podiatrists indicated that they use a variety of disinfectants for cleaning; however, the frequency of cleaning varied between clinics. Two of the clinics reported cleaning the immediate work area; patient chair, clinical unit, and podiatrists' chairs once per day and the remaining 10 clinics reported cleaning the immediate work area between each patient treated. Seventy-five per cent of clinics sampled reported cleaning the treatment room once per week and a small number reported using a household floor brush or vacuum cleaner. An endotoxin exposure concentration of  $32.6 \text{ EU m}^{-3}$  (8-h TWA) was recorded in one clinic, where the podiatrist reported using a household vacuum cleaner to clean the work area between patient appointments. This was the highest endotoxin exposure value recorded in the study. The use of a household brush or vacuum cleaner for cleaning is likely to generate high concentrations of bioaerosols by resuspension of settled microbial laden dust from work surfaces.

Microbial laden respirable dust has the potential to deposit deep in the alveolar region of the lung and could have significant health implications for workers with respiratory diseases, such as asthma. During the field study, it was observed that many of the podiatrists sampled in this study wore gloves while treating a patient, however rarely used RPE. When RPE was used, surgical dust masks, without assigned protection factors, were typically worn. Similar results were reported in the questionnaire survey; only 35% of podiatrists reported using a dust mask and as many as 70% reported not having a mechanical ventilation system.

Eight per cent of the podiatrists who participated in the questionnaire survey confirmed that they had been diagnosed with asthma; this rate is 1% lower than the Irish National average (Asthma Society of Ireland). Only 9% of questionnaire respondents suffered from nasal irritation, significantly lower than the value of 57%, which was reported by Gatley (1991). A possible explanation for the large discrepancy in the two figures is that the majority of the podiatrists who participated in Gatley's study were using toenail drills without extraction. Nowadays, most of the toenail drills available include an extraction unit, and in this

study, 47% of the questionnaire respondents reported using nail drills with dust extraction.

Given that this was a small study with 12–15 podiatry clinics participating, a larger scale study is necessary, building on the findings of this pilot project, to better understand occupational exposures within this under studied sector. Some conclusions can be made from this initial study. The inconsistent cleaning and use of exposure control measures observed in this study may be explained by a number of contributory factors, such as lack of awareness of health risks posed by inhalable dusts. Given that most of the participants in this study had been practicing for a number of years and that there is no Regulatory Podiatry body in Ireland, health and safety knowledge on topics such as infection control and personal protective equipment may have been forgotten in the absence of any refresher training. A starting point to address this gap could be the implementation of a targeted health and safety guidance tool for practitioners to raise awareness of health and safety hazards inherent in podiatry work incorporating practical control measures to minimize risk.

#### SUPPLEMENTARY DATA

Supplementary data can be found at <http://annhyg.oxfordjournals.org/>

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