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Aims and scope

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The Journal of Environmental Health Research is a peer reviewed journal published in three formats: printed full journal, printed abstracts and on-line journal.

The Journal publishes original research papers, review articles, technical notes, professional evaluations and workshop/conference reports and short communications covering the diverse range of topics that impinge on public and environmental health including: occupational health and safety, environmental protection, health promotion, housing and health, public health and epidemiology, environmental health education, food safety, environmental health management and policy, environmental health law and practice, sustainability and methodological issues arising from the design and conduct of studies.

A special category of paper – the 'first-author, first-paper' – is designed to help build capacity in environmental health publications by encouraging and assisting new authors to publish their work in peer-reviewed journals. Here the author will be given active assistance by the editors in making amendments to his or her manuscript before submission for peer review.

The Journal provides a communications link between the diverse research communities, practitioners and managers in the field of public and environmental health and aims to promote research and knowledge awareness of practice-based issues and to highlight the importance of continuing research in environmental health issues.

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Editorial team

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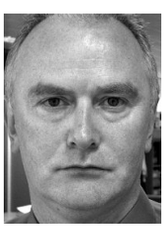

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Editorial

Marie Vaganay
Editor in Chief, JEHR

Towards evidence-based environmental health

In the modern world of competing priorities and scarce resources there is ever increasing need to ensure that environmental health interventions are innovative, effective and proven to work. Demonstrating the contribution that environmental health practice makes to wider public health and wellbeing is becoming increasingly important in order to secure future resources and inform future policy and strategy development. This could be achieved by adopting the key principles of evidence-based practice (EBP).

Simply put, EBP is practice that is supported by a clear, up-to-date, rationale and informed by best available evidence. EBP aims at designing and delivering effective, efficient interventions but also involves evaluating and disseminating the impacts of these interventions.

To date EBP has been prominently associated with the health and health allied sector including public health to such extent that the term evidence-based medicine (EBM), evidence based social work (EBSW), evidence based public health (EBPH) are used extensively.

Although the environmental health discipline is well supported by research in many fields (microbiological, toxicological, epidemiological...), the practice of environmental health and the evidence supporting environmental health practice and interventions is scarce.

There is excellent, important, innovative and challenging work carried out by EHPs across the country as demonstrated in the *Environmental Health News* and there is increasing widespread recognition that the development of evidence-based environmental health (EBEH) will provide key benefits. EBEH would help in evaluating the effectiveness of initiatives, researching and applying innovative solutions, informing policy-makers and suggest strategies for development and implementation. So why are environmental health practitioners not engaging more systematically with EBP?

Research carried out in the EBP in the health and health allied sector demonstrate that common barriers to undertaking EBP and disseminating research can be summarised into four categories:

- Knowledge – this relates to research skills and knowledge;
- Practice – time available, access to information, workload, lack of opportunities;
- Attitudes – perception of EBP, valuing the contributions of EBP, confidence;
- Organisational – lack of support from management and colleagues, valuing research/research culture.

To overcome these barriers EHPs must feel that embracing an evidence-based environmental health approach provides personal benefits as well as benefits for their institutions/organisations. Because EBP contributes towards the promotion and dissemination of good practice, it offers opportunities for personal (reflective practice), professional and career development; increasing the profile of environmental health departments and organisations and the potential for future funding.

If the profession is to adopt an evidence-based environmental health approach, barriers for EHPs must be clearly identified and addressed. Undoubtedly this will require a change of culture for organisations as well as practitioners and necessitate support (financial, time, resources). An evidence-based environmental health will enable practitioners to communicate the efficacy of environmental health, whether that is to chief executives of companies, the elected members of local authorities, stakeholders, government or the general public and in my opinion, regardless of the difficulties facing institutions and individuals, is an opportunity not to be missed.

The *Journal of Environmental Health Research* provides an excellent outlet for evidence-based environmental health. The editorial board is committed to encourage contributions improving the environmental health practice and continues to provide support for practitioner wishing to disseminate results of projects, reviews, professional reflections/evaluations, and technical notes that provide critical insights into practice issues.

Guest editorial

Stephen Battersby
President of the CIEH

I am delighted to be invited to write a guest editorial for the *Journal of Environmental Health Research* (JEHR) as one of my last tasks as President of the CIEH. I have always been keen to support the Journal and it is one of my disappointments that more members of the environmental health profession in these islands have not made use of it. It can be a vicious circle; those colleagues undertaking research want to be published in a higher profile journal, yet the profile of JEHR will not be raised until even more high quality papers are submitted and the necessary resources are put into making it more widely referenced and used.

Research and evidence provided by research and the publication of papers, including on practice issues, is an essential prerequisite for the CIEH to be able to argue its case and to meet the object for which it exists. Use of such evidence is also necessary for individual members to be effective advocates for change both within organisations and communities. It supports environmental health practioners in advocating better or different ways of addressing environmental health hazards, health inequalities and health inequity whether at home or beyond these shores. This is particularly true when it comes to the proposed changes to the public health structures in England and the role of local government.

It is unfortunate that within the CIEH there has been a rather spasmodic commitment and incoherent approach towards research. To me, this should be a priority issue. There has been no real research strategy or recognition of the need until recently. Without a positive commitment by the new CIEH Board of Trustees and the Assembly of Representatives, it will continue to be the case that research and publication remains a peripheral issue. Evidence that comes from published work is essential for the CIEH to be an effective body that promotes "for the public benefit the theory and science of environmental health in all its aspects and the dissemination of knowledge about environmental health".

The positive thing is that now there is some movement on this. The Joint Education & Professional Standards Board & Policy Development Board in the autumn of 2011 agreed to establish a task and finish group to develop a coherent CIEH research policy. I am pleased to be chairing this. The Group, among other things, aims to develop a research and publishing mentoring scheme in partnership with both CIEH accredited and other universities where environmental health research is undertaken (such as at Surrey University for example, a recent Queen's Anniversary Prize winner for global work on improving access to safe drinking water and sanitation). The aim is to find ways of re-establishing JEHR as an outlet for research for all environmental health practitioners. The Task Group is due to report in April 2012.

Of course, there is already an Education and Research Special Interest Group with a remit to provide a focal point within the environmental health community, both nationally and internationally, for the advancement of learning, training and research. The Task Group has the job of identifying how the various initiatives can complement each other. Members of the E&R SIG have to be seen as a resource for the CIEH generally and for those at CIEH headquarters in particular. Neither can afford to be introspective. There must be greater collaboration and co-operation over a range of related policy issues. A key objective of the SIG is to advance research capabilities within environmental health to ensure the development of an evidence base for practice including supporting an annual research conference. This is to be encouraged.

A review of captive exotic animal-linked zoonoses

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Abstract

Captive exotic animal-linked zoonoses are part of a major global emerging disease problem. Exotic animals are notably represented in the pet trade, zoos, and to a far lesser extent in circuses, with exotic pets being the primary concern. Combined, in the UK there may be approximately 42 million exotic pets (including fishes) in private homes, an unknown number in zoos, and in circuses less than 40 individuals. A wide range of species is involved, and a large and expanding array of potentially pathogenic agents. Sixty-one percent of human diseases have a potentially zoonotic origin and 75% of global emerging human diseases have a wild animal link.

Exotic pets in particular may represent a source of largely unrecognised and unrecorded microbes and macroparasites in the domestic environment. Pet markets constitute an especially high risk of infection and these risks are fundamentally uncontrollable. Future guidance may include advising against keeping exotic animals as pets unless excellent monitoring for diseases and essential husbandry practices are pursued. Zoos and circuses also involve zoonotic risks but may be relatively low because public visits and exposure are infrequent.

The prevalence of exotic animal-linked zoonoses in the UK is unknown. Many cases of zoonotic disease are probably misdiagnosed as other conditions and under-reporting in general is a likely major factor in under-ascertainment of cases. In addition, border and domestic biosecurity is lacking. New guidance on zoonoses monitoring, prevention and control is included as well as upgraded public health guidance that emphasises special caution against over-reliance on hand washing and other widely recommended measures.

Animal facilities should be required to provide independently sanctioned guidance on health risk and maintain strict record-keeping that includes detailed animal inventories, treatment data and post-mortem reports as well as pet purchaser details to assist in contact tracing in the event of outbreaks. Local authorities should also liaise with animal facilities to develop obligatory zoonotic disease response plans.

Key words: *Exotic pets, zoos, circuses, zoonoses, disease, prevention, control*

Introduction

Captive exotic animals are notably represented in the pet trade (and keeping) and in zoos, and to a far lesser extent in circuses. Combined, in the UK there may be approximately 42 million exotic pets (including fishes) in private homes, an unknown number in zoos, and less than 40 in circuses. Actual numbers are very difficult to accurately determine owing to the poor regulation of the market and the high animal death rates, in particular for the pet trade, and generally deficient inventory keeping for zoos. The prevalence of exotic animal-linked zoonoses in the UK is unknown. However, many cases of zoonotic disease are probably misdiagnosed as other conditions and under-reporting in general is a likely major factor in under-ascertainment of cases (Warwick, 2004).

Potential health threats from captive exotics probably vary according to captive context. For example, for exotic pets direct public contact with animals and their cages and other intermediary surfaces is common, whereas for zoo and circus animals public contact is less frequent.

Zoonoses, as defined by the World Health Organisation, includes "any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa" (Anon., 2011). Some zoonoses have a long association with people. It is probable that for at least as long as humans have killed animals for food they have inadvertently contracted food-borne parasites. Since at least the Middle Ages 'the plague', tapeworm infestation and other zoonoses afflicted humans, as animals became our cohabitants either incidentally with rodents or deliberately with farmed species (Wilson and Sande, 2001; Hubálek and Rudolf, 2011).

Accordingly, zoonotic infections and infestations are not new, but today they form part of the phenomenon of emerging human diseases because they constitute a growing, and in many cases, novel health threat (Brown, 2003; Chomel *et al*., 2007; Wolfe *et al*., 2005; Zinsstag *et al*., 2007). This pathological renaissance is largely attributable to two factors, both of which can substantially be controlled. One factor is that the efficiency and economics of modern transportation offers humans convenient access to increasingly remote areas of the world – introducing people to novel environments within hours or days (Weber and Rutala, 2001; Brown, 2004). Another factor is that wild animal species are conveniently transported from distant regions of the world to the domestic market, in particular for pet purposes, again within a very short period of time.

A key difference between these two situations is that for foreign human travellers, adopting prophylactic measures is all part of responsible journeying. However, where importing exotic animals is concerned, public awareness of the potential threat they pose is very limited (Smith *et al*., 2010). Exotic pets, of course, will become a home feature and, for example, most, if not all, reptiles will be harbouring one or another potentially pathogenic agent (Warwick *et al*,. 2001; Mermin *et al*,. 2004). In effect, an exotic animal may harbour a raft of potentially infective microbes and macroparasites making any animal a possible Trojan Horse of infection and infestation (Warwick, 2006).

A survey of 1,410 human diseases found 61% to be of potentially zoonotic origin (Karesh *et al*., 2005). Also, 75% of global emerging human diseases have a wild animal link (Brown, 2004). Concern over modern zoonoses, often citing pets, has been voiced for decades, for example in Lamm *et al*., (1972) and Kahrs *et al*., (1978). The present sientific and medical literature contains a substantial number of works outlining current concerns, and again most of these appear to involve exotic pets. For example, Brugere-Picoux and Chomel (2009) state that most emerging disease in France is zoonotic with some causing unprecedented crises, and cite the exotic pet trade craze as a significant factor.

Relatedly, recent major scientific articles and reports published in the USA have emphasised that border controls do not meet the challenge of preventing incursion of zoonotic disease (as well as other threats, for example to agriculture and wildlife) from the exotic pet trade (Locke, 2004; Ehnert and Galland, 2009).

The Government Accountability Office for the United States surveyed major authorities and scientists involved in border protection and prevention and found that agencies need better collaboration to reduce the risk of animal-related diseases (GAO, 2009).

UK borders are also an imperfect membrane having, for example, performed poorly regarding avian influenza H5N1, which was significantly undetected in a consignment of imported pet birds (Anon., 2005). Fishes, amphibians and reptiles undergo no routine border quarantine. Comprehensive screening in general is either impractical or impossible and this represents a persistent biosecurity hazard for the UK. Tables 1a-d provides examples of fish, amphibian, reptile, bird, mammal, and mammal-primate-borne zoonotic infections and infestations.

Injuries (including bites and scratches), envenomations and stings from exotic pets and in other situations, including zoos, result in a small but important related animal-human health issue. National Health Service Health Episode Statistics for England conservatively indicate that between 2004 and 2010 there were 760 full consultation episodes at hospitals, 709 admissions, and 2,121 hospital bed days associated with injuries probably from exotic pets (Warwick and Steedman, submitted). Studies in France and Germany found 404 envenomation cases arising from mostly snake, fish and invertebrates between 1996 and 2006 (Schaper *et al*., 2009), although none were fatal. Many injuries, envenomations and stings may also result in infections.

Exotic pet-linked disease

By far the most significant zoonoses issue resides with the importation, trade and keeping of exotic pets. An exotic pet may be considered any animal that is non-native and non-domesticated. In England and Wales there are around 4,500 pet shops and an unknown but significant number of unlicensed commercial pet sellers (Warwick, Steedman and Lindley, 2011).

Pet Food Manufacturer's Association surveys (PFMA, 2009, 2010, 2011) including fishes, reptiles, and birds suggested that combined these animals occupy around 12.6% of UK homes and number approximately 42 million animals. Dogs and cats, by comparison, are present in around 40% of homes and may equate to approximately 16 million animals. The keeping of some exotic animals appears to be increasing dramatically. For example, between the 2009 and 2011, the number of UK homes with reptiles reached 1.6%, a rise in popularity of approximately 28% over three years (PFMA, 2009, 2010, 2011). With the possible exception of aquarium fishes, the great majority of exotics are probably maintained singularly or in very small numbers per household. An assortment of other exotic pets exists in relatively small numbers, including mammals such as civets, lions and kinkajous, and reptiles such as crocodiles.

In the USA in the 1960s and 70s pet turtles were found to be responsible for approximately 280,000 of all cases or 14% of human salmonellosis, and branded as significant and major public health hazards – a finding that resulted in a ban on small turtle sales, and a 77% reduction in the disease in the following year (Mermin *et al*., 2004). A slow re-emergence of other reptiles as pets has again resulted in raising prevalence of reptile-related salmonellosis (RRS) cases to around 70,000 or 3-5% of

	Disease	Genus of Pathogen	Source
Bacterial	Campylobacteriosis	*Campylobacter*	amphibian, reptile, bird, mammal-primate
	Endemic relapsing fever	*Borrelia*	amphibian, reptile, mammal
	Gastroenteritis	*Salmonella*	fish amphibian, reptile, bird, mammal, mammal-primate
		Staphylococcus	amphibian, reptile, bird, mammal
		Clostridium	amphibian, reptile, bird
		Escherichia	amphibian, reptile, bird, mammal
		Shigella	amphibian, reptile, mammal-primate
	Mycobacteriosis/Tuberculosis	*Mycobacterium*	fish, amphibian, reptile, bird, mammal-primate
	Salmonellosis	*Salmonella*	fish, amphibian, reptile, bird, mammal, mammal-primate
	Streptococcosis	*Streptococcus*	fish, amphibian, reptile
	Yersiniosis	*Yersinia*	amphibian, reptile, bird, mammal
	Septicaemia/general infection	*Acinetobacter*	amphibian, reptile, bird
		Alcaligenes	amphibian, reptile, bird
		Bacteroides	amphibian, reptile
		Clostridium	fish, amphibian, reptile, bird, mammal
		Citrobacter	fish, amphibian, reptile, bird, mammal
		Corynebacterium	amphibian, reptile, bird
		Enterobacter	amphibian, reptile, bird, mammal
		Enterococcus	amphibian, reptile, bird
		Fusobacterium	amphibian, reptile, mammal
		Klebsiella	amphibian, reptile, bird
		Moraxella	amphibian, reptile, bird, mammal
		Morganella	amphibian, reptile, mammal
		Pasteurella	amphibian, reptile, bird, mammal
		Edwardsiella	fish, amphibian, reptile, mammal
		Peptococcus	amphibian, reptile
		Proteus	amphibian, reptile, bird
		Pseudomonas	amphibian, reptile, bird, mammal
		Aeromonas	fish, amphibian, reptile, bird, mammal
		Serratia	amphibian, reptile, bird
		Staphylococcus	amphibian, reptile, bird, mammal
		Streptococcus	amphibian, reptile, bird, mammal
	Bartonellosis	*Bartonella*	mammal
	Pneumonia	*Klebsiella*	bird, mammal-primate
	Dermatitis	*Erysipelothrix*	fish, bird
	Psittacosis	*Chlamydophila*	bird, mammal
	Q-fever	*Coxiella*	reptile, bird, mammal
	Vibriosis	*Vibrio*	fish, amphibian, reptile, bird
	Brucellosis	*Brucella*	mammal
	Leptospirosis	*Leptospira*	amphibian, reptile, bird, mammal

Table 1.0a
Example exotic animal zoonotic infections and infestations – bacterial.
Derived from: Krauss (2003); Hubálek and Rudolf (2011); Weese and Fulford (2011); Frye (unpublished); Warwick (2006); Bridges et al., (2001); Chai et al., (2005), others.

Table 1.0b
Example exotic animal zoonotic infections and infestations – viral. Derived from: Krauss (2003); Hubálek and Rudolf (2011); Weese and Fulford (2011); Frye (unpublished); Warwick (2006); Bridges et al., (2001); Chai et al., (2005), others.

	Disease	Genus of Pathogen	Source
Viral	Hepatitis-A	*Picornavirus*	amphibian, mammal-primate
	Western encephalitis	*Togaviridus*	amphibian, reptile, bird
	West Nile virus	*Flaviviridus*	amphibian, reptile, mammal-primate
	Herpesvirus simiae-B	*Herpesvirus*	mammal-primate
	Monkeypox	*Poxviruses*	mammal-primate
	Molloscum contagiosum	*Poxviruses*	mammal-primate
	Measles	*Rubeola*	mammal-primate
	Rabies	*Rhabdoviris*	mammal, mammal-primate
	Haemorrhagic fever	*Marburg*	mammal-primate
	Avian influenza	*AIV H5N1*	bird
	Newcastle disease	*Paramyxovirus*	bird mammal
	Cowpox	*Orthopox*	mammal

Table 1.0c
Example exotic animal zoonotic infections and infestations – mycotic and allergen. Derived from: Krauss (2003); Hubálek and Rudolf (2011); Weese and Fulford (2011); Frye (unpublished); Warwick (2006); Bridges et al., (2001); Chai et al., (2005), others.

	Disease	Genus of Pathogen	Source
Mycotic	Coccidiomycosis	*Coccidioides*	amphibian, reptile, mammal
	Cryptococcosis	*Cryptococcus*	amphibian, reptile, bird
	Septicaemia	*Candida*	amphibian, reptile, bird
	Streptothricosis	*Dermatophilus*	mammal-primate
	Candidiasis	*Candida*	mammal-primate
	Ringworm	*Trichophyton*	mammal, mammal-primate
	Histoplasmosis	*Histoplasma*	bird, mammal
Allergen	Allergic alveolitis	*Avian antigen or mycotic spore?*	bird

all salmonelloses in the USA, and has again incurred warnings of health risks (Woodward *et al*., 1997; Mermin *et al*., 2004). Amphibian and reptile-keeping in the USA may involve approximately 9-11 million animals (APPA, 2005), whereas in the UK the figure is probably fewer than one million animals (PFMA, 2010).

Aitken *et al*., (2010) estimate that RRS may account for 1% or 1,160 cases in the UK annually. A study in Sweden (Hoelzer, Moreno-Switt and Wiedmann, 2011) that focused on data between 1990 and 2000 suggested that RRS there may have constituted around 5% of all cases of the disease and conclude that direct or indirect exposures to reptiles clearly represent a substantial risk to human health. The Hoelzer, Moreno-Switt and Wiedmann's (2011) findings closely resemble the USA experience and may suggest that the UK data are an underestimate. A case control study in 2009 indicated that reptile keepers in the UK were nearly 17 times more likely to get sick than those who had no contact with these animals (HPA, 2009a).

Attempts by the pet industry to eradicate Salmonella from reptiles were unsuccessful and led to the emergence

	Disease	Genus of Pathogen	Source
Micro-parasitic	Amoebiasis	*Entamoeba*	amphibian, reptile, mammal-primate
	Cryptosporidiosis	*Cryptosporidium*	fish, amphibian, reptile, bird
	Giardiosis	*Giardia*	mammal, mammal-primate
	Toxocariasis	*Toxocara*	mammal
	Schistosomiasis	*Schistosoma*	bird, mammal
	Scabies	*Sarcoptes*	mammal
Macro-parasitic	Sparganosis	*Diphyllobothrium*	fish, amphibian, reptile, bird, mammal
	Dracunculosis	*Dracunculus*	amphibian, reptile
	Fascioliasis	*Fasciola*	amphibian, reptile
	Larva migrans	*Gnathastoma*	fish, amphibian, reptile, mammal
	Loaiasis	*Loa*	amphibian, reptile
	Strongyloidiasis	*Strongyloides*	mammal, mammal-primate
	Hymenolepis	*Hymenolepsis*	mammal-primate
	Clonorchiasis	*Clonorchis*	fish
	Metorchiasis	*Metorchis*	fish, bird, mammal
	Heterophyidiasis	*Heterophyes*	fish, bird, mammal
	Echinostomiasis	*Echinostoma*	fish, bird, mammal
	Anisakiasis	*Anisaki*	fish
	Baylisascariasis	*Baylisascaris*	mammal
	Neuro-angiostrongyliasis	*Angiostrongylus*	mammal

Table 1.0d
Example exotic animal zoonotic infections and infestations – micro- and macro-parasitic. Derived from: Krauss (2003); Hubálek and Rudolf (2011); Weese and Fulford (2011); Frye (unpublished); Warwick (2006); Bridges et al., (2001); Chai et al., (2005), others.

of antibiotic resistant strains of the bacteria (Mermin *et al*., 2004). Methicillin-Resistant *Staphylococcus aureus* (MRSA) has also been isolated from many animals, including exotic pets (Weese, 2010).

Aleksandra *et al*., (2011) investigated 949 wild-caught and captive-bred reptiles imported into Slovenia from 2000 to 2005, and 68 different species for the presence of endo- and ectoparasites. In 26 (representing 47.3%) snakes, the authors identified 12 different groups including nematodes, trematodes, acanthocephalids, pentastomids and protozoans along with two different species of ectoparasites; in 252 (76.1%) lizards 18 different groups were identified including nematodes, cestodes, trematodes, acanthocephalids, pentastomids and protozoans. One trombiculid ectoparasite was also found. In 498 (88.5%) turtles, eight different groups including nematodes, nestodes, trematodes and protozoans were determined in animals. Three different species of ectoparasites were also observed in turtles.

Inoue *et al*., (2009) evaluated 546 small mammals of 28 species imported into Japan as exotic pets and identified isolates from 407 as *Bartonella* spp. of which four were zoonotic. Kasickova *et al*., (2009) studied 287 faecal specimens of captive exotic Psittaciformes, Passeriformes and Columbiformes birds purchased randomly from pet stores, avian breeders and keepers and screened for the parasite *Microsporidia* spp. and identified the organism in 40.1% of faecal samples.

The natural carriage of potentially pathogenic organisms and particles by exotic animals is possibly augmented by the introduction of supplementary microbes, for example bacteria, in the captive animal diet – which may then be propagated in the pet animal gut and later shed with magnified importance (Taormina, 2000; Hoelzer, *et al*., 2011).

Exotic pet keeping involves both overt and covert threats to public health. As with many risks, vulnerable

groups including children under five, the immunocompromised, and the elderly are at greater risk, but healthy young people are also affected. While the risk of some cases of potential infection can be reduced with conscientious attention to hygiene and other animal management protocols, in the domestic environment exotic pet keeping represents a continuous risk with no absolute resolving recommendation other than discouraging the practice.

The UK has issued formal warnings and guidance for over 10 years about health risks associated with reptile keeping (for example, Ward, 2000; HPA, 2009b. Despite repeated efforts at public education reptile-related salmonellosis cases continue to rise, and following a run of RRS cases in children in northern England in 2010, the HPA reiterated its 2009 guidance (HPA, 2009b).

Wildlife (pet) markets

The selling of exotic pets at pet fairs or wildlife markets is unlawful in the UK. However, some events remain, and for this reason, as well as the fact that UK citizens attend wildlife markets abroad, we briefly include them here. Pet markets have been highlighted as a significant risk to public health for several reasons. A large number and wide variety of species are held in close-confinement and this results in both stress for animals (which increases their own susceptibility to pathogens), as well as the opportunities for shedding, mixing and dissemination of potential pathogens. Furthermore, public direct and indirect contact with animals of uncertain origin and health state introduces a significant risk factor. Also, person-to-person contact is common and invites incidental microbial dissemination (Warwick, 2006).

A limited study of seven door handles at a major pet market in Germany in 2010 revealed two positive species of salmonella, S. *ramatgan* and S. *subspecies* V (PETA unpublished), both of which are reptile-associated. A detailed investigation of key European pet markets in 2011 (Arena, Steedman and Warwick, 2012) assessed visitor behaviour and public health implications and found that five-minute observation periods indicated that 3.6% of visitors had direct contact with animals and 27.3% had indirect contact, that is, contact with a presumed contaminated source, with subsequent modes of contact being 18.7% hand to mouth, 52.2% hand to body, and 19.9% person to person. Pet markets constitute an especially high risk of transmission of infectious agents to the public and these risks are fundamentally uncontrollable.

Zoo animal-linked disease

In the UK there exists 100 British and Irish Association Zoos and Aquariums (BIAZA) and possibly 245 non-BIAZA facilities (BIAZA, pers. comm.) holding an unknown number of animals. However, the Zoological Society of London, which is a large zoo, for example holds 18,499 animals (ZSL, 2011).

Publically accessible animal collections are described diversely as zoos, zoological gardens, safari parks, petting zoos, and farms. Some are distinctly identifiable as traditional zoos while others are less easily categorised. Given the sometimes loose structure of these facilities we will apply a relatively broad view. There appears to be little data on confirmed zoonoses from UK animal collections. However, numerous zoonotic incidents and outbreaks are associated with public visits to zoos.

Bender and Shulman (2004) reviewed and surveyed state public health veterinarians and epidemiologists in the USA and found that 11 published outbreaks of zoonoses had been identified as related to zoos, and farms, whereas an additional 16 unpublished outbreaks or incidents were identified unofficially. Also, most states had no formal guidance of zoonoses prevention and control. A tuberculosis outbreak affected seven handlers associated with rhinoceroses and monkeys in Louisana (Stetter *et al*., 1995). A salmonella-contaminated wooden handrail surrounding a Komodo dragon exhibit at a Colorado zoo in 1996 caused an outbreak of salmonellosis involving 65 confirmed cases and possibly several hundred unconfirmed cases (Friedman *et al*., 1998). Oh *et al*., (2002) found that 55 zoo employees showed evidence of *Mycobacterium* (tuberculosis) presence, although none had the active disease.

In a study of primates, carnivores, perissodactyls, artiodactyls and proboscideans at two Italian zoos, Fagiolini *et al*., (2010) found one or more intestinal parasites were present in 61.5% of samples, including *Cryptosporidium* spp., *Toxocara* spp., and *Strongyloides* spp., and concluded that zoonotic protozoans and gastrointestinal helminths are common in zoo mammals. Beck *et al*., (2011) studied 131 faecal samples of 57 mammalian species at Zagreb Zoo for the presence of *Giardia* spp. and found prevalence to be 29%, while all animals were asymptomatic. In another study of *Giardia* spp. among zoo primates in Spain, Martinez-Diaz *et al*., (2011) obtained 20 faecal samples from 16 species of which 70% were positive. Levecke *et al*., (2007) analysed 910 faecal samples from 222 primates of 31 species in four zoos and found the protozoans *Entamoeba* spp. and

Giardia spp. prevalence to be 44% and 41% respectively. Ledwon *et al*. (2008) examined 425 zoo parrot faecal samples for the presence of *Mycobacterium* spp. and found 73 samples to be positive, although the subtypes were mostly of moderate human pathogenicity. A Danish study identified 43 typically exotic salmonella serovars, mostly from zoo reptiles (Pedersen *et al*., 2009).

A study of 60 workers at an Austrian zoo screened for the prevalence of antibodies against selected zoonotic agents found markers indicating that 97% of individuals had been exposed to at least one zoonotic agent, although in some cases exposure may have been owing to situations outside the zoo environment (Juncker-Voss *et al*., 2004).

Petting zoos

Petting zoos are either autonomous animal collections or sections of larger facilities where the public, often children, are granted direct access to animals. While some are formally defined, others are arbitrary arrangements within events such as animal shows. Domesticated and farm animals are commonly present, but often exotic species including tortoises, lizards, snakes and llamas are also available.

Keen *et al*., (2007) report that in the USA since 1999 there have been at least 17 agricultural fair, petting zoo, or open farm related *Escherichia coli (E. coli)* outbreaks, affecting 1,317 people and resulting in 69 hemolytic-uremic syndrome cases and two deaths.

The variety of 'petting' species involved implies potentially diverse microbial and macroparasite threats, for example, Salmonellosis and other gastroenteric disorders (*Salmonella spp., E. coli*), *Cryptosporidium* spp. Q-fever (*Coxiella* spp.), tuberculosis (*Mycobacterium* spp.), ringworm (*Trichophyton* spp.), and threadworms (*Strongyloides* spp.), and the direct contact nature of these events is a notable concern (Chomel *et al*., 2007). A study by Keen *et al*., (2007) of *Salmonella enterica* and Shiga-toxigenic *E. coli* O157 among 997 subclinical animals at 36 contact exhibits in Association of Zoos and Aquariums-accredited facilities in the USA found that prevalence was less than 0.6%, although these findings relate to a small number of potentially pathogenic bacterial agents.

Circus animal-linked disease

The UK is thought to have eight circuses holding fewer than 40 exotic animals (Captive Animals Protection Society, pers. comm., 2011). Exotic animals present in circuses include elephants, llamas, camels and other large mammals as well as some large reptiles, for example pythons and crocodiles, and public access to circus animals is sometimes permitted under supervision. Nevertheless, a range of reptile- and mammal-borne infections and infestations are associated with circus animals, perhaps most notably tuberculosis (Michelak *et al*., 1998) and cowpox (Hemmer *et al*., 2010; Hubálek and Rudolf, 2011).

With regards to circuses, handlers are probably most at risk, and in one outbreak, twelve animal handlers in Illinois contracted tuberculosis from infected elephants (Michelak *et al*., 1998). Contact with reptiles including pythons and crocodiles involves the potential risk of many bacterial infections, most notably salmonellosis (Mermin *et al*., 2004).

Prevention and control of disease

Healthcare providers are generally poorly informed regarding the potential threats from zoonoses (Rosen and Jablon, 2003), which is particularly disturbing given the relative prevalence of, in particular, exotic pet keeping. Under-ascertainment and misdiagnoses of zoonoses are probably frequent in part because healthcare professionals fail to ask pertinent questions regarding household habits and fail to distinguish zoonotic disease from superficially similar common conditions (Warwick, 2004). For example, it is highly likely that the true number of reptile-related salmonellosis is underestimated through cases being incorrectly attributed to contaminated or inadequately cooked food products, a more commonly recognised route of transmission.

While some zoos are encouraged to formulate both public and occupational health plans to prevent zoonoses (Roberts, 1995) and several protocols are in place around the world, for example, Miller (2011), HSE (2011), the exotic pet and circus industries appear less well prepared. The UK has general guidelines for investigating of zoonotic disease (HPA, 2009c).

There are at least two examples of husbandry-related legislation that, when properly enforced, may help to prevent the spread of zoonoses – the Dangerous Wild Animals Act 1976 (DWAA) and the Zoo Licensing Act 1981 (ZLA). The DWAA was introduced to ensure that potentially dangerous animals pose no risk to the public, although pet shops themselves are exempt from the regime. The ZLA is a quality assessment requirement for zoological collections in Great Britain. Both these Acts are regulated via local authority licensing. While there may be

clear potential for both the DWAA and the ZLA to reduce zoonotic risks, the lack of historical and current epidemiological data precludes assessment regarding the possible contributions offered by these legal frameworks.

Contamination, hygiene and hand washing

For several years formal advice has been issued in order to reduce public exposure to zoonotic disease, in particular, reptile-related salmonellosis. Some of this advice has attempted to balance reptile-keeping with hygiene measures, for example an information leaflet jointly produced by the Department of Health, Department of Environment Food and Rural Affairs and the Health Protection Agency (HPA, 2009b).

A key feature of current advice involves recommending hand washing as a protection against infection and transmission. Another example is that advice issued by some local authorities to organisers of some animal shows has included the use of disinfectant sprays and gels as part of disease prevention and control. However, in relation to farm visits, for example, the Health Protection Agency (UK) importantly points out that disinfectant sprays and gels are not wholly reliable materials for cleansing hands and safeguarding against infection, and recommend additional thorough hand washing with soap and water as improved protection (HPA, 2011).

Hand washing has been shown to have positive health benefits and save lives from infectious disease. Two factors are theoretically involved in hand washing – direct removal of unwanted material and the neutralisation of active microbial agents.

There are numerous studies monitoring and comparing the efficacy of different hand washing methods (for example, rubbing hands and non-rubbing hands) and chemical sanitisers (for example, alcohol, plain soap, and antibacterial soap) (Doebbeling *et al*., 1988; Girous *et al*., 2002; Fischler *et al*., 2007; Grayson *et al*., 2009; Jabbar *et al*., 2010) and this research shows varying degrees of reduction in bacterial density on relevantly treated hands.

However, a key yet often-overlooked result is that although hand washing typically achieves varying *reductions* in microbial density it does *not eliminate* potential pathogens. This equates to a reduction but *not* elimination in risk or protection from disease.

Hand washing as a recommendation is also well known to be poorly adhered to and performed, and compliance among even professional healthcare workers rarely exceeds 40% (Trampuz and Widmer, 2004). This does not inspire confidence in animal-related personnel or the public adopting stringent hand washing even where advised to do so.

Surgical gloves offer another well-recommended mechanism for reducing contamination, although again this does not offer complete protection as microbes have been shown to penetrate this barrier and contaminate underlying skin (Doebbeling *et al*., 1988). Indeed, glove microbial leakage is known to attain 4% to 63% for vinyl and 3% to 52% for latex (Larson, 1995) – making further disinfection of hands essential even where gloves have been used.

Simply, hand washing as generally practised does not provide reliable protection against animal-borne contaminants. While an understandable recommendation, hand washing – with and without disinfectant gels and sprays – may generate undue over-reliance and misplaced confidence regarding disease prevention and control, and this may lead to infection from complacency (Warwick, Lindley and Steedman, 2011).

In order to safely cleanse human hands rigorous cleansing with powerful antimicrobials comparable to pre-theatre surgery protocols are required. Such measures are practically impossible in the domestic environment. Also, theoretically cleaned hands likely remain at least residually contaminated and easily capable of spreading microbes over diverse surfaces including an individual's clothes, hair, and skin, as well as inanimate objects and other people around them (Warwick, *et al*., 2001). Further, surgically-cleansed hands remain liable to rapid re-contamination via momentary contact with any previously contaminated source (Warwick *et al*., 2001).

No level of hand hygiene offers protection to human skin against scratches and bites from animals. Relatedly, direct contact between any animal and open human lesions, such as sores, or via debris reaching the human mouth, eye or ear are additional potential routes of infection (Warwick *et al*., 2001). Aquatic animals may quickly contaminate large volumes of water – resulting in risks from splashes, droplets, and smears.

In brief, hand washing, with gels, sprays and domestic soaps is not a reliable method of preventing animal-borne human infection and great caution is required on how such advice is presented in future.

Zoonosis/condition	Source	Signs & symptoms
Salmonellosis/gastroenteritis	Fish, amphibian, reptile, bird, mammal	Nausea, vomiting, diarrhoea, abdominal cramps and pain, fever, painful joints, meningitis, flu-like
E. coli infection/gastroenteritis	Amphibian, reptile, bird, mammal	Nausea, vomiting, diarrhoea, abdominal cramps and pain, fever, painful joints, meningitis, flu-like
Campylobacteriosis/astroenteritis	Amphibian, reptile, bird, mammal-primate	Nausea, vomiting, diarrhoea, abdominal cramps and pain, fever, painful joints, meningitis, flu-like
Leptospirosis	Amphibian, reptile, bird, mammal	Flu-like, vomiting, icterus, telangiectasia, uveitis, splenomegaly, meningitis
Psittacosis	Bird, mammal-primate	Flu-like, pneumonia, fever, cough
Vibriosis	Fish, amphibian, reptile, bird	Gastrointestinal, pain, vomiting, fever, otitis
Lyme disease/bartonellosis	Mammal	Flu-like, fever, rash, gastrointestinal
Toxocariasis	Mammal	Eye problems
Giardiasis	Mammal-primate	Gastrointestinal, fever, nausea, fatigue, weight loss
Tuberculosis	Fish, amphibian, reptile, bird, mammal-primate	Respiratory, flu-like, fever, weight loss
Q-fever	Reptile, bird, mammal	Fever, flu-like
Cryptosporidiosis	Fish, amphibian, reptile, bird	Acute gastrointestinal disturbance, nausea, vomiting, pain, fever, flu-like
Macroparasite infestation	Fish, amphibian, reptile, bird, mammal, mammal-primate	Gastrointestinal disturbance, abdominal cramps and pain, weight loss, flu-like
Ringworm	Mammal, mammal-primate	Patchy skin, inflammation, itching
Allergic alveolitis	Bird	Persistent dry cough, chest irritation

Table 2.0
Common zoonoses signs and symptoms. If experiencing these indicators report to a healthcare professional. These are a small sample of relatively common animal-to-human diseases.

Important: The onset of signs and symptoms of an animal-related disease may occur within hours or not for several weeks or months following exposure to an exotic animal. Most cases of diseases are not serious, but it is important to report any suspicion of having an animal-linked disease because treatment may vary from regular illnesses and early access to medical help can alleviate greater problems as well as assist health workers provide best advice.

Conclusions and recommendations

Of the three primary subjects considered in this report, exotic pets, zoos, and circuses, we have no reservations in stating that the overwhelming evidence shows that by far the greatest potential threat to human health resides with the trade in and keeping of exotic animal pets. Not only are exotic pets well established as sources of diverse pathogens, direct and indirect contact associated contamination, and significant and major sources of human disease, but their increasingly ubiquitous occupation in the home presents close-quarter and enduring risk factors. Further, poor understanding of risk factors throughout the trade and keeping chain, which sometimes continues into the healthcare and public health professions, sets exotic pet keeping apart as an important threat to public health.

Table 3.0
Possible useful standard-setting questions to ascertain source of infection. (Reproduced from Warwick 2004).

a	recently consumed foods (and their condition)
b	visits to restaurants
c	foreign travel
d	visits to hospital
e	visits to farms
f	visits to zoos and other wildlife centres
g	visits to a pet shop
h	whether the patient household possesses any pets
i	whether the patient has visited a household that possesses pets
j	whether in particular in c-g above, the patient or others in the household may have had direct or indirect contact with persons or inanimate material from these categories

Both zoo animal populations and public attendance at zoos are substantial, and zoonotic episodes and outbreaks are known from direct and indirect contact with animals. Wherever possible direct human contact with zoo animals should be avoided. Where no direct public-animal contact is involved a potential risk remains from possibly contaminated intermediary areas and surfaces to which the public have access. However, although many people visit zoos, attendance is occasional and thus involves relatively low exposure to zoonotic risk. Exposure to zoonotic threats as encountered in zoos should, however, be treated as significant, and continuous awareness of zoonoses should be maintained for zoo personnel as well as greater education regarding public attendees.

Public attendance at circuses too can be considerable, and zoonotic episodes and outbreaks are known from direct and indirect contact with circus animals. While the number of animals in circuses may be relatively low, microbial dissemination to wider areas, including discrete locations (as for pet and zoo scenarios), should be presumed, causing all publically accessible areas to be potentially contaminated.

The fact that data on cases and prevalence are sparse should not be presumed to indicate that actual prevalence is low. Our view is that zoonoses are stealthy infiltrative infections and infestations that are probably pervasive and masked by under-reporting and misdiagnosis.

Education

We recommend that all pet shops, zoo-animal sections, and circuses maintain a 'zoonoses signs and symptoms' chart to increase awareness and offer early alert to personnel for possible infections and infestations (see Tables 1a-d and 2). Local authorities may wish to improve their own awareness of zoonoses monitoring (see Table 3). A simplified point of contact or sale 'take-away' awareness and guidance notice should be provided to all public attendees on entry to any pet shop, zoo or circus (see Figures 1 and 2).

Future guidance may include advising against keeping exotic animals as pets unless excellent monitoring for diseases and essential husbandry practices are pursued, as well as offer clear and uninhibited instruction on disease prevention and control so that people attending animal centres or purchasing animals are well informed of potential risks.

Record-keeping

While zoos often maintain good inventories of all animals, their histories, morbidities, treatment and mortalities, the same cannot be said of pet shops. This lack of self-monitoring is concerning because not only can this facilitate the unchecked spreading of disease, but also zoonotic outbreaks may not be preventatively intercepted. Accordingly, we recommend that all pet shops, zoos and circuses maintain comprehensive inventories including: all animals 'in and out'; full morbidity and treatment records; post-mortem reports for deceased individuals where recommended by a veterinary surgeon; and a list of all suppliers of animals to as well as all purchasers (or other acquirers) of animals from any animal centre. This, more comprehensive and responsible approach to dealing with prevention of

EXOTIC PETS

HYGIENE AND CAUTIONS

IMPORTANT: Hygiene measures, such as hand-washing, where performed thoroughly and with correct chemicals, can significantly reduce the amount of germs on your hands but *does not* guarantee protection against becoming sick or remove the possibility of passing germs directly or indirectly to others.

Advice included here can help to *reduce* but not *eliminate* the risk of contracting illness from exotic pets.

Ownership of exotic as pets such as fishes, amphibians, reptiles, birds, and mammals such as raccoons and primates involve special risks to the health of animal keepers and to the health of those around them. *It is not advisable to keep exotic animals as pets*. Many people, however, already have exotic pets, and this most likely causes thousands of cases of human illness annually and occasional deaths.

It is important to note that because exotic pets occupy the home, and that germs are easily spread around surfaces, walls, door-handles, clothes and other items, even thoroughly cleaned hands can quickly become contaminated again by simple contact with any of these items. Pet stores and the people who work there should also be regarded sources of contamination. Thorough cleaning of exotic pet-related germs from the home may be practically impossible.

- *Children should be supervised so that they do not put their mouths close to or kiss exotic animals.*
- *Do not eat, drink or smoke whilst handling an exotic animal.*
- *Always wash your hands thoroughly after touching or handling any exotic animal, their cage or any other equipment.*
- *Dispose of waste water and droppings from exotic pets down the toilet – and not in the sink or bathtub.*
- *Always wash your hands immediately and thoroughly after feeding your exotic pet and after handling raw (including frozen or defrosted) mice, rats and chicks.*
- *Ensure that all surfaces that come into contact with exotic pet animals, (including areas that you may have touched), and raw or defrosting exotic animal food are cleaned thoroughly afterwards.*
- *Do not use kitchen sinks to bathe exotic pets or to wash their cage or equipment. If you use a bathroom sink or bathtub, it must be cleaned thoroughly with disinfectant afterwards.*
- *It is strongly advised that anyone handling an exotic animal or an object that may have been in contact with an exotic animal should wash their hands immediately and thoroughly afterwards. First use antibacterial soap and water, taking care to rub hands vigorously together, being careful to clean all areas. Second, apply an alcohol-based cleaning agent.*
- *If you touch any exotic animal, avoid further touching your hair, clothes (including pockets), doors and other items (including car doors, steering wheels and gear change levers) until you have thoroughly cleansed your hands.*
- *Thoroughly cleaning hands is particularly important before touching or feeding a baby or young child. Not to do so would pose a strong health risk to the infant.*
- *Local authorities, doctors, vets facility managers should advise their patients and customers of the health risks associated with having an exotic animal as a family pet and should provide appropriate health protection advice.*

Figure 1.0
Avoiding animal-linked disease associated with exotic pets

Figure 2.0
Avoiding animal-linked disease associated with zoos, petting zoos, open farms, and circuses

ZOO ANIMALS, PETTING ZOO ANIMALS, OPEN FARM ANIMALS, AND CIRCUS ANIMALS

HYGIENE AND CAUTIONS

IMPORTANT: Hygiene measures, such as hand-washing, where performed thoroughly and with correct chemicals, can significantly reduce the amount of germs on your hands but *does not* guarantee protection against becoming sick or remove the possibility of passing germs directly or indirectly to others.

Advice included here can help to *reduce* but not *eliminate* the risk of contracting illness from zoo animals, petting zoo animals, open farm animals, and circus animals.

Some zoos, petting zoos, open farms, and circuses allow public contact with animals. It is important to note that the animals, their handlers and the general environment around them including fences, stand-off barriers, seats, and other common and even remote areas can harbour germs, and even thoroughly cleaned hands can quickly become contaminated again by simple contact with any of these items.

Because visits to these centres are infrequent and exposure to animals often minimal, risks of contracting animal-linked diseases are relatively low, but must not be overlooked.

- *Children should be supervised so that they do not put their mouths close to or kiss exotic animals.*
- *Do not eat, drink or smoke whilst handling an animal.*
- *It is strongly advised that anyone handling an exotic animal or an object that may have been in contact with an exotic animal should wash their hands immediately and thoroughly afterwards. First use antibacterial soap and water, taking care to rub hands vigorously together. Second, apply an alcohol-based cleaning agent.*
- *If you touch any exotic animal, avoid further touching your hair, clothes (including pockets), doors and other items (including car doors and steering wheels and gear change levers) until you have thoroughly cleansed your hands.*
- *Thoroughly cleaning hands is particularly important before touching or feeding a baby or young child. Not to do so would pose a strong health risk to the infant.*
- *Local authorities, doctors, vets facility managers should advise their patients and customers of the health risks associated with visiting zoos, petting zoos and open farms and should provide appropriate health protection advice.*

disease will greatly assist in contact-tracing members of the public in the event of a zoonotic outbreak being linked to that facility.

Inspection and monitoring

Local authority (LA) health inspectors have an important role in the recognition of potential disease outbreaks and their sources. Table 3, originally published as advice to General Practitioners, is equally valid for LA inspectors reporting on suspect conditions.

Local authorities may wish to liaise with pet shops, zoos and circuses, and perhaps also animal rescue centres, and enquire whether they hold existing protocols for the control of zoonoses, and where in-situ ascertain whether upgrades are needed. Zoonoses prevention and control protocols should be obligatory. Again, some of the material in this report may assist with template-formation for upgrading (or instituting) protocols.

Local authorities should periodically observe animal facility hygiene protocols and their advice to the public as well as

conduct periodic microbiological analyses of facilities for the prevalence of potentially pathogenic agents.

Hygiene protocols

We consider that formal advice on contact with exotic animals requires urgent upgrading. LAs should emphasise that while thorough hand-washing with antimicrobial chemicals may help to reduce the risk of infection, the process itself neither guarantees clean hands nor protects against rapid recontamination from proximal items and surfaces and thus does not offer reliable protection against animal-borne disease. Hand washing may be of minimal or negligible efficacy where continuous exposure to contamination sources is involved, for example with exotic pets in the domestic environment. While there is strong evidence implicating exotic pet keeping as a major public health hazard, further research is needed into possible prevalence of zoo-, petting zoo- and circus animal-acquired zoonoses.

Develop a zoonotic disease response plan

As per Locke's (2004) recommendations, which we have adapted for the UK, environmental health services in consultation with the Department of Health and centres for disease control and prevention, should work with interested parties including private organisations, research institutions, health care providers, and veterinarians to develop a zoonotic disease response plan. A response plan should be a dynamic resource that can be readily changed as circumstances require.

Threats to public health from zoonotic risks increase in relation to the level of exposure to potential pathogens and transmission opportunities. Greater numbers of animals and diversity of species incur significantly increased risk of human infection and infestation diseases. Accordingly, local authorities may wish to consider modifying facility operators' license conditions to include greatly restricting the numbers of animals and types of species that can be held or sold.

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Evaluation of indoor breeding activities of mosquitos during the dry season in Abeokuta, Southwestern Nigeria

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Abstract

Mosquitoes have temporal and spatial habitat distributions and a full understanding of the breeding habitats is important in planning effective anti-mosquito control measures. This study was carried out to present information on the indoor breeding activities of various species of mosquitoes as compared with outdoor breeding activities during the dry season in Abeokuta, Nigeria. Three replicates of four test-containers: bamboo stump, clay pot, plastic and tin were placed indoors and replicated outdoor (as control) for the experimental design in four selected sites within Abeokuta metropolis between January and March 2010. Of the six species encountered, *Aedes aegypti* constituted the most abundant species (62%) that bred indoors followed by *Culex quinquefasciatus* (28%). Other species in decreasing order of abundance are *Eretmapodite chrysogaster* (5%), *Culex tigripes* (2.80%), *Aedes albopictus* (1%) and *Aedes vittatus* (1%). There was variation in the number of larvae and mosquito species collected in both outdoor and indoor experimental design, but the difference was not statistically significant ($p>0.05$). Bamboo stump harboured the highest number of mosquito larvae and species in both indoor (48%) and outdoor (83%) collections while the tins recorded the least. The breeding of mosquito vectors in indoor and outdoor containers suggests the need for public health enlightenment on the danger inherent on indiscriminate disposal or stack-up of containers and improper storage of water in and around the house.

Key words: Mosquito larvae, indoor breeding, receptacles, dry season, Nigeria

Introduction

Mosquito-borne diseases remain the leading health problem and it is estimated that at least 500 million people suffer from mosquito-borne diseases and more than 1.1 million people die of malaria annually (Madhumathy *et al*., 2007). These diseases have accounted for huge economic loss, mortality, low productivity and social discrimination in many developing countries (Adeleke *et al*., 2010) and to a significant health burden in developed countries via travellers who have not taken sufficient precautions and/or prophylactic medications before travelling.

Larval control (source reduction or suppression) has been identified as one of the most effective methods for the control of mosquito- borne diseases (Singh *et al*., 2006). This control strategy has proved indispensable as the key to malaria eradication efforts in most developed countries such as the United State of America and some countries in Europe such as Turkey (Kitron and Spielman, 1989; Mwangangi *et al*., 2009). Prior to launching the anti-mosquito larval measures, there is a need for a full understanding of the considerable diversity of the breeding habitats available for the ovipositing mosquitoes in different localities.

Abeokuta is one of the malaria holoendemic cities in Nigeria (Ojo and Mafiana, 2001). The recent report by Adeleke *et al*., (2010) on indoor sampled adult mosquitoes in Abeokuta revealed the presence of 10 mosquito species which are potential vectors of different tropical diseases including malaria and bancroftian filariasis. Previous studies on mosquito larval habitats in the city concentrated on outdoor breeding mosquitoes (Mafiana *et al*., 1998; Adeleke *et al*., 2008; Soniran *et al*., 2008), but no attempt has been made to study the indoor breeding habits of mosquitoes and the likeness or diversity in the species composition between outdoor and indoor ovipositing mosquitoes. This study was therefore undertaken to determine the species composition and container preferences of indoor breeding mosquitoes as compared to the outdoor ovipositors during the dry season in Abeokuta, Ogun State Nigeria.

Materials and methods

Study area

Abeokuta is located on latitude 7°10'N and longitude 3°2'E in a derived savanna in Southwestern Nigeria (Figure 1). The city has two seasons; the wet season between April and October and the dry season between November and March. The residents are predominantly Yoruba by tribe with varying occupations which include trading, artisan and civil service.

Experimental set-up

The larval collection was carried out in four stratified locations: Ibara, Obantoko, Carwash and Asero all located within Abeokuta metropolis, between January and March, 2010. Ibara is a government reserved area with sparse human population while Carwash and Asero are densely populated areas with poor sanitary conditions. Obantoko is, however, a semi-urban area which lacks drainage with vegetation around residential areas. Most of the houses have mutilated window and door nets and domestic animals are sparsely found in Ibara but more commonly seen at other sites. Four artificial

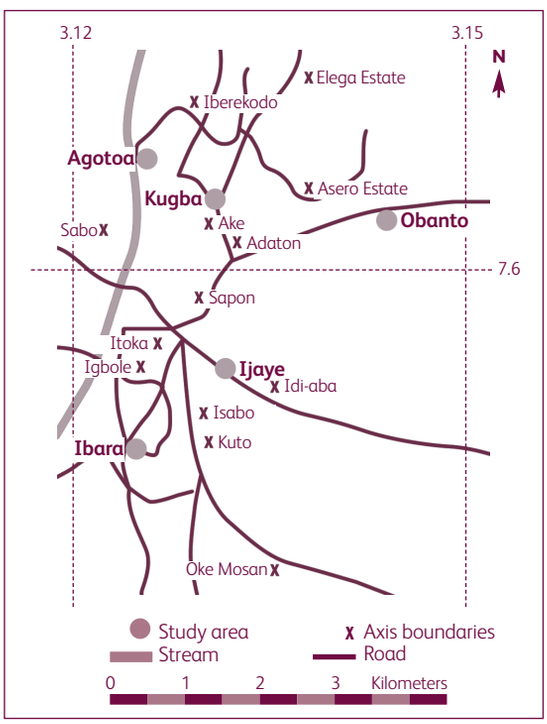

Figure 1.0
Map of Abeokuta Metropolis, Southwestern Nigeria

containers: plastic, tin, bamboo stump and clay pot were filled with water and placed indoors (for the experimental study) and outdoors (as control) in three randomly selected houses in each of the study locations. Apart from the bamboo, which has a diameter of about 12cm, other containers have approximately 16cm diameter and height 14cm. Plastic containers and clay pots are commonly used for water storage by the residents. Previous studies have shown the importance of bamboo stumps and tin containers as potential breeding sites (Mafiana, 1989; Adeleke, 2003; Soniran *et al*., 2008). The mosquito larvae (all instars) were collected weekly from the study sites following the procedure described by Mafiana (1989) and Adeleke (2003). The larvae were stored in labelled containers and transferred to the laboratory for identification.

Identification of mosquito larvae

The larvae were identified with the aid of a dissecting microscope using the keys described by Christopher (1933) and Hopkins (1953). In order to strengthen the identification process, some larvae were allowed to emerge into adults and subsequently identified with the keys described by Gillet (1972).

Statistical analysis

Data were analysed using SPSS. Chi-square analysis and analysis of variance (ANOVA) were used to test for the significant difference in number and diversity of mosquito larvae collected indoor and outdoor in different containers, after the data have been transformed by square root of x+0.5.

Results

A total of 393 mosquito larvae comprising six species were collected at the study sites during the period of the study. *Aedes aegypti* was the predominant species accounting for 62% of the larvae collected followed by *Culex quinquefasciatus* (28%), *Eretmapodite chrysogaster* (5%), *Cx. tigripes* (3%), *Aedes albopictus* (1%) and *Ae. vittatus* (1%). The number of larvae and species diversity showed variation in indoor and outdoor collections with outdoor collection accounting for 80% of larvae during the study, although the chi-square analysis of the transformed data showed that the differences were not statistically significant (x^2=12.00, p=0.446). All six mosquito species caught bred outdoors, while only three species: *Ae. aegypti*, *Cx. quinquefaciatus* and *E. chrysogaster* were encountered indoors (Table 1).

There was significant variation in the occurrence and number of mosquito larvae collected in the test containers during the study ($p<0.05$). Bamboo stump yielded the highest number of larvae (indoors 83% and outdoor 48%) followed by clay pots and plastic containers. Mosquitoes were least likely to select tin containers outdoors (5%) and none were collected from the indoor tin containers. *Ae. aegypti* and *Cx. quinquefasciatus* bred in all the outdoor containers while *E. chrysogaster* bred in all except the tin containers. *Ae. vittatus, Cx. tigripes* and *Ae. albopictus* only bred in outdoor bamboo stumps (Table 2). However, only *Ae. aegypti* bred in all the containers indoor except tin container while *Cx. quinquefasciatus* and *E. chrysogaster* utilised two and one container respectively (Table 3). In all, only *Ae. aegypti* and *Cx. quinquefasciatus* bred in the tin container.

Discussion

The six species of mosquitoes encountered in the present study concurs with the previous studies in Abeokuta metropolis (Mafiana *et al*., 1998; Adeleke *et al*., 2008; Soniran *et al*., 2008). However, the difference observed in mosquito diversity and number of larvae collected indoors as compared with the outdoor is

Species	Indoor collection	Outdoor collection	Total (%)
Aedes aegypti	59	185	244(62)
Ae. vittatus	0	4	4 (1)
Culex quinquefasciatus	16	94	100 (28)
Eretmapodite Chrysogaster	3	16	19 (5)
Cx. tigripes	0	11	11 (3)
Ae. albopictus	0	5	5 (1)
Total (%)	78 (19.84)	315 (80.15)	393

Table 1.0 Numbers and proportions of the mosquito larvae collected in Abeokuta

Species	Containers				Total (%)
	Bamboo (%)	Clay (%)	Tin (%)	Plastic (%)	
Ae. aegypti	86 (27.30)	63 (20)	13 (4.12)	23 (7.30)	185 (59)
Ae. vittatus	4 (1.27)	0 (0)	0 (0)	0 (0)	4 (1)
Culex quinquefasciatus	39 (12.38)	49 (15.55)	3 (0.95)	3 (0.95)	94 (30)
Cx tigripes	11 (3.49)	0 (0)	0 (0)	0 (0)	11 (3)
Eretmapodite chrysogaster	05 (1.58)	6 (1.90)	0 (0)	05 (1.58)	16 (5)
Ae. albopictus	05 (1.58)	0 (0)	0 (0)	0 (0)	5 (2)
Total	**150 (47.62)**	**118 (37.46)**	**16 (5.08)**	**31 (9.84)**	**315 (100)**

Table 2.0 Mosquito species breeding outdoor in the receptacles in Abeokuta

Species	Containers				Total (%)
	Bamboo (%)	Clay (%)	Tin (%)	Plastic (%)	
Aedes aegypti	47 (60.25)	10 (12.82)	0 (0)	2 (2.56)	59 (76)
Culex quinquefasciatus	16 (20.51)	0 (0)	0 (0)	0 (0)	16 (21)
Eretmapodite chrysogaster	2 (2.56)	1 (1.28)	0 (0)	0 (0)	3 (6)
Total	**65 (83.3)**	**11 (14.1)**	**0 (0)**	**2 (2.56)**	**78**

Table 3.0 Mosquito species breeding indoor in the receptacles in Abeokuta

remarkable and this, to the best of our knowledge and the available literature, presents the first record on indoor breeding activities of the mosquitoes in the study area. The low number of mosquito species and larvae collected indoors could be attributed to the resting behaviours of the mosquitoes. Apart from *Ae. aegypti* and *Cx. quinquefasciatus*, other species encountered during this study are known to be exophilic (Gillet, 1972; Service, 1999) and thus expected to utilise the closer breeding sites to their resting places when their gonotrophic cycle is completed. Moreover, the observed variation in species diversity could have been influenced by some environmental factors not known to this study.

The high occurrence of mosquito species and larvae in bamboo stumps and clay pots when compared to plastic

and tin containers may be a reflection of the conduciveness of each habitat to facilitate the survival of the mosquito species. Both tin and plastic containers are easily susceptible to heat and dryness may hinder the ovipositing females as they require environments with optimum environmental conditions for the development and survival of the larvae (Mafiana, 1989). Moreover, the degree of utilisation of the habitats could also be related to the innate habitat selection of the mosquito species. Most of the mosquitoes encountered have been known as tree-hole breeders and their preference for bamboo stumps is predictable (Gillet, 1975, Soniran *et al*., 2008). The preference of Anopheles mosquitoes for breeding in open drains and ground pools could also be the reason for its absence in this breeding experiment (Aigbodion and Anyiwe, 2003). The breeding of *Ae. aegypti* virtually in all the habitats confirms the earlier consensus that *Ae. aegypti* is an indiscriminate breeder, adapting to a wide range of habitats (Okorie, 1970; Anyanwu *et al*., 1999; Adeleke, 2003, Soniran *et al*., 2008).

The results of this study raise a number of public health concerns that need to be addressed. The dry season is normally characterised with acute water shortage when most residents usually resort into mass water storage in different containers. These containers, if not properly covered, could serve as breeding sites for disease vectors as two (*A. aegypti* and *Cx. quinquefasciatus*) out of the three species encountered indoors are potential vectors of deadly and life threatening diseases such as yellow fever, dengue and bancroftian filariasis (Ukpai and Eluewa, 2010). On the other hand, the prolific breeding of the mosquitoes outdoors signals the danger associated with indiscriminate disposal of unwanted containers, the act that is common in many areas of the town (Adeleke *et al*., 2008). There is, therefore, a need for public health education campaigns that focus on the dangers inherent in the indiscriminate disposal of containers and storage of water inside the house as this serves as a potential breeding sites for the mosquito vectors. There is also need for further studies to evaluate the knowledge and awareness of the residents on mosquito-borne diseases and possible barriers that could be encountered during public health education on vector borne diseases at the study area.

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Indoor air quality and allergic rhinitis among office workers in a high-rise building

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Abstract

The objective of this study was to examine the effect of airborne fungi on allergic rhinitis among office workers who worked in a large building with a heating, ventilation, and air conditioning system in Bangkok, Thailand. The authors conducted a cross-sectional study during the period of April through May 2008. Questionnaires were used to collect data. The air samples were collected using a Sampl'Air Pro Lite air sampler while environmental-related factors were also measured. The results reveal that the prevalence of allergic rhinitis among office workers and that in the workplace were 49.21% and 9.25%, respectively. The concentration of airborne fungi was 164.0 CFU/m^3. Relative humidity (r = 0.305) was most strongly correlated with airborne fungi concentrations. Concentration of airborne fungi was not associated with work-related allergic rhinitis. A history of asthma among office workers, respiratory sensitisation-sensitisation when exposed to hot or cold weather, visible mould and presence of carpeting showed significant association with allergic rhinitis in the workplace ($p < 0.05$).

Key words: airborne fungi, office building, allergic rhinitis, air conditioning system

Introduction

As people spend almost 90% of their time indoors such as in offices or at home and school, indoor air quality has become of concern as a health issue (WHO, 1983). While air conditioning systems are installed to provide a more comfortable environment for occupants such artificial environments are not without risk. Lack of control of heating, ventilation, and air conditioning systems (HVACs) may aggravate the growth of micro-organisms, which may contribute to rhinitis, bronchitis, pharyngitis, pneumonia, conjunctivitis, and keratitis (Cooley *et al*., 1998; Li *et al*., 1997; Verhoeff and Burge, 1997; Jones, 1999). Several factors such as outdoor air, building materials, and accumulated dust are also sources of microbial contaminants in indoor environments. Presence of mould, musty smell and water intrusion are warning signs, reflecting the inefficiency of a building's ventilation system.

Fungal exposures in ventilated buildings have drawn much attention in recent years since several studies reported their consequences on irritation, infections (Burge, 1989), building-related symptoms (BRSs) (Harrison *et al*., 1992), and allergic rhinitis (Gravesen, 1979) in office workers who work in the high-rise building with HVACs. Allergic rhinitis, which decreases workers' productivity and results in absences from work, is the most common of all allergic disorders. It is caused by exposure to allergens such as dust mite droppings, cockroach droppings, animal dander, pollen and mould spores. In ventilated buildings, mould spores become the major concern.

Numerous studies have found a higher prevalence of allergic rhinitis among office workers than in the general population (Chao *et al*., 2002; Menzies *et al*., 1998; Radon *et al*., 2008). However, few studies have reported on this problem in Thailand. The objective of this cross sectional descriptive study is to determine the prevalence and the factors associated with work-related allergic rhinitis among office workers in a high-rise building in Bangkok, Thailand.

Materials and method

Study population and data collection

A cross-sectional descriptive study was conducted among office workers who worked in a 19-floor high-rise building located at the centre of Bangkok, Thailand, during the period of April through May 2008. This building was selected as the study area since serious problems of water intrusion and large amounts of visible mould had already been reported. Other allergens such as dust mite, cockroach, animal dander and pollen were not considered as no problems have been reported. This building is sealed with windows and uses a HVAC. Ventilation is provided by a mechanical system and high efficiency purified air (HEPA) filter and humidifiers are not installed. The building is used mainly for teaching, research, and office accommodation.

Participants were selected using a screening questionnaire. Eligibility criteria included the location of their workplace varying from the second floor to the nineteenth floor and whether or not they come to work for at least three full days per week. Of 394 office workers, 253 were identified as eligible consenting participants and all participants signed a consent form approved by the ethics committee of Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand.

The participants were asked to provide information about their age, length of working in this building, job characteristics (research and nonresearch), medical history (history of asthma, family history of allergic rhinitis, and respiratory

sensitisation) and working environment (visible mould, musty smell, presence of carpeting, water intrusion and water condensation on window surfaces). The extent of allergic rhinitis and work-related allergic rhinitis was measured by a set of questions modified from the questionnaire of International Study of Asthma and Allergies in Childhood (ISAAC) in Teeratakulpisarn *et al*., (2000). The main questions on allergic rhinitis and work-related allergic rhinitis symptoms among office workers were as follows:

Allergic rhinitis symptoms:

(1) Did you have nasal congestion, an itchy nose, sneezing, and running nose in the past 12 months without having a cold?

Work-related allergic rhinitis symptoms:

(1) Did you have nasal congestion, an itchy nose, sneezing, and running nose with a cold at least twice in the past month?;
(2) Did the above symptoms occur only, or got worse, at the workplace? and
(3) How often the above symptoms occur: did it occur at least 1-3 days per week?

These modified questionnaires were piloted and tested for their content and validity. A Cronbachs' alpha coefficient of 0.86 was obtained (data not shown).

Allergic rhinitis was defined as (1) having the symptoms of nasal congestion, an itchy nose, sneezing and running nose without a cold in the past 12 months. Work-related allergic rhinitis was defined as in the past month (1) having the above symptoms with a cold at least twice; (2) expressing the manifestation at work or seeing it worsen at work and (3) frequency of the manifestation occurred at least 1-3 days per week. Those reporting none of the above symptoms were considered unaffected by allergic rhinitis.

One hundred participants met the above definition of allergic rhinitis, 24 participants met the definition of work-related allergic rhinitis and 113 participants were diagnosed as unaffected by allergic rhinitis. The mean age of all participants was 34.0 + 10.6 years and the mean length of working in this building was 4.0 + 3.06 years. Their workplaces were located on different floors. They had a similar working routine and style, i.e. worked at least eight hours, ate food in a cafeteria within the building and took rest periods in their workplace. The demographic information on 253 participants is shown in Table 1.

Environmental parameter measurements

Measurements of building environmental parameters were carried out to determine indoor air quality. At each floor, we conducted the measurements of carbon dioxide (CO_2), air temperature (T) and relative humidity (RH) using an indoor air quality monitor (IAQ model PGM5210) and the collection of indoor air samples for determination of the concentration of airborne fungi using an air sampler (Sampl'Air Pro Lite). The CO_2 was measured as surrogate for fresh air supply. The site of measurement on each floor was randomly selected. At each site, the IAQ monitor was placed for 15 minutes and the air sampler with the flow rate of 100 L/min was placed for 1 minute to collect the air onto a Petri dish containing sabouraud dextrose agar. The instruments were positioned at the room centre 1 meter above the ground. All measurements were performed during working hours and were carried out in duplicate to verify the reliability of the instruments. Colony forming units were identified at the Department of Microbiology, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand. Outdoor air was sampled in the same manner for comparison purposes.

Statistical analyses

We first explored frequency distributions of demographics, job characteristics, medical histories and working environment. For categorical variables, we used the chi-square test to evaluate differences in distribution of covariates for affected and unaffected work-related allergic rhinitis among office workers. Pearson's correlation coefficients were obtained for each physical parameter and the concentration of airborne fungi. Logistic regression procedures were used to examine the risks of having work-related allergic rhinitis. Univariate and multiple variable logistic regression procedures were employed to calculate unadjusted odds ratios (OR) of potential risk factors associated with work-related allergic rhinitis. Confidence intervals were also reported for each OR. Confounding factors were evaluated on the basis of their hypothesised relationship with covariates of interest and with work-related allergic rhinitis. Confounding was assessed by entering potential confounders into a logistic regression model one at a time and by comparing the adjusted and unadjusted ORs (Rothman and Greenland, 1998). The confidence intervals were calculated at the 95% level, and all reported *p*-values were two tailed. The statistical analyses were performed using SPSS (version 13.0, SPSS Inc., Chicago, IL).

Results

Overall, the prevalence of allergic rhinitis was 49.0% (124/253) and the prevalence of work-related allergic rhinitis was 9.5 % (24/253) in this study population.

Participants with work-related allergic rhinitis were mainly female (66.7%). They were non-researchers (95.9%), were aged 30-41 years (37.5%) and had worked in this building for 4-7 years (54.2%). As compared to the unaffected group, they were more likely to have a family history of asthma ($p < 0.001$), a previous diagnosis of asthma ($p < 0.001$), a previous diagnosis of allergic rhinitis ($p < 0.001$) and to exhibit respiratory sensitisation/ sensitisation when exposed to hot or cold weather ($p = 0.05$), before and after raining ($p = 0.02$) and when exposed to dust ($p < 0.01$). They also reported musty smell ($p = 0.013$), visible mould ($p = 0.007$), water intrusion ($p = 0.031$) and carpeting ($p = 0.052$) in their workplace environment (Table 1.0).

The temperature, relative humidity, and concentrations of airborne fungi, and carbon-dioxide with respect to indoor air quality are listed in Table 2.0. None of the parameters is outside the acceptable values mandated by Department of Pollution Control (PCD), Thailand. The outdoor concentration of airborne fungi was 386 CFU/m^3 (250-425).

Table 3.0 summarises Pearson's correlation coefficients between each of the physical parameters and concentration of airborne fungi. Airborne fungi concentrations were statistically significantly and positively correlated ($p = 0.003$) with relative humidity and negatively correlated with carbon dioxide ($p = 0.037$). Relative humidity ($r = 0.305$) was most strongly correlated with airborne fungi concentrations.

We next evaluated the relative risk of potential risk factors in relation to work-related allergic rhinitis. For this analysis, we used multivariable logistic regression procedures to control for confounding factors. Results from this analysis are summarised in Table 4.0. After adjusting for confounding by other variables (age, length of working in this building, job characteristics, family history of asthma, previous diagnosis of asthma, previous diagnosis of allergic rhinitis, respiratory sensitisation/sensitisation when exposed to hot or cold weather, before or after raining, musty smell, visible mould, water condensation on window surface, water intrusion, carpeting, airborne fungi concentration, temperature, carbon dioxide concentration, and relative humidity), we noted that participants who have a family history of asthma had a 3.32-fold increased risk of work-related allergic rhinitis as compared with those unaffected (OR = 3.32, 95% CI: 1.24-8.98). Participants who displayed respiratory sensitisation/sensitisation when exposed to hot or cold weather had a 13.05-fold increased risk of work-related allergic rhinitis as compared with those unaffected (OR = 13.05, 95% CI: 1.48-115.33). Participants whose workplaces show visible mould or a presence of carpeting had a 14.10-fold and 7.49-fold increased risk of work-related allergic rhinitis as compared with those unaffected (OR = 14.10, 95% CI: 1.69-117.35; OR = 7.49, 95% CI: 11.93-29.16), respectively. Neither physical parameters nor concentration of airborne fungi were associated with work-related allergic rhinitis.

Discussion

The 49.21% prevalence of allergic rhinitis noted among office workers in our study is higher than estimates reported for several studies. For instance, Pumhirun *et al*., (1997) reported the prevalence of allergic rhinitis in Thailand as 20% of the general population. Vichyanond *et al*., (2002) reported the prevalence of allergic rhinitis among university students in Bangkok as 26.3%. Boonsawat *et al*., (2004) reported the prevalence of allergic rhinitis in 20 to 44 years old persons from four provinces of Thailand as 37.7% and indicated that the highest prevalence was found in Bangkok. The higher prevalence in our study suggests that the sealed windows and HVAC could be causative factors of the allergic symptoms. High humidity owing to inefficiency of the building's ventilation system will enable mould to thrive. Exposure to mould spores can sensitise the nasal mucosa both in healthy and unhealthy persons. The presence of visible mould noted in this study confirmed the likely risks associated with this building.

Our result also found that the prevalence of work-related allergic rhinitis in the workplace was 9.5%. Workers who had respiratory sensitisation/sensitisation when exposed to hot or cold weather, had asthma and worked in the workstation with visible mould on the surfaces and presence of carpeting were at two or more times higher risk of developing allergic rhinitis compared to those who were not exposed to the above factors. This finding is consistent with the study of Ekpanyaskul (2005) who reported the prevalence of rhinitis in office workers as 6.67% and found a twice higher risk of sick building syndrome in workers with asthma compared with those in the general population. Boonsawat *et al*., (2004) indicated that 68.5% of persons with asthma could suffer from allergic rhinitis. Although a lower incidence of

Table 1.0
Characteristics of study population according to allergic rhinitis

Characteristics		Study population (n = 253)						
		Allergic rhinitis (n = 124)				Unaffected allergic rhinitis (n = 113)		
		Work-related (n = 24)		Other-related (n =100)				
		n	%	n	%	n	%	*p-value*
Sex	Male	8	33.3	33	33.0	25	22.1	**0.061**
	Female	16	66.7	67	67.0	88	77.9	
Age (year)								
1st Q (<26)		6	25.0	30	30.0	34	30.1	**0.789**
2nd Q (26-29)		2	8.3	20	20.0	19	16.8	
3rd Q (30-41)		9	37.5	24	24.0	31	27.4	
4th Q (>41)		7	29.2	26	26.0	29	25.7	
(mean + SD)		34.7 + 7.9		33.9 + 10.7		34.4 + 11.2		
Length of working in this building (year)								
1st Q (<1)		6	25.0	26	26.0	37	32.7	**0.860**
2nd Q (1-3)		3	12.5	21	21.0	24	21.2	
3rd Q (4-7)		13	54.2	33	33.0	29	25.7	
4th Q (>7)		1	4.2	9	9.0	19	16.8	
(mean + SD)		4.4 + 2.5		3.9 + 2.9		3.9 + 3.4		
Job characteristics	Research	1	4.2	17	17.0	22	19.5	**0.293**
	Nonresearch	23	95.9	82	82.0	89	78.8	
Having family history of asthma	Yes	11	45.8	26	26.0	8	7.1	**<0.001**
	No	13	54.2	74	74.0	104	92.0	
Having previous diagnosis of asthma	Yes	11	45.8	35	35.0	14	12.4	**<0.001**
	No	13	54.2	65	65.0	99	87.6	
Having previous diagnosis of allergic rhinitis	Yes	9	37.5	45	45.0	11	9.7	**<0.001**
	No	15	62.5	55	55.0	101	89.4	
Having respiratory sensitisation — **When exposed to hot or cold weather**	Yes	23	95.8	72	72.0	67	59.3	**0.005**
	No	1	4.2	28	28.0	45	39.8	
Having respiratory sensitisation — **Before and after raining**	Yes	11	45.8	29	29.0	21	18.6	**0.020**
	No	13	54.2	71	71.0	90	79.6	
Having respiratory sensitisation — **When exposed to dust**	Yes	22	91.7	85	85.0	73	64.6	**<0.01**
	No	2	8.3	15	15.0	39	34.5	
Having musty smell	Yes	16	66.7	50	50.0	42	37.2	**0.013**
	No	8	33.3	50	50.0	71	62.8	
Having visible mould	Yes	23	95.8	71	71.0	67	59.3	**0.007**
	No	1	4.2	29	29.0	46	40.7	
Having water condensation on window surface	Yes	8	33.3	25	25.0	22	19.5	**0.182**
	No	16	66.7	74	74.0	91	80.5	
Having carpeting	Yes	5	20.8	9	9.0	5	4.4	**0.052**
	No	19	79.2	90	90.0	107	94.7	
Having water intrusion	Yes	17	70.8	59	59.0	54	47.8	**0.031**
	No	7	29.2	40	40.0	59	52.2	

* Having missing data

Indoor environmental parameter	Mean (±SD) / Median (1stQ-3rdQ)
Concentration of airborne fungi (CFU/m^3)	164.00 (105.00-203.00)
Relative humidity (%)	32.54 (±10.62)
Temperature (°C)	25.16 (±1.08)
Concentration of carbon dioxide (ppm)	443.15 (425.7-533.73)

CFU/m^3 is colony forming unit of mould, ppm is part per million, mean value with standard deviation (±SD) for normal distribution and median value with interquartile range (IQR: 1stQ - 3rdQ) for non-normal distribution

Table 2.0
Measurement of indoor environmental parameters (n = 96)

Indoor environmental parameter	Pearson's correlation (r)	*p-value*
Relative humidity (%)	0.305	0.003
Temperature (°C)	0.091	0.391
Concentration of carbon dioxide (ppm)	-0.218	0.037

Table 3.0
Pearson's correlation coefficient (r) for each physical parameter in relation to the concentration of airborne fungi (CFU/m^3)

Characteristics		OR	95% CI	*p-value*	OR**	95% CI	*p-value*
Having family history of asthma	No	1	Ref	0.001	1	Ref	0.017
	Yes	4.43	1.83-10.71		3.32	1.24-8.98	
Having respiratory sensitisation when exposed to hot or cold weather	No	1	Ref	0.016	1	Ref	0.021
	Yes	12.08	1.60-91.24		13.05	1.48-115.33	
Having visible mould	No	1	Ref	0.014	1	Ref	0.014
	Yes	12.50	1.66-94.40		14.10	1.69-117.35	
Having carpeting	No	1	Ref	0.022	1	Ref	0.004
	Yes	3.70	1.20-11.40		7.49	1.93-29.16	

** Odds ratio (OR) and 95 % confidence intervals (95 % CI) are adjusted for age, length of working in this building, job characteristics, family history of asthma, previous diagnosis of asthma, previous diagnosis of allergic rhinitis, respiratory sensitisation/sensitisation when exposed to hot or cold weather, before or after raining, musty smell, visible mould, water condensation on window surfaces water intrusion, carpeting, airborne fungi concentration, temperature, carbon dioxide concentration, and relative humidity.

Table 4.0
Odds ratio and 95 % confidence intervals (CI) for risk of work-related allergic rhinitis among study population (n = 24)

work-related allergic rhinitis was found in this study, special attention should be paid to a group at higher risk, where health checkups, surveillance, and preventive programmes should be provided.

The concentrations of airborne fungi in our study showed a median of 164 (IQR = 105-203) CFU/m^3 which was much lower than those found outdoor (386 CFU/m^3). Since no threshold level for concentration of indoor airborne fungi has been assigned in Thailand, the number reported in this study could not be taken as a marker of serious indoor air quality. Several building studies have suggested that concentrations of airborne fungi greater than 500 CFU/m^3 should be considered as an indicator of serious indoor contamination likely to give rise to many of the health problems mentioned above (Harrison *et al*., 1992; Gravesen, 1979; Rea *et al*., 2003; Burge, 1989).

We found that relative humidity (r = 0.305) was most strongly correlated with airborne fungi concentrations. Heat and humidity tend to support the growth of airborne fungi (Kutintara and Parrott, 2003) and measured concentrations displayed statistically significantly positive correlations (p = 0.003) with both relative humidity and temperature (p = 0.39). The optimum temperature and relative humidity for most fungi are 15-30°C and 44%-90%, respectively (Burge *et al*., 1989). In our study, the average indoor humidity was 32.54% and ranged from 8.2-82.6%. The average indoor temperature was 24.9°C and ranged from 20.4-31.1°C. Based on these results, humidity and temperature levels were ideal for fungal growth. Increases in temperature and humidity were noted when the air conditioning was turned off at the end of the day.

Temperature and water availability are essential environmental factors for promoting microbial growth in an indoor environment (Chao *et al*., 2002; Wong *et al*., 2008). Water availability is the amount of water available for fungal growth on a substrate. Temperature influences fungal growth indirectly by interacting with water activity (Burge *et al*., 1989). The level of relative humidity is determined by temperature and water content in the air. Although we were not able to evaluate water content in the air, we did note a positive association between relative humidity and temperature.

We also noted that levels of airborne fungi showed a statistically significantly negative correlation with carbon dioxide concentrations (p = 0.037). This finding is similar to that reported by Chao *et al*., (2002). The CO_2 concentration is measured to indicate insufficiency of fresh air supply. The concentration of carbon dioxide depends on the number of workers and their activity. If the number of workers and their activity levels remain constant, the CO_2 concentration is negatively related to the amount of outdoor air supply (Burge *et al*., 1989). In our study, we found less variation of CO_2 concentration at each site measured, assuming that the ventilation rate was equal throughout the building. Therefore, the outdoor air might be a source for indoor airborne fungi rather than the internal sources. This is supported by the concentration of outdoor airborne fungi reported in this study (386 CFU/m^3).

Although water intrusion, musty smell and water condensation on window surfaces were not associated with concentration of airborne fungi and were not significant risk factors for work-related allergic rhinitis, their existence reflects inadequate efficiency and maintenance of HVAC system in the studied building.

Our study has several limitations. First, this study was cross-sectional in design, and thus the results were solely based on the information provided by the subjects themselves; neither any physical examination of the subjects by an allergy specialist nor any symptom score analyses, skin prick test and measurement of total IgE/allergen specific IgE level were carried out. Second, this high-rise building was purposefully selected as it already had some reported problems. Therefore, the findings of our study may be extrapolated to other similar problematic buildings but may not be extrapolated to country as a whole. Third, self-administered questionnaires modified from ISSAC were used as a tool for screening work-relatedness to allergic rhinitis. Workers with the respiratory symptoms might over-report the manifestations of allergic rhinitis and environment in their workplace.

Conclusion

In conclusion, we noted that work-related allergic rhinitis among office worker was associated with family history of asthma, sensitisation when exposed to hot or cold weather, visible mould and presence of carpeting. The prevalence of work-related allergic rhinitis in this population was lower than estimates reported for the general population in Thailand (Vichyanond *et al*., 2002). Our findings emphasise the need for additional studies which should involve both clinical examinations of subjects and detailed identification of the types of fungi present in indoor atmospheres to help identification of causal relationships between work-related allergic rhinitis and the workplace environment. In addition, regular inspections of the HVAC system with respect to cleanliness or contamination should be carried out.

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Beyond safety to wellbeing: How local authorities can mitigate the mental health risks of living in houses in multiple occupation

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Abstract

The regulation of houses in multiple occupation (HMOs) by local authorities focuses on ensuring the physical safety of occupants through adequate standards of building quality, safety provision and management suitability. However, it has been suggested that HMOs may also pose a particular threat to the mental health of residents. In this paper we consider the suitability of current regulations to tackle the possible risks to the mental health of HMO residents and then outline how the current public health agenda may present an opportunity for environmental health professionals to tackle these issues in new ways. Using a framework which encompasses the psychosocial processes thought to link residents' mental health with their housing conditions, we describe how local authorities can address some of the mental health risks posed by HMOs but that the current enforcement culture, in which prosecution is seen as a last resort makes decisive action against landlords very difficult. In recognising the many vulnerable households living in HMOs, we argue that local authorities dealing with housing standards and environmental management are strategically placed to be more ambitious and proactive in protecting the health of local residents particularly through the developing public health and wellbeing partnerships. We call for empirical research to look at how local authorities actually use current legislation as well as other strategies to manage HMOs and protect the mental health of tenants.

Key words: Houses in multiple occupation, mental health, local authorities, regulation, shared housing, private rented sector, environmental health

Introduction

One of the statutory roles of local councils in the UK is to maintain housing standards both in social housing and the private rented sector (PRS). Good housing standards make a valuable contribution to public health and wellbeing and the relationship between housing and health is well documented (Pevalin 2008, Pollack *et al.,* 2008, Shaw 2004). The relationship between mental health and housing does not have the same body of evidence or long history of research as housing and physical health. However, interest in the connection between mental health and housing has been increasing (Evans *et al*., 2003). In 2010 suitable housing was identified by the UK government as a key component for mental health (Department of Health 2011) and factors such as overcrowding, small room sizes and high rise buildings among other factors have all been shown to impact upon the mental health of residents (British Medical Association 2003, Evans *et al.,* 2003, Page 2002).

The PRS in Britain is becoming an increasingly important source of housing provision with an estimated 30% increase since 2005 of households in England living in the PRS (Department of Communities and Local Government 2011). The housing strategy for England published in 2011 emphasises the importance of investment in the PRS and praises the high standards generally found in the sector (Department of Communities and Local Government 2011). However, there is recognition of the need to take a harder line on 'rogue landlords' (Department of Communities and Local Government 2010a). The Parliamentary Office of Science and Technology (2011) reported that the PRS highest proportion of non-decent homes (compared with other housing tenures), short tenancy agreements and general lack of secure tenure may contribute to mental health problems and discourage tenants from seeking home improvements, reporting problems to landlords in case of eviction and investing in rented homes.

Of all housing types in the PRS, HMOs can prove a particularly difficult for local authorities to tackle. They fulfil an important role in the UK housing market especially for those who are unable to access other tenures resulting in many vulnerable individuals suffering some of the worst landlords. However, not all HMO landlords are of a poor standard and equally not all tenants are vulnerable. For example, in some contexts HMOs offer accommodation to students and young professionals who wish to live in central locations they would not otherwise be able to afford. HMOs nonetheless frequently comprise the bottom end of the sector and it is this type of HMO that this paper focuses upon.

Previous research has highlighted the relationship between mental health problems and HMOs. Shaw *et al*., (1998) note that HMO residents are eight times more likely than the general population to suffer from mental health problems as well as having other problems:

> *'These groups [living in HMOs] are more likely to be drug or alcohol-dependent, many have spent their early lives in care, or are ex-prisoners, and have nowhere else to go' (Shaw et al., 1998: 67).*

HMOs have also been linked to increased antisocial behaviour and a decline in owner occupation in the communities where they are situated (Hubbard 2008).

Furthermore HMOs may pose a greater threat to the mental health of residents than other forms of housing tenure because of greater insecurity, less control and poorer social networks (Barratt 2011).

The need to improve the management of HMOs and to ensure that they are a safe and healthy housing option is made all the more urgent by the expectation that demand for HMO accommodation is going to increase. The effect of the downward pressure on housing benefit payments will mean that those living in the PRS are likely to be looking for cheaper accommodation options. In particular the increased age at which a person is entitled to the full one-bedroom local housing allowance rate, from 25 to 35 years, is expected to result in approximately 88,000 extra people (McCann 2011) between 25-34 years now requiring lower cost and possibly HMO accommodation. However, legal processes to bring HMOs up to required standards are frequently lacking suitable resources and can be frustrating and lengthy for the local authority enforcer and tenant alike (Rugg and Rhodes, 2008). It can also lead to cases of rental increase, and retaliatory eviction (Crew 2007) with tenants sometimes suffering harassment and feeling powerless about their situation improving, and many are unaware of the services available to help them (Emanuel 1993).

This paper discusses the options available to local authorities to manage Houses in Multiple Occupation (HMOs) and how wider use of various regulations and other public health and wellbeing interventions may help protect and enhance tenants' mental health. We start by presenting a framework for understanding how HMOs may influence the mental health of tenants.

Housing and mental health

A review of literature regarding the relationship of housing and mental health by Evans *et al*., (2003) looked at the impact of overall housing quality on mental health, including 27 studies from 1983-2001, and concluded that mental health was positively correlated to housing quality. A more recent review of literature relating to unhealthy housing in the UK (Pevalin *et al.,* 2008) identified studies looking into different aspects of housing and mental health concluding that pollution, noise, poor building design, infestation and living in unpopular areas and high rise flats can contribute to mental illness and in some cases drug and alcohol abuse. Page (2002) reaches similar conclusions but also emphasises how overcrowding and residence in temporary accommodation have been shown to adversely affest mental health, especially among children whose long term development can be affected. Adults living in temporary accommodation have been shown to suffer from increased levels of depression, domestic violence, alcoholism, family stress and relationship breakdown (Shaw *et al*., 1998). Page (2002) adds that HMOs offer a similar type of accommodation to more temporary living arrangements in hostels or bed and breakfast accommodation, but with a lack of alternate accommodation, households frequently stay longer than anticipated. Rugg and Rhodes (2008) emphasised how behaviour and housing are closely interlinked socially and economically, and 'slum' rentals at the bottom end of the PRS tend to target those with already chaotic lives and as such, anti-social behaviour from those with addictions or existing mental health problems is more likely in this sector.

Understanding mental health in HMOs

The Evans *et al*., (2003) framework details five psychosocial processes that link housing and mental health providing a useful model to consider the possible mental health impact of living in a HMO.

HMO accommodation is potentially problematic in relation to each of these factors (Barratt 2011). We now outline why:

Identity

Evans *et al*., (2003) point out that a person's identity and their self-esteem may be influenced by the house and community that they live in. They note "The house is a symbol of self, reflecting both inwardly and outwardly who we are, what we have accomplished and what we stand for" (Evans *et al*., 2003: 492). Forchuk *et al*., (2006) carried out a study with men and women who had received psychiatric treatment. Respondents emphasised how important it was for them to be proud of where they lived and that this was a central element of being well. The poor quality of many HMOs may result in declining self esteem among residents who may feel embarrassed about where they live.

[1] The legal definition of a HMO is complex and includes some types of self-contained accommodation. However, this paper uses a narrower definition of a HMO: a building in which unrelated occupiers of the building share basic amenities such as kitchens, bathrooms or toilets.

Beyond safety to wellbeing: How local authorities can mitigate the mental health risks of living in houses in multiple occupation

Control
Good housing should offer protection to residents. Evans *et al*., (2003) note that this should not just be from the elements but also from unfavourable social conditions and that it is within our houses that we should be able to control who enters and what takes place. An inability to control circumstances within our own home may lead to feelings of low self efficacy. Page (2002) identified that forced social interaction can pose a threat to mental health. HMOs by their definition include some element of shared space, which instantly reduces the control that individual residents have over the space in which they live. Furthermore, the close proximity of other residents means that the choices of other residents impacts greatly on individuals. HMOs therefore offer significantly less control compared with other types of housing.

Insecurity
Good housing should be a source of security to tenants; however, Evans *et al*., (2003) point out that poor quality housing has been shown to lead to insecurity through repeated problems with maintenance, having to engage with people from bureaucratic organisations and high rates of involuntary relocation, all of which can lead to psychological stress. Illegal evictions and tenant harassment by landlords contribute to the insecurity felt by tenants, some of whom are already transient (Stewart *et al*., work in progress). Another aspect of insecurity is potential danger from the accommodation or other residents' behaviour, particularly for families.

Social support
Housing and the neighbourhood in which people live play an important role in defining the social support a resident can access. Evans *et al*., (2003) note that the way in which buildings and roads are laid out, including details such as the door orientation, can influence patterns of social interaction. In one of the earliest studies on this topic women living in high-rise flats found that they experienced a high degree of isolation attributed to the building's verticality and lack of garden (Fanning 1967). Furthermore, housing can influence who people interact with. For example, living in an area with high property prices may provide access to neighbours with knowledge about jobs. Within HMOs the shared facilities and the close proximity of residents may lead to increased levels of social interaction, although we have already noted that this may not always be desirable, especially owing to the high vulnerability of some HMO tenants.

Parenting
Evans *et al*., (2003) establish that parenting styles are influenced by the circumstances in which families live. Parents are likely to become more restrictive if the housing quality is low and the neighbourhood thought to be dangerous. Additionally, parents' self-esteem and feelings of self efficacy might be affected by housing problems that they are unable to solve. A lack of privacy may prevent parents from building close intimate relationships with their children. Page (2002) notes that the lack of control parents have over the internal environment of shared accommodation results in greater parental anxiety and limits the control parents have over the people and behaviours their children are exposed to. Living only in one room would severely limit space to play and would be a source of stress for the parent.

These five processes do not exist distinct from each other; they are closely related and some issues fall under more than one process. However, this brief consideration of the framework suggested by Evans *et al*., (2003) helps demonstrate why HMOs may pose a greater threat to the mental health of HMO residents than other, self contained housing tenures. We will now explore the regulations that are used by local authorities to manage HMOs as well as wider planning, public health and wellbeing provisions and consider how they can help to mitigate the impact of HMOs on the mental health of residents, basing our discussion around the five psychosocial processes identified above.

Current HMO legislation and its impact on the mental health of residents

Houses in Multiple Occupation are currently regulated under the Housing Act 2004 and the Management of Houses in Multiple Occupation Regulations 2006. The Housing Act 2004 (Part 1) introduced the Housing Health and Safety Rating System (HHSRS), to replace the previously outdated statutory standard of fitness, as well as mandatory licensing for larger HMOs. This includes HMO properties that are three or more floors and house five or more people from three or more households. Licensing was introduced in recognition of the potential danger these properties pose to residents as well as attempting to deal with the growing challenges being posed by HMO properties, especially in cities with large student populations and seaside towns (Department of Communities and Local Government 2010b, Agarwal and Brunt 2006, Department of Communities and Local Government 2008). Overall, these changes in HMO legislation were seen as a progression from previous

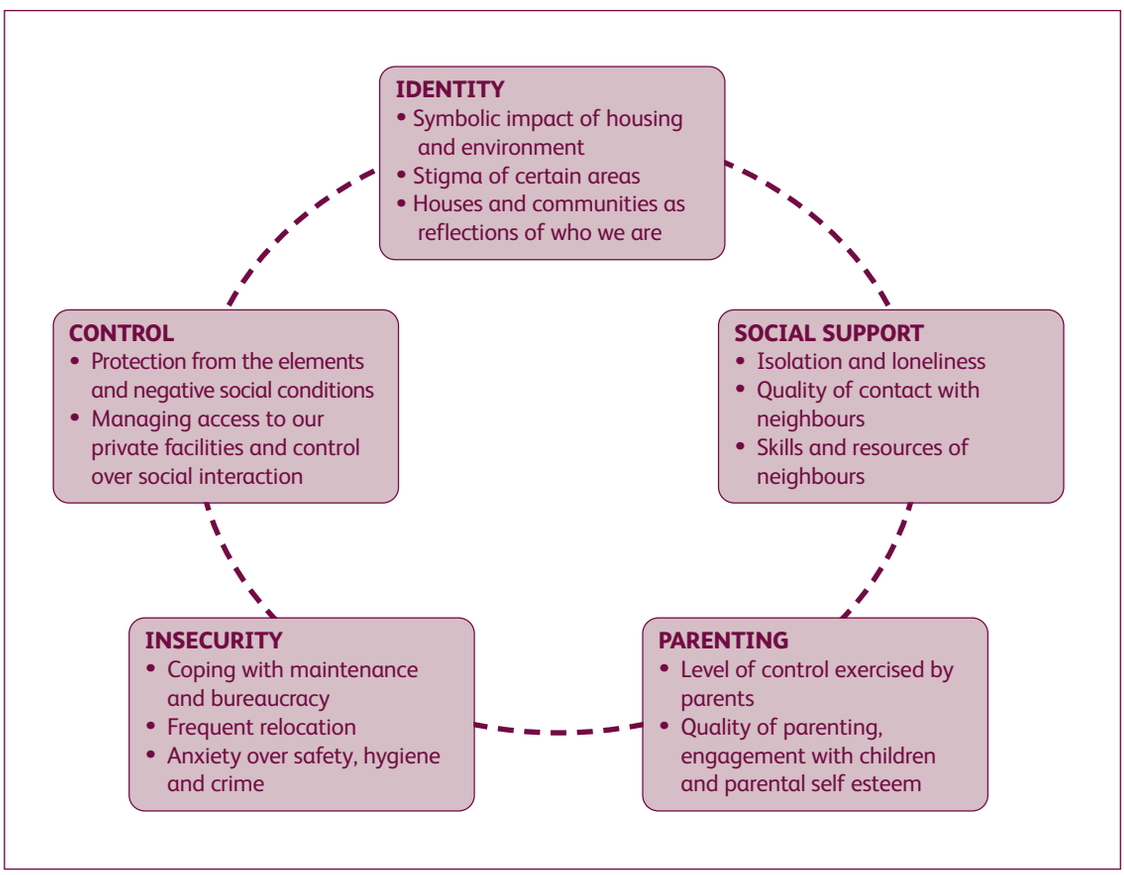

Figure 1.0
Psychosocial processes thought to link between housing and mental health (Adapted from Evans *et al*., 2003)

reactive measures (Stewart 1999; Stewart 2001) to a more dynamic and evidence-based approach.

The Management of Houses in Multiple Occupation Regulations 2006 apply to all HMO properties in which facilities are shared, irrespective of whether or not they are licensable. These regulations make the manager responsible for ensuring that their contact information is available to residents; that fire safety measures are in place and that common parts are properly maintained. Essentially, they cover basic health and safety requirements aimed at protecting against injury and disease. However, in terms of the psychosocial framework previously outlined these regulations could protect the mental health of residents by making them feel safe, reducing insecurity and increasing their sense of control as they are able to contact the landlord and deal with problems in the property when they arise. Although the word 'maintain' is ambiguous, if the property is maintained to a high standard, this could help to boost the self esteem of residents, giving them a positive sense of identity.

Additional requirements must be met for HMOs requiring a licence and each landlord or HMO manager of a licensed property must be considered 'a fit and proper person' to manage the property; factors such as a past criminal record are taken into account when making this judgment. Any previous history of poorly managing HMOs would be considered although in effect checks are limited. While the licence may provide reassurance for the tenant that certain standards are adhered to and the knowledge that the manager or landlord was a 'fit and proper person' may contribute toward a greater feeling of security for tenants, the extent of checks actually made in practice remains uncertain. It is also unclear to what extent tenants are aware of the licensing system or the impact it has on property and as a result the impact

of the licence on mental health may be limited despite tenants being physically much safer if the licence conditions are met.

The Housing Health and Safety Rating System and mental health

The Housing Health and Safety Rating System (HHSRS) is used in England and Wales (with separate standards for Scotland and Northern Ireland) to assess risk in residential properties including HMOs in conjunction with other applicable legislation. If a sufficiently serious risk is identified, legal action can be taken against a landlord to ensure that potential hazards are addressed. HHSRS requires that 'psychological' hazards that pose a threat primarily to mental health are considered: crowding and space; entry by intruders; lighting; and noise. The importance of being able to regulate these hazards is emphasised in the earlier framework (Figure 1.0). Protecting against entry by intruders, for example, will increase a resident's sense of security and control as they are able to keep unwanted influences out of the home environment. The lack of privacy caused by overcrowding can lead to increased levels of stress and aggression among individuals (Hopton and Hunt 1996). Growing up in overcrowded conditions has been shown to affect the healthy emotional development of children, making this particularly stressful for parents. Regulating for light and preventing accommodation from being too dark can help to improve mental health as sunlight has been linked to the prevention of and recovery from mental illness (Rosenthal *et al*., 1984, Beauchemin and Hays 1996). The conversion of properties into HMOs may result in some rooms having limited light sources, making this issue particularly pertinent. The property's outlook could influence whether or not the view from the room reinforces a positive or negative sense of self. Furthermore, the only private space available to HMO residents is their own room. Therefore, if the view from their room is poor or the light compromised, it is not possible to spend time in another, brighter part of the house, making protection from this hazard particularly important in this housing tenure.

As well as risks to mental health being identified under psychological requirements, the potential for hazards usually associated with physiological harm to affect mental health are also identified within the health effects of other hazards. In relation to mould and damp it is recognised that this can cause embarrassment and contribute to social isolation and one hazard, 'flames, hot surfaces etc' identifies 'acute psychological distress' that victims of scolds and burns, as well as the parents of children that are burnt, can suffer for many years after the incident is recognised (Office of the Deputy Prime Minister 2006).

The links between housing and mental health therefore feature in the hazards identified. However, the system for assessing the severity of potential harm from any particular hazard makes it difficult to account for threats to mental health and some concerns were expressed in the developmental stages of HHSRS in respect of how mental health (e.g. stress, depression) issues would be incorporated (Stewart 2002). The system of harm classification as well as the paucity of data regarding the impact of housing on mental health limit the capacity of HHSRS to adequately incorporate a psychological dimension. For each hazard identified, details are provided regarding the probability of an individual being affected and the extent of harm likely to be caused. Harm is defined as 'an adverse physical or *mental* effect on the health of a person' (Office of the Deputy Prime Minister 2006: 11). Four classes of harm are identified under HHSRS – Class I being the most severe and Class IV the least. For all the hazards detailed under 'psychological requirements' the vast majority of those who are affected are thought to suffer Class IV harm (the lowest class of harm) resulting in relatively minor health effects. However, it is noted that there is a paucity of data in relation to psychological impacts of these hazards, making it difficult to accurately attribute a class of harm.

Being unable to accurately identify the level of potential psychological harm attributed to any given hazard means that individuals utilising HHSRS are then unable to meaningfully calculate whether the hazard is defined as a Category I or II hazard. The significance of this is that local authorities are obligated to take action against a landlord if the hazard is considered to be Category I. If the risk is considered to be a Category II hazard, a local authority can take action if it is deemed serious enough. Alternatively if there are numerous hazards, which would not necessitate action individually, these can all be combined, enabling the local authority to take action given the overall hazard score of the property. However, owing to the low class of harm associated with psychological hazards, it is unlikely that the hazard score would be high enough to enable the local authority to take action. Therefore, it is very unlikely that action could be taken against a landlord based on consideration of

psychological hazards alone. In the HHSRS Operating Guidance (Office of the Deputy Prime Minister, 2006:16) it is explained that this process of hazard scoring enables very different hazards to be compared and 'enable(s) hazards which may result in physical injury to be compared with ones which could cause illnesses or affect mental health'. But this is doubtful as the paucity of data does not enable such comparison to be made despite the potential of the hazard scoring system. Further development in application and enforcement of the HHSRS may bring forward new ideas in how mental health can be more highly rated.

HMO regulation and the problems of sharing

Having looked at the most common legislation used to regulate HMOs, we now discuss how sharing facilities and living in close proximity to individuals from different households impacts on mental health and outline how current legislation can tackle this.

Within HMOs some of the greatest threats to the mental health of tenants come from the actions of other tenants. Landlords currently have a duty to ensure that the behaviour of tenants in the property does not impinge on the surrounding community but it is not specified that tenants should be protected from the behaviour of other tenants. However, some protection is provided to HMO tenants through the legislative provision for dealing with anti-social behaviour in the PRS. Residents can make complaints about antisocial behaviour to the landlord of the perpetrator. If the landlord fails to take action and the complaint is sufficiently serious but the landlord does not take steps to rectify the issue, a special interim management order can be put in place by the local authorities under section 103 of the Housing Act 2004. This facilitates the intervention of the local authorities in tackling the problems arising from that property. Furthermore, under the HMO licence conditions the local authority is able to specify additional conditions, for example how the landlord will deal with the behaviour of tenants. This may be through detailing expectations of tenant behaviour in the tenancy agreement, keeping records of all ASB incidents or fitting security cameras in properties with a history of ASB. In an area where anti-social behaviour has become a significant problem and there is a high proportion of properties not being managed properly, selective licensing for all private landlords within that area can be introduced under part 3 of the Housing Act 2004. This could help protect HMO tenants as well as the wider community. In terms of mental health, preventing ASB behaviour in the property will make tenants feel safer and more secure, especially for parents who wish to protect their children from negative behaviour. Minimising the impact on the wider community of ASB from HMOs may result in improvements in the local area, boosting the esteem of those living there and reducing stigmatisation.

As it stands, both the HHSRS and the HMO management regulations fail to consider enforcing steps that provide greater privacy and security for HMO residents, which could help tackle the problems of sharing. For example legislating for the sound insulation properties of partition walls, floor and ceilings would make it much easier for individuals in the property to live together by preventing noise pollution. The Building Regulations 2010, Part E (Government of England and Wales 2010) outline sound insulation requirements when the property goes through a change of use but this cannot be enforced retrospectively so there is no recourse to tackle poor sound insulation in older properties. Currently, landlords may be asked to take action such as improving insulation or the provision of double glazing in order to reduce the impact of ambient noise levels. However, guidance for noise hazard assessment states *'noise from unreasonable behaviour of neighbours should not be included in the assessment'* yet nothing is specifically stated regarding HMO properties when a tenant's neighbours live *within* the same property (Office of the Deputy Prime Minister 2006: 105). This would make enforcement of greater noise insulation difficult using HHSRS. There is provision for dealing with excess noise caused by tenants in the Anti Social Behaviour Act 2003 (Government of England and Wales 2003) (although issues with noise are not necessarily examples of ASB) or through the Noise Act 1996 if noise is being emitted from a '*dwelling*' exceeds the permitted level.

A further optional condition of the HMO licence is that the landlord attends a suitable training course. If done well, this could lead to better conflict management within the property, increasing the sense of security for all tenants and helping to reduce stress and anxiety. The licence conditions for HMOs and guidance for tenants experiencing ASB in the PRS emphasises the role of the landlord in tackling many of these issues. Therefore, if landlords are more able to deal with them effectively the burden on the local authority would be reduced. Additionally, landlord accreditation schemes are becoming more widespread in the UK and it is becoming an increasingly professionalised industry. This provides a

good opportunity to inform landlords about the links between mental health and housing and develop management practices that reduces the stress of living in shared accommodation.

Other regulations and the challenges of enforcement

There are other criminal and civil remedies under non-housing legislation that can also be considered, although the extent to which they are successfully used, or even used at all, remains unclear (Stewart 1999, Stewart 2001), particularly since the introduction Housing Act 2004 and its wider coverage of hazards than the earlier statutory standard of fitness.

The status of the HMO as a business means that the Health and Safety at Work etc Act 1974 could be used to enforce improvements in common parts, for example if lighting or security was thought to be inadequate. Page (2011) listed several different pieces of legislation that he has used in relation to HMO regulation over the course of his career including the Prevention of Eviction Act 1977; Landlord and Tenant Act 1985, Section 11; Sections 27 and 28 of the Housing Act 1985; and Defective Premises Act 1972, the later two being civil proceedings. Therefore current powers do enable environmental health enforcement officers to take action for hazards that may negatively affect the mental health of HMO residents but it may require using legislation in more creative ways than is currently observed in typical day-to-day practice. However, Hutter (1988) noted that actions are sometimes 'controlled' by how discretionary powers are used and although this was over two decades ago this observation is felt to be relevant in practice today.

Although the legislation seems to provide a variety of tools to use to maintain HMO standards and therefore protect the mental health of tenants, enforcement in the PRS and HMOs in particular proves problematic and may account in part for the low numbers of prosecutions. In a review of legislative approaches to controlling housing conditions, Burridge and Ormandy (2007) note that the power of individual tenants to ensure that landlords maintain housing standards has traditionally been very limited, pointing particularly to the weak regulatory impact of the tenant landlord contract. In light of this the state has become increasingly involved in lawful intervention on behalf of tenants in the PRS. Cowan and Marsh (2001) point out that a compliance-based strategy has developed with regards to the PRS, meaning that prosecution is used only as a last resort. They highlight that the emerging perception of the PRS as 'partners in local housing strategies' (Cowan and Marsh 2001: 853) has resulted in legislation that appears set to punish poor landlords. However, in reality officers are constrained by the objectives of their local authority, financial realities and judicial attitudes.

The situation is also complicated when a property may be deemed an HMO under housing legislation, but not under planning or building legislation. Close organisational working is therefore necessary to seek the highest standards, for example in proactive application of building controls on conversion to multiple occupancy, in requirements for noise insulation and fire safety, although there are many cases where housing legislation is applied reactively, which sometimes generates difficulties for tenants and landlords alike.

Despite a plethora of legislation and regulations, informal action – i.e. where no legal notices are served – remains the main means of securing housing improvements. There are calls for a more strategic approach to using the HHSRS (Chartered Institute of Environmental Health 2008) and this could help inform the local evidence base on successful interventions. Even though the PRS presents some of the worst housing conditions for some of our most vulnerable tenants, there is still relatively low importance granted to interventions in this sector (Audit Commission 2009). Therefore, despite the range of legislative powers available to local authorities, significant barriers prevent their effective use. We now consider how a very different approach on the part of environmental health professionals could help to find alternative solutions to promoting mental health among HMO residents

Developing wider partnerships to enhance mental health

In order to deliver more effective mental health and wellbeing outcomes, those charged with delivering housing enforcement also need to look more widely, particularly within the field of public health, for emerging opportunities to work in ways that bring housing and health together more closely than seen in recent decades. The Local Government and Public Involvement in Health Act 2007 required Primary Care Trusts (PCTs) and local authorities to produce Joint Strategic Needs Assessments (JSNA) of the current and future health and wellbeing of their communities. This demands wide stakeholder involvement with identified links to other

strategies and it needs to be founded on a local evidence base to have credibility (Emanuel 2011). With regard to mental health it was noted:

> *'Local government will play a central role in ensuring that local partnership arrangements can deliver the shared mental health objectives. Partners will include social care, education, the police and criminal justice system, housing, the environment, employers, charities and voluntary organisations, as well as health' (Department of Health 2011).*

This develops potential roles for environmental health professionals in wider public health and wellbeing partnerships including health and wellbeing boards and recognises that HMO enforcement alone cannot address the multiple causes and effects of mental health in its relationship with housing.

Local community-based projects in areas of high HMO concentration highlight the importance of combining enforcement of regulations to maintain housing standards while also engaging other agencies with the aim of tackling some of the underlying socio-economic issues in these areas. The successes of these projects reflect the comment in the Rugg Review that some issues seen as 'housing' issues are in fact 'wider policing' issues (Rugg and Rhodes 2008).

The award winning 'Operation Jupiter' (2006), at Weston-super-Mare is a good example of a multi-agency partnership that tackled the effects of problematic HMOs in a spatially concentrated area populated by a transient community. The local community was concerned about the number of vulnerable people moving to the area with drug and alcohol problems and the effect this was having on community stability, nuisance and anti-social behaviour. Central to the approach was strong enforcement of legal housing standards, closer inter-agency working and appropriate support for the community. In particular, the strategy sought to prevent an influx of potential tenants to unsuitable accommodation which would further aggravate their need and a gradual withdrawal of the more unsuitable accommodation (Grant 2008). Approximately 18 months into the project seven HMO premises had been sold, redeveloped or were subject to a 'change of use' application. Three further premises were proposed for sale to a Registered Social Landlord and forty nine Housing Standards enforcement notices had been served (Operation Jupiter 2006). The possibility of residents ending up in poor quality accommodation was therefore reduced and options were also explored to increase the supply of self-contained accommodation by working with private sector landlords and housing associations. This is likely to have beneficial effects on the mental health of people that are now living in improved accommodation and on the community more widely as the environment of their neighbourhood improves.

In another seaside town, the Margate Task Force has provided great impetus in drawing together agencies (including environmental health, housing, children's services, police, environmental health, children's services, probation service, primary care trust and drug and alcohol rehabilitation services) in tackling a similarly vulnerable and needy community characterised by multiple deprivation. The programme is based around strong private sector housing enforcement of HHSRS and HMO licensing conditions to address unsatisfactory HMO accommodation while offering substantial social support to the local and transient community (Stewart *et al*., work in progress). Programmes such as these protect mental health among HMO tenants very directly – not only through ensuring the HMO is of the correct standard but by tackling some of the underlying issues that may also contribute to mental health problems.

The need for evidence

Yet even these approaches currently face significant challenges owing to the lack of evidence to demonstrate the effectiveness, particularly the cost effectiveness, of housing and health interventions. Housing must be seen as a public health and wellbeing priority for this to change (Davidson *et al*. 2011). The Building Research Establishment (2008) and Chartered Institute of Environmental Health (2008) partly address this by demonstrating the value of private sector housing to public health. Specifically, they describe the HHSRS Cost Calculator, which calculates the health costs that arise from particular hazards and compares this with the cost of intervention. The calculator tool concentrates on physical rather than mental health impacts but the report does provide examples of how mental health has been included in some private sector housing strategies. The CIEH online Private Sector Housing Evidence Base aims to address knowledge gaps in this area and make information on effective housing and health interventions more available including that which tackles HMOs and mental health specifically. Rugg and Rhodes (2008) emphasised the importance of making best practice examples widely available and the database is an attempt to achieve this. Sound evidence will be of growing importance in securing resources from the emerging Health and Wellbeing Boards

(Emanuel 2011). Furthermore, local authorities need to be able to effectively demonstrate the effect their work will have on addressing mental health, a priority area for government (Department of Health 2010; Dunning 2010; Department of Health 2011). Understanding how the work of environmental health professionals and the management of private sector housing can contribute to the public health agenda could be an important component of this.

Conclusion

How housing affects mental health is a complex and under researched issue, particularly in HMOs. Using the framework developed by Evans *et al*., (2003) we have shown that current legislation has the potential to contribute significantly to the safety and quality of housing and this is likely to positively affect the mental health of tenants, through creating a sense of safety and security. However, we have also outlined how the current regulations and enforcement culture make it difficult for those working in private sector housing enforcement to take action against landlords, especially where the threat is to mental rather than physical health. The paucity of data regarding the impact of housing conditions on the mental health of residents adds to this difficulty. If the HHSRS is to be effectively used to protect mental as well as physical health, the lack of evidence of the relationship between housing and mental health needs to be urgently addressed so that this can be fully incorporated in the risk assessment framework of HHSRS.

In addition to regulatory action we have also emphasised the importance of interagency working so that HMO regulation is not tackled in a vacuum divorced from the socio-economic drivers that can fuel the issues in areas of high HMO concentration in low income settings. We have described two case studies where interagency working is delivering positive outcomes for HMO tenants as well as the wider community. If support for this type of intervention is to grow, and attract the funding and local mobilisation necessary for their success, documentation of their achievements needs to be forthcoming. This needs to be backed up by examples of best practice and learning points from private sector housing teams, which should be widely shared rather than local authorities tackling very common issues in separate silos. Furthermore, the involvement of local authorities in health and wellbeing boards and the creation of JSNAs should include officers involved in private sector housing regulation as well as environmental health professionals more widely so that the public health role of housing regulation and environmental health is fully recognised.

HMOs are going to become an increasingly important form of housing which is expected to attract increasing numbers of vulnerable tenants. Effective management of HMOs by local authorities is likely to include broader approaches that utilise appropriate legislation within wider public health and wellbeing strategies to help protect and enhance mental health. Before this can happen, however, the significant knowledge gap about how local authorities actually regulate and police HMOs needs to be addressed; otherwise progress in this area will remain in the theoretical rather than practical domain.

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Smoking in cars : How long are children exposed to elevated air borne particulate levels in cars post smoking of tobacco?

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Abstract

Legislation came into force in Wales in April 2007, making enclosed public places smoke-free. This legislation has proved highly popular and has achieved widespread compliance. As a result there has been improved indoor air quality and reduced passive smoke exposure for many members of the public.

This legislation applies to all forms of public transport (e.g. buses, coaches, trains, taxis) and also to vehicles used for work purposes. The legislation does not apply to private vehicles, and as such this study was undertaken to investigate the levels of second-hand smoke (SHS) from smoking within these vehicles. In order to do this, particulate matter was measured as $PM_{2.5}$, a particulate matter with a diameter below 2.5µm, which is of particular concern because particles of this size can travel deep into the respiratory system posing a health hazard. The measurements were taken within private vehicles while cigarettes were being smoked and undertaken so as to reflect the normal behaviour of smokers within their own vehicles during short journeys. $PM_{2.5}$ is the pollutant most strongly associated with increased risks of mortality.

It was the aim of the study to simulate the exposure of passengers within the vehicle to second hand smoke and in particular the potential exposure to children while seated in child restraining seats. $PM_{2.5}$ concentrations were monitored during 32 car journeys. There were seven participants of the study, including two non-smokers, who all volunteered to drive their own cars. During the study they were asked to drive, and where relevant smoke in their normal manner, making no changes to their normal behaviour. Most smokers tended to light a cigarette as soon as the journey commenced. Under these conditions the drivers also chose whether or not windows were opened and whether fan heaters were in use. To account for this, during certain tests, conditions were dictated with drivers being asked to close or open windows.

The results of the study indicate that concentrations measured in smokers' vehicles were significantly and consistently higher than those measured in non-smokers' vehicles.

Also under investigation was the period of time that the $PM_{2.5}$ levels remained at elevated levels above monitored base levels. The results of the study indicate that under certain conditions, elevated $PM_{2.5}$ concentrations may persist for a significant period of time.

Introduction

Particulate matter (PM) is a term used for particles found in the air including dust, dirt, smoke and liquid droplets. Such particles originate from many sources, the major man-made emitters being industrial processes, vehicle exhausts and other combustion sources (COMEAP 2009). Particles 2.5µm, or less, in diameter are referred to as 'fine' particles and these are roughly $^1/_{30}$th the diameter of a human hair. There is emerging evidence to suggest that the adverse health effects of such particles are caused principally by their ability to penetrate deep into the respiratory tract (Donaldson and Borm, 2007).

Environmental Tobacco Smoke (ETS), also referred to as second-hand smoke (SHS) or passive smoke, consists of a combination of mainstream smoke exhaled by the smoker and sidestream smoke from the burning of tobacco products (Schick and Glantz 2005). SHS is a toxic air contaminant and is known to contribute to preventable adverse health issues (SCOTH 2004). Exposure to $PM_{2.5}$ can have a significant effect on health, both in the short and the long term. In particular, exposure has been shown to increase deaths from cardiovascular disease, respiratory disease, and lung cancer amonge adults (Pope *et al*., 2002). Children exposed to SHS show a greater likelihood of lower respiratory infections, ear infections and increased severity of asthma symptoms Children may be more vulnerable to SHS-induced respiratory diseases owing to smaller airways and greater oxygen demand, hence higher respiratory rates, as well as less mature immune systems (Royal College of Physicians 2010).

These particles can be suspended in the air for long periods of time and it is this characteristic that is of great significance when considering the impact of passive smoke on non-smokers. Clearly the level of exposure to SHS is much greater in enclosed spaces.

Increasing numbers of people are taking measures to make their homes and private vehicles smoke-free. This was highlighted by difficulties experienced when establishing this study. The number of adults who are smokers has significantly reduced during recent years (WHO 2002) and of those approached to take part in this study, a large proportion did not smoke within their own vehicles. It was also a consideration that a number of potential volunteers were unwilling to participate because of the social stigma attached to smoking and did not want their smoking habits made public. A recent YouGov survey found that 78% of those interviewed agreed that smoking should be banned in cars where under 18 year olds were passengers (YouGov 2010).

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Figure 1.0
TSI SidePak AM510 Personal Aerosol Monitor

Figure 2.0
Typical monitoring position of TSI SidePak

Method

In the 1990's attention was initially directed towards particles of less than 10mm diameter (PM_{10}) but epidemiological evidence regarding the health impacts of smaller particles has now changed the focus to smaller particles of less than 2.5mm diameter ($PM_{2.5}$) (DEFRA 2007).

Prior to 2009 there was very little monitoring of concentrations of $PM_{2.5}$ particles. At this time an expansion in the UK monitoring programme occurred in order to meet the requirements of the EU Clean Air for Europe Directive.

During the study $PM_{2.5}$ concentrations were measured using a TSI SidePak AM510 Personal Aerosol Monitor. The 2.5µm impactor fixed to the inlet of the SidePak ensured that particles greater than this size would not enter the device and would therefore not be recorded. The SidePak was zero calibrated prior to each sampling test. The SidePak is fitted with a 10mm cyclone for respiratory sampling. The operating conditions require, and dictate, a flow rate of 1.7 litres/minute.

Sampling was designed, as far as possible, to reflect the normal behaviour of the volunteers participating in the study and monitored the smoking activity of persons within vehicles during short journeys. Each test, other than the static tests, was undertaken under driving conditions reflecting the normal behaviour for the volunteer taking part. Typically this would be a journey to work or a short shopping trip.

Monitoring positions were chosen to reflect the location of the respirable zone of a child while restrained in a child seat. This was achieved through the positioning of the Tygon™ tubing, attached to the inlet of the SidePak, at that of a child's head height, where possible on a child's car seat. In order to give comparative data $PM_{2.5}$ concentrations were measured within vehicles of both smokers and non-smokers. Further comparative measurements were obtained by using both diesel and petrol powered vehicles; measurements when static as well as during short journeys; and with car windows opened and closed.

The background levels of $PM_{2.5}$ within vehicles will vary depending upon a number of factors such as the speed of the vehicle and local traffic congestion. Climatic factors may also influence the background levels with the degree of sunlight and temperature affecting monitored levels (APHEIS 2006).

Four main smokers' vehicles were used for data collection: a Mazda MX5, a Citroen Picasso, a Citroen Berlingo and a Ford Fiesta. All these vehicles were owned and driven by volunteers recruited from the general community who confirmed that they routinely smoked while driving. All consented to being part of the study and all behaved as they normally would in respect of both smoking and driving.

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Three vehicles of non-smokers were used in the study for comparative purposes: a Fiat Multipla; a Skoda Fabia and a Fiat Panda. None of these cars had ever been used by smokers, as drivers or as passengers. As with the smokers' vehicles the drivers were volunteers who consented to take part in the study, and who, while participating in the study, drove as they would normally.

A number of factors was recorded for each test undertaken. These were: vehicle type; the use of mechanical and artificial ventilation; whether car windows were open or closed; the type of cigarette smoked (proprietary brand or hand-rolled); the number of cigarettes smoked during the test period and the length of time since smoking had occurred within the vehicle prior to the test commencing.

A comparison of the tobacco within the branded cigarettes and that used for hand rolling was undertaken. This was done by removing and weighing the tobacco contained in individual branded cigarettes and that removed from hand-rolled cigarettes provided by volunteers. The hand rolled tobacco was of a much denser quality with larger leaf particles which were moist, the branded being dry and dust-like. On average the branded tobacco proved to contain three times the weight of tobacco of that used to produce a hand rolled cigarette.

Having measured and recorded the $PM_{2.5}$ concentrations, the SidePak was connected to a personal computer and the data were downloaded using the 'TrakPro' software. As with other studies using the TSI SidePak (Wilson *et al.,* 2007) a calibration factor was applied to the measurements.

Results

The $PM_{2.5}$ levels monitored in the smokers' vehicles were not solely from the combustion products of smoking, but include emissions from various other sources. In order to assess this, background level tests were also carried out using non-smokers' vehicles to establish a baseline range. Any levels monitored in a smoker's vehicle which were in excess of the non-smoking vehicle levels might then be assumed to be owing to the act of smoking. The journeys taken by the smokers during the tests were not standardised and varied in length and route taken depending on the driver, thus reflecting the driver's normal behaviour. This was also undertaken to remove any bias from external sources.

Initially, tests were carried out on static vehicles of both smokers and non-smokers to assess any impact from the normal engine combustion process. The tests showed that the levels were comparable for both smokers' and non-smokers' vehicles; the levels being in the range 10-40µg/m³. The exception to this was in a vehicle of a smoker who was in the habit of never opening any windows while driving or when parked. The recorded levels in this instance averaged 1,000µg/m³.

Concentrations were monitored for a number of non-smokers journeys, all undertaken with windows closed and air condition systems not operating. The average of all levels recorded was 25.5µg/m³, with the highest peaks at 150µg/m³ and 87µg/m³. The levels did not vary greatly during monitoring, a minimum range of 2-22µg/m³ and a maximum range of 25-150µg/m³ being recorded.

Participants were asked to drive and smoke as they would normally while the monitoring was carried out. They were asked to note the start and finish times of the journey and conditions such as whether windows were open or closed were noted. Ideally, drivers were asked to leave the monitoring equipment running for a period of time after the journey, thus allowing monitoring to continue when the vehicle was parked at the end of the journey. This was not always possible but when achieved the windows were closed during this period for security reasons.

The data obtained from the tests on smokers' vehicles revealed elevated levels of $PM_{2.5}$ that were notably higher during active smoking than the pre- and post - smoking periods.

With references to tests undertaken with windows closed. The results showed a large increase in levels of $PM_{2.5}$ with some results showing a 1,000 and 2,000-fold increase.

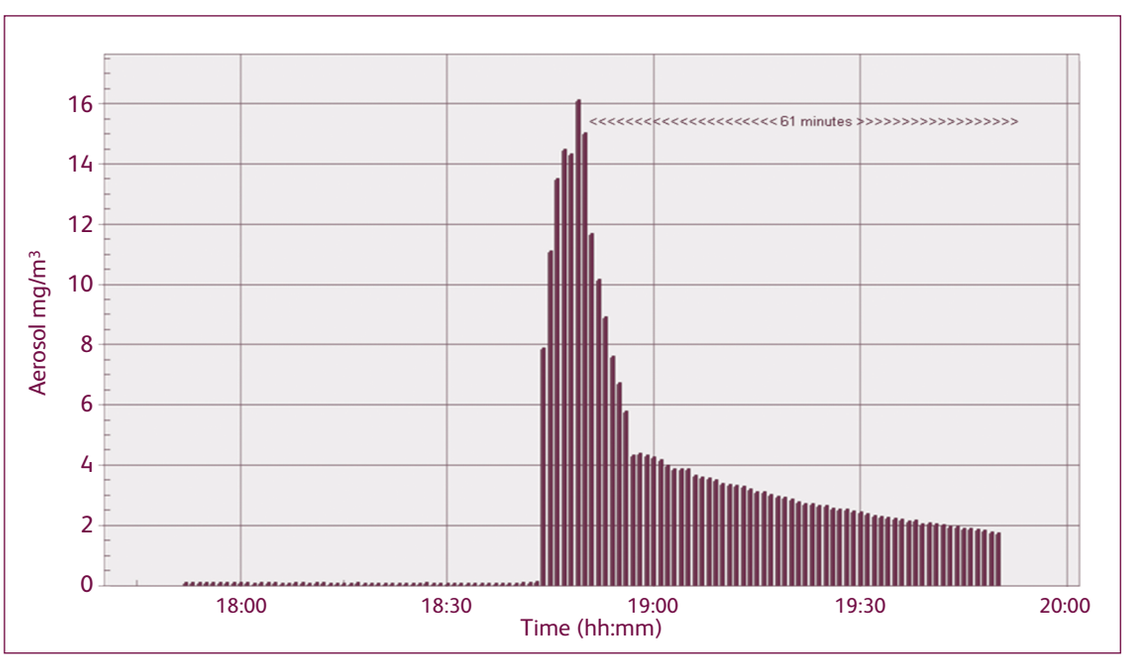
In one test an initial level of 22µg/m³ rose to a peak of 16,000µg/m³ within six minutes of the cigarette being lit and smoking commencing. Sixty minutes after smoking had ceased, concentrations remained at 1,900µg/m³.

In another test two short journeys were undertaken. An initial concentration of 10µg/m³ $PM_{2.5}$ was recorded which rose to 14,400µg/m³ after smoking had occurred for two minutes. Once the vehicle was parked, this level initially dropped and then increased to a level of 6,000µg/m³. The monitoring continued in this test while the vehicle was parked for a further 20 minutes and at this point the concentration of $PM_{2.5}$ remained at 2,000µg/m³. A similar picture was found with the second journey of this test

Table 1.0
PM2.5 levels in smoker's and non-smoker's vehicles

	Initial Level $PM_{2.5}$ (µg/m³)	Max. Level $PM_{2.5}$ (µg/m³)	Time elapsed since smoking took place (minutes)	Concentration $PM_{2.5}$ (µg/m³)
Smoker's vehicle (windows closed)	20	16,000	61	1,900
	10	9,500	82	500
	40	2,900	90	200
	10	14,400	28	2,000
	13	15,800	4	20
Smoker's vehicle (windows open)	15	4,800	10	50
	20	3,400	40	800
	30	16,000	12	900
Non-smoker's vehicle	25	27		
	38	150		
	10	25		

Figure 3.0
Smoker 2 Journey – windows closed



Initial monitoring period 1 – the vehicle was static, no smoking taking place. Period 2 – 1 hand-rolled cigarette lit and smoked for approximately 3 minutes. Period 3 – journey continued. Vehicle parked and driver not in vehicle, monitoring continued for approximately 50 minutes. Test carried out with windows closed and fan heater not operating.
Test results: Pre-test <20µg/m³; peak 16,000µg/m³; level after smoking ceased for 61 minutes 1,900µg/m³.

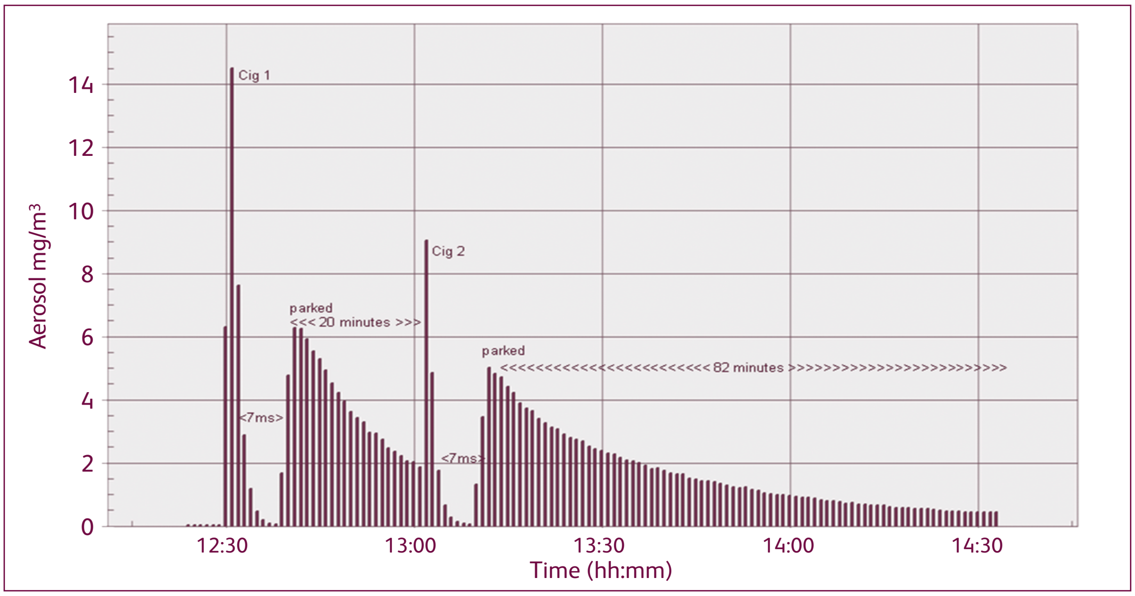


Figure 4.0
Smoker 3 Journey – windows closed

Period 1 – branded cigarette smoked during journey. Period 2 – vehicle parked, smoker not in vehicle, windows closed. Period 3 – Driver returns to vehicle and smokes cigarette during journey. Period 4 – vehicle parked, driver leaves car, monitoring continues for approximately 60 minutes. Windows remained closed during test with fan heater on. Test results: pre-test <10μg/m³; maximum peak 14,484μg/m³; level after smoking ceased for 82 minutes 500μg/m³.

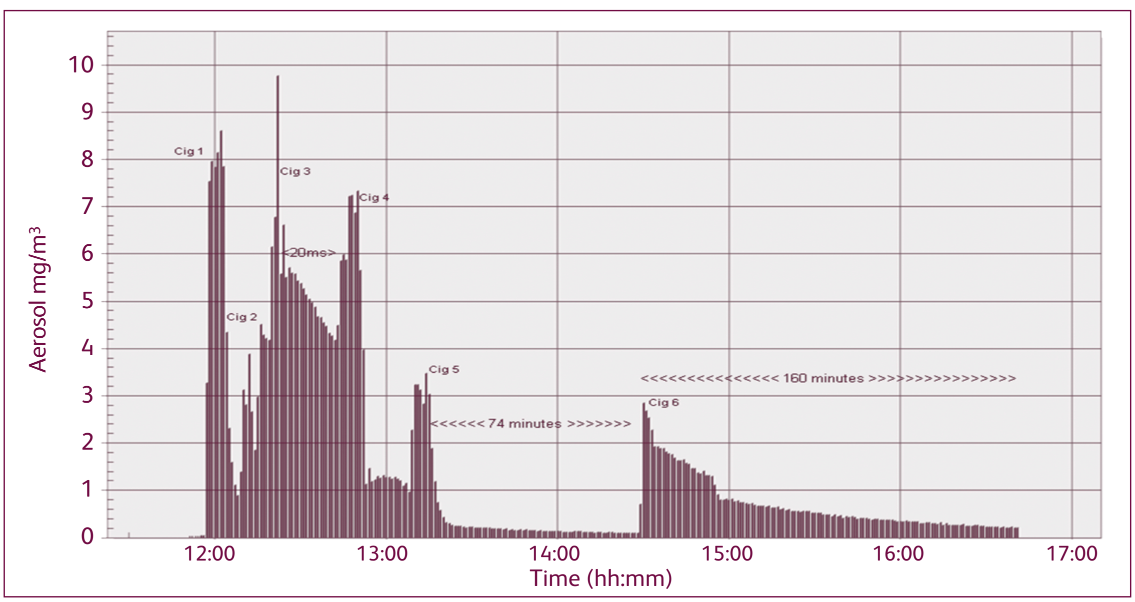


Figure 5.0
Test 4, smoker 5 journey – windows closed

During the test five hand-rolled cigarettes were smoked during three short journeys. After the first short journey the vehicle was parked for a 20 minute period, then for 74 minutes, after another short journey, as indicated. At the end of the journey the vehicle was parked, driver leaves vehicle and monitoring continues for 160 minutes. Test carried out with windows closed and fan heater on. Test result: pre-test <10μg/m³; maximum peak 9,747μg/m³; level after smoking ceased for 160 minutes 300μg/m³.

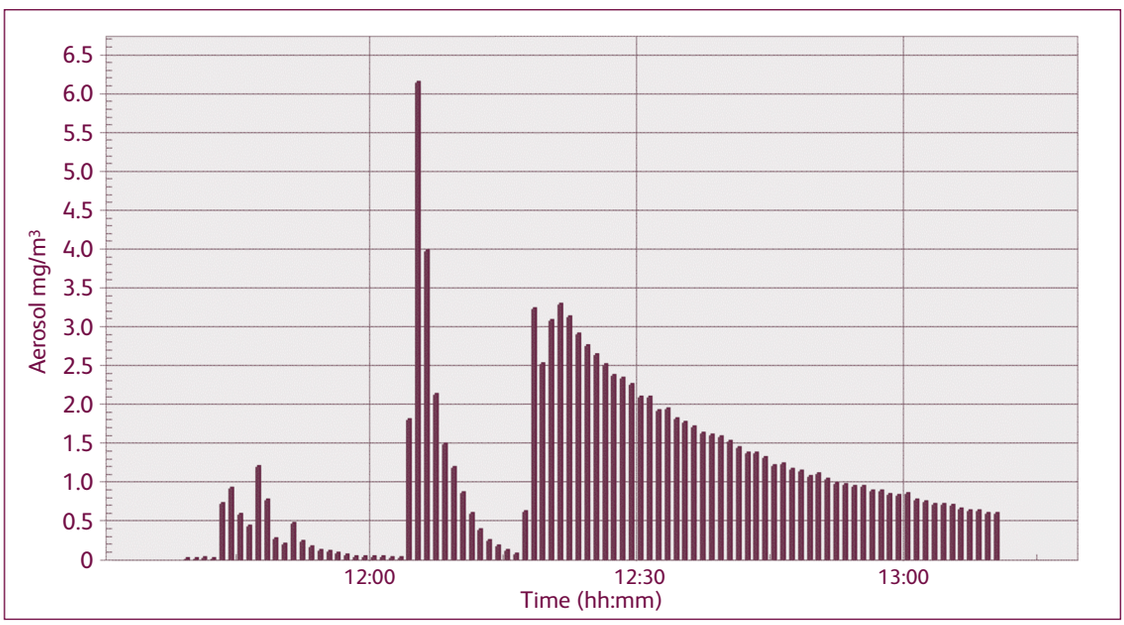


Figure 6.0
Test 5, smoker 5 journey – window open

Test carried out over three short journeys with one branded cigarette smoked during each short journey. The three peaks indicating the lighting and smoking of the cigarettes. Monitoring continued at the conclusion of the journeys for approximately 50 minutes. Test carried out with windows open. Test result: pre-test< 20µg/m³; peaks 6,200µg/m³ and 3,300µg/m³; level after smoking ceased for 50 minutes 600µg/m³.

which recorded a peak level of 9,000µg/m³. Eighty-two minutes after smoking had ceased, a concentration of 500µg/m³ was recorded in the parked vehicle.

Table 1 details an example of results from tests undertaken, indicating levels recorded prior to the test commencing, the maximum level recorded during the test and also the level recorded at the conclusion of the test. The time elapsed since smoking ceased and the $PM_{2.5}$ concentration at that point were also noted.

The time taken to return to pre-smoking levels was variable; those tests undertaken with windows open returning to pre-smoking levels quicker than those undertaken with windows closed, as had been predicted. On average the concentrations within vehicles were considerably higher when vehicles windows were closed compared to the tests when windows were open.

Tests were undertaken when both branded and hand-rolled cigarettes were smoked. On average the branded cigarettes, which contained three times more tobacco, produced concentrations of $PM_{2.5}$ twice as high as those produced when hand-rolled cigarettes were smoked.

It was found that for the vehicle with the smallest internal volume (Mazda MX5) the levels of $PM_{2.5}$ returned to pre-smoking levels within 10 minutes. This proved to be a much shorter time than for other vehicles, which took between 28-90 minutes. This was the case whether or not the windows of the car were opened or closed.

Figures 5.0 and 6.0 indicate results from the same driver and vehicle with differing test conditions. During Test 5 the windows were open whereas in Test 4 they remained closed; the peak level during Test 4 being significantly higher. This result is even more significant as during Test 4 hand-rolled cigarettes were smoked which generally produce a lower level of emissions than branded cigarettes. In Test 4 this factor is outweighed by the concentrating effect of the vehicle having closed windows.

Discussion

This study examined levels of $PM_{2.5}$ as a marker for SHS during short car journeys.

Currently there is no recognised threshold below which negative health effects from exposure to $PM_{2.5}$ are

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known to be absent. The current regime focuses on limiting long term exposure through the use of annual mean standards. This exposure reduction approach has been introduced for $PM_{2.5}$ in recognition of the absence of a safe level for exposure. However, there is no clear evidence as to which $PM_{2.5}$ components produce health effects; therefore all components must be treated as potentially harmful. It is estimated that for every 10µg/m³ increase in $PM_{2.5}$ the relative risk from long term exposure increases by 6% for deaths from cardio-pulmonary disease and by 8% for deaths from lung cancer (Pope *et al.,* 2002).

Although there are no recognised thresholds the US Environmental Protection Agency air quality index rates 24 hour exposure to $PM_{2.5}$ concentrations as follows:

> *Rates of 40µg/m³ or less are deemed as "unhealthy for sensitive groups" with levels of more than 250µg/m³ being "hazardous" for all individuals.*

The results from this study are consistent with those obtained by Rees and Connolly (2006). In their study recordings were taken as 24-hour mean values and thus were directly comparable to the US Environmental Protection Agency index.

The results obtained in this study cannot be directly compared to the US EPA standards as in this study only single-event, one-minute recordings were taken rather than 24-hour or annual mean concentrations. However, it seems likely that some concentrations measured were so significant that relevant 24-hour mean concentrations may have been exceeded if monitoring had continued over this period of time. Further statistical analysis might be conducted in order to test this hypothesis.

It is suggested by Rees and Connolly in their 2006 study that the main route of exposure of children to SHS is the time spent in the home with adults who smoke. As such the SHS exposure in cars is likely to be only a small percentage of their total exposure.

There are a number of improvements that could be made to any future studies:

i. Results were only obtained from a small number of tests; a larger sample base would be required to confirm the trends recorded.

ii. More details should be recorded during individual tests to give accurate real-time measurements. Specific documented timed recordings should be taken of the time a cigarette was lit, how long the smoking occurred for and the specific times that the vehicle was parked. In order to carry out this, an observer would need to be located within the vehicle to record the necessary details. This however introduces a possibly ethical difficulty into the study in that any observer would themselves be exposed to SHS. The health and safety implications of this would have to be carefully considered.

iii. External factors such as the time a vehicle is static in stationary traffic; whether the vehicle is positioned adjacent to a potential polluting source, i.e. industrial source or smoky exhaust from neighbouring vehicles, may also influence a rise in monitored concentrations.

iv. The volume of the driver/passenger space of vehicles used in the course of further monitoring should be considered when assessing the effects of having windows open or closed or the effects of ventilation systems on measured concentrations

Conclusions

The results from this study indicate that levels of SHS and of $PM_{2.5}$ within cars are greatly increased during smoking and also that these elevated levels persist for a considerable period of time after smoking has ceased. The concentrations recorded are of a level that presents serious health implications to all passengers and in particular to children who may be unable to express an opinion and may have no other option but to inhale this second hand smoke.

Banning smoking in cars when children are passengers presents difficulties in terms of both monitoring and enforcement. Such a ban has, however, been established by legislation in a number of countries such as the United States of America (in several States), Canada, South Africa and Australia, all with substantial success (Thomson and Wilson, 2009).

The results of this study allow members of the public to make an informed choice, which may be enough to persuade them to stop allowing their children to be exposed to high levels of harmful air pollution. The information from this study has proved sufficient for two volunteers involved in the study to not only stop smoking in their vehicles but to stop smoking altogether.

Acknowledgments

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The adequacy and public perception of the public toilet provision on Guernsey

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Abstract

In recent years there has been a decline in the state of public toilets and, with over 50% of the public toilets being closed, this has become a cause for public concern. Local authorities have no legal requirement to provide public toilets and because of this some towns have no public toilet provision. The aim of this study was to investigate the adequacy and provision of the public toilets on the Island of Guernsey. This investigation was undertaken through observation of the 30 public toilet blocks and a questionnaire exploring the provision of the public toilets, emailed to a representative sample of the Island population. All 18 of the toilets for those with disabilities, 26 (out of 30) of the male and 27 (out of 30) of the female public toilets were observed and the response rate to the questionnaire was 48% (n=264). Results confirmed that there are an adequate number of public toilet facilities for the Island's population in accordance with the British Standards. Fifty-five per cent of respondents were satisfied or very satisfied with the number of facilities. However concerns were expressed about the number of the public toilet that were closed during the winter months and the proposed closure of toilets in an effort to save money. The research concluded that the adequacy, provision and impression of the public toilets on Guernsey was good, but more attention needs to be given to year-round availability and the additional facilities required within them.

Key words: Public Toilets, WC, Lavatory, Antisocial behaviour, Disabled Toilets

Introduction

Since the 1850s, attitudes towards the provision of public toilets have shifted significantly. Originally, local authorities competed with each other to create beautiful, magnificent and hygienic towns and cities (Department for Communities and Local Government, 2008). State of the art public toilets were built with no expense spared, showing off the latest developments in sanitary engineering and architecture (Greed, 2005). The impetus for good toilet provision was a result of factors such as the need to control disease and pollution in the large cities of the time, and more positively, they were built as a result of civic pride, and the desire to create beautiful hygienic cities (Greed, 2005). The sanitation needs of the public have changed with a great majority having private access to toilets and washing facilities. Demands upon the local authorities' resources have moved to other services, resulting in a shift in the importance of public toilet provision from that of the high importance it once was.

As there is no statutory requirement for the provision of public toilets it is entirely up to the good will of the authorities to provide them. The 1936 Public Health Act (Section 87) gives local authorities the power to provide public toilets, but there is no mandatory requirement to do so. Unfortunately in the modern economic climate, this good will and discretion to meet the public's needs is weighed in the balance against other local demands. Under section 87 (3c) of the Public Health Act (1936), local authorities are allowed to charge for use of all public toilets, but not urinals. This in effect has denied local authorities a revenue source, and is not consistent with the principle of gender equality (Department for Communities and Local Government, 2008). Following the recent sexual equality regulations – the Sex Discrimination Act (Amendment) Regulations (2008), this long-standing anomaly was removed creating new scope and incentives for better provision (Department for Communities and Local Government, 2008).

The provision of public toilets is important for several reasons: people need to be able to access toilets when away from home; their closure, lack of availability or generally poor standards can be a cause for concern among would-be users. The decision to close a substantial proportion of public toilets may contribute, over time, to an increase in the number of National Health Service (NHS) patients with urinary tract infections and/or incontinence (Edwards, 1998). As well as contributing to people feeling a lack of dignity and poor hygiene as they may have to resort to street fouling and the potential for the spread of infection (Central Cities Institute, 2002; Department for Communities and Local Government, 2008). If well-planned, designed, maintained, clearly signposted toilet facilities are accessible to the public, they can contribute to local economies by creating town and city centres where people want to spend more of their time, and consequently their money. Unfortunately, in Britain there is very little strategic planning for the provision of public toilets, even though they are a vital part of any urban regeneration programme (Lockwood, 2001). This is not reflected in other countries such as Japan, which fully integrate toilet provision into its town and city planning (Miyanishi, 1996).

As there are no statutory requirements for authorities to build or maintain public toilets, regulations or codes of practice for the building of public toilets are sparse. Until

recently only BSI BS6465, Parts 1 and 2 offered guidance and recommendations. The only provision for public toilets is one sentence in BSI BS6465 Part 1 (2006), section 7.4, which states: '*the provision of sanitary appliances in public toilets should be determined according to local need*', therefore leaving it open for local authority interpretation. Fortunately, this weakness has been identified and there is a draft standard BSI BS6465 Part 4 (2010) which gives recommendations on the location, numbers, sitting, design and management of public toilets. This new standard will be applicable to the provision of new facilities, and to the retention and refurbishment of existing facilities. In 2006 the Singapore Restroom Association updated and reprinted its 1999 *A guide to better toilet design and maintenance*, and in the United Kingdom (UK), the British Toilet Association (BTA) offers a consultancy service auditing the councils' provision based on what users have highlighted, and the BSI BS6465 recommendations. The BTA's demands for the Government to place an obligation on local authorities to provide adequate public toilet facilities have not been dealt with owing to a lack of support from within the Government. In essence, The Public Health Act (1936) gives local authorities the power to provide public toilets, but imposes no duty to do so.

It is evident that this lack of strategic toilet policy planning is also reflected on the Channel Island of Guernsey. In light of this, Guernsey was chosen as the location for this research study, because it is the home of researcher and to establish the impact the public toilets may have on the islands population and its touristic nature. Guernsey is situated roughly 30 miles from the French coast and some 70 miles from the south coast of England. The Island has an area of approximately 24 square miles, divided into 10 parishes, and services an island population of 62,274 which fluctuates in the summer months, increasing by about 3,000 (States of Guernsey, 2010). Guernsey is Crown Dependant, but independent of the UK, and is outside the European Union. Its main financial income is from the finance industry followed by tourism. Even though Guernsey is independent of the UK, it does adopt many of the UK guidelines and recommendations.

Guernsey has a total of 30 public toilet blocks as well as those situated in Government buildings. These toilets consist of coastal toilets, which are mainly situated beside kiosks (local beach cafes), and those managed by the individual parishes and harbour authorities. The provision of facilities for disabled people and for parents of young children and babies varies across the Island. The lack of adequate accessible well-lit and good quality public toilets affects a wide range of people including women, families with young children, disabled people, the elderly and anyone who has frequent need of a toilet (Greed, 2004; Department for Communities and Local Government, 2008). Poor provision can result in people feeling a lack of dignity as they may have to resort to street fouling. Vulnerable groups who feel unable to go out without the assurance of access to clean, safe and accessible toilets are at risk of social isolation. The extent of the problem on the Island of Guernsey is unclear. Therefore, this study was undertaken to address the local gaps in knowledge, establish the provision and perception of the public toilet provision on Guernsey.

Methods

Non-participant observation

Over a two-week autumn period (1st to 14th November 2010) each of the 30 public toilet blocks were individually visited and surveyed using an adapted checklist developed by Hanson *et al*., (2007) based on the BTA (2000). Through direct non-participant observation, where the researcher is not directly part of the situation being observed – in essence an outsider looking in (Lanoë, 2002). The male, female and disabled toilets of each of the toilet blocks were directly surveyed by the researcher using the adapted qualitative checklist. As there were only 30 public toilet blocks available for surveying, it was decided to include them all, thus aiming to provide comparative and representative data describing the public toilets on Guernsey. The results were recorded directly 'on the spot' using a portable computer (Viewpoint7 Tablet VP70 from Customer Research Technology). Prior to the consultation period, a pilot of the data collection method using three of the public toilet blocks was undertaken and subsequent changes and amendments made. At the end of the consultation period the data collected were downloaded and presented on a spreadsheet for analysis (using Microsoft Excel).

Questionnaire

A semi-structured, mixed methodology questionnaire was adapted from the Oxford City Council *Your views on Public Toilets* (2009) questionnaire, the Bournemouth Borough Council *Seafront public toilet Satisfaction survey* (2005) and Hanson *et al*., (2007) Attitude Survey. The questionnaire was initially pre-tested by three health professionals who completed it while being observed. As suggested by Gillham (2002) ease of use was assessed at

this stage; queries and comments noted. Following minor amendments the questionnaire was emailed to a pilot group of 12 people. This identified the validity, reliability and any misunderstandings of the questions. Further amendments were made to the questionnaire before distribution. The questionnaire was emailed to the participants on an already developed, market research data base (*www.islandanalysis.com*). The sample was a representation of the Island's population, with an age range of 18 upwards and a 50:50 male/female split.

The inclusion criteria were those who are over the age of 18 and answered 'Yes' to the survey question 'have you used Guernsey's public toilets in the last 12 months?'. To achieve reliability and accuracy, it was decided that the questionnaire would be sent to all 431 potential respondents on the data base. A further 124 questionnaires were e-mailed to researcher's email contact list. Informed consent for participation in the study was assumed by the respondent completing and returning the questionnaire as suggested by Thomas (2000). Respondents' anonymity was maintained by allocating a unique identification number.

Two weeks following the initial mail shot of the questionnaire, a follow-up reminder was sent to those who had not responded, and a further two week period was allowed for late responses. At the end of the consultation period, the information was downloaded and presented on a spreadsheet for analysis using a descriptive statistical tool (Microsoft Excel) as suggested by Salkind (2007). The qualitative findings were analysed using a qualitative content analysis style according to the major themes identified in the data. Qualitative content analysis involves breaking down data into smaller units, coding and naming the units according to the content they represent, and grouping coded material based on shared concepts (Polit and Beck, 2008). Recurring themes that emerged from the data were as follows:

- The implications of public toilets for men and women
- Disabled toilet access
- The affects of antisocial behaviour
- Closure of public toilets and
- The issue of payment to use public toilets.

Results

Non-participant observation

On the Island there are 18 disabled toilets, 30 male and female toilets, situated in the toilet blocks. During the consultation period, four of the male toilets and three of the female toilets were closed for the winter months. All the 18 disabled toilets were accessed. The majority of the facilities were easily accessible with good signage apart from one male toilet which had 12 slippery steps leading down to it. The disabled toilets were only accessible with a RADAR (The Royal Association for Disability Rights) key.

Generally, the toilet facilities had a 97% rate for good lighting, good contrast in internal decoration and clean facilities; only two of the male toilets did not meet the standards. Only one of the 27 female and none of the disabled toilets had a sanitary bin. Fifteen of the male toilets, 21 of the female toilets and 14 disabled toilets had accessible waste bins. Baby changing facilities were present in only four of the male toilets and 20 of the female toilets. There were no adult changing facilities in any of the toilets. Twenty of the male and 22 female toilets had automatic all-in-one hand washing facilities (hole in the wall type), but all 18 disabled toilets had a wash basin and hand towels or hand dryer. Only one of the male toilets had liquid soap and five had a bar of soap; seven of the female toilets had liquid soap dispensers and 20 had bars of soap. Of the disabled toilets, only two had liquid soap dispensers, 15 had bars of soap and one had no soap at all.

On average the female toilets had three toilet cubicles per facility, and the male toilets had one toilet cubicle and two urinals. Seven of the female facilities had four or more toilet cubicles, and 18 of the male toilets had four or more urinals/toilet cubicles per facility. In total there are 84 female toilet cubicles, 58 male toilet cubicles and 69 male urinals. All the 18 disabled facilities had a toilet but no urinal, they all had sturdy grab rails present, none of the facilities had an alarm, and 17 of them had transfer spaces free of obstruction. Twelve of the 18 disabled toilets had the flush lever on the transfer side.

Questionnaire

Of the 555 questionnaires emailed to the participants, there was a 48% response rate. Figure 1.0 displays a breakdown of the number of respondents in respect to their age group. Fifty-six per cent of the respondents were female and 44% were male; however 10% of the respondents did not meet the inclusion criteria. Therefore only 90% of the responses were eligible for inclusion in the study.

The respondents were asked to identify, with reasons, which public toilet they felt was the best facility. The

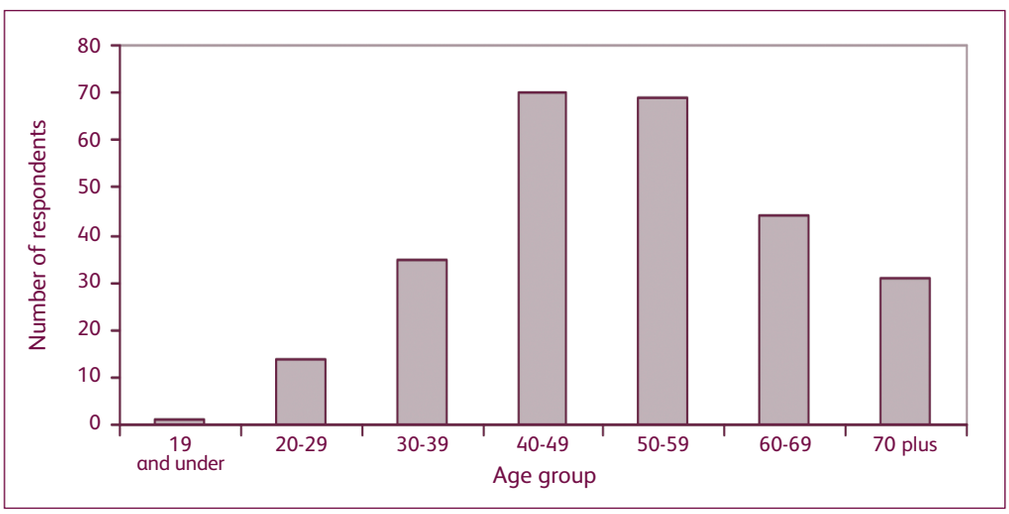

Figure 1.0
The number of respondents by age groups

Figure 2.0
Average rating with regards to elements of Guernsey's public toilet blocks (1=very unsatisfied/ unimportant, 5=very satisfied/important)

majority (34%) of the responses rated the bus terminus toilets mainly because of their convenient location to the main shopping area and their cleanliness.

When asked to rate the importance of the various elements of the public toilets' cleanliness (67%) and personal safety (45%) were rated as very important. However, when asked how satisfied they were with the same elements, 47% were satisfied and a further 8% were very satisfied with cleanliness. For personal safety 57% were satisfied and 10% were very satisfied. Other very high rating elements are opening hours and location; the removal of

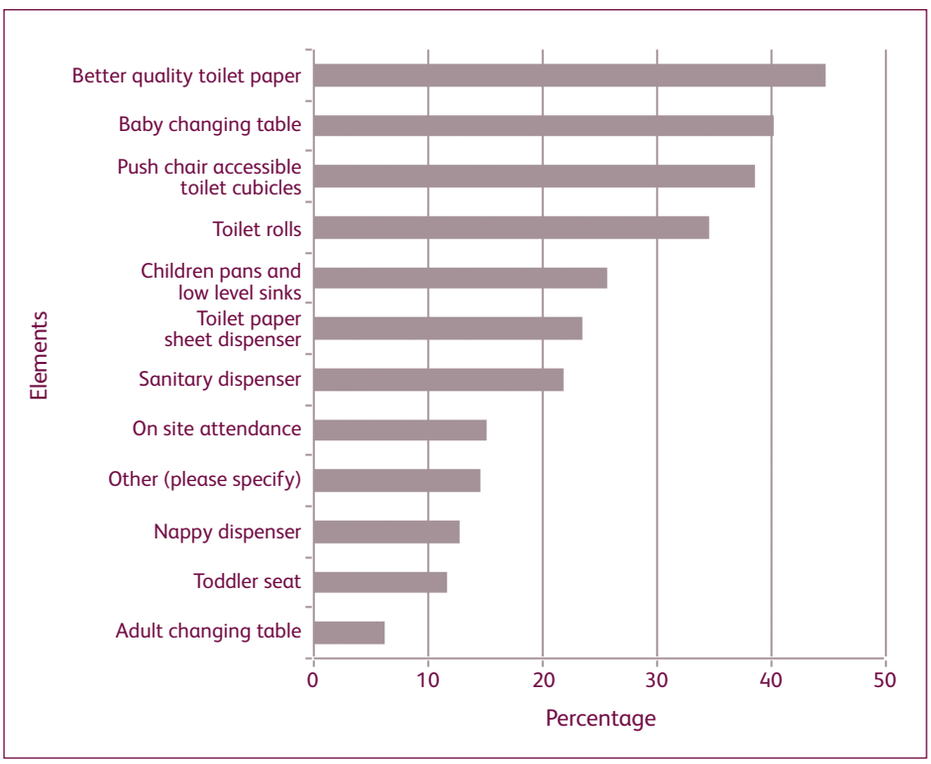

Figure 3.0
Percentage of additional facilities the respondents would like to see in the public toilets

graffiti/vandalism was rated as being the least important with 7% identifying this as being very unimportant. Figure 2.0 displays an average rating of how satisfied/very satisfied the respondents felt about specific elements of the public toilet blocks against how important/very important they felt about the same elements.

Additional facilities that the respondents would like to see in the public toilets were also identified. Forty-five percent of the respondents identified better quality toilet paper as the additional facility they would like to see most. Baby changing tables were identified by 40% of the respondents. With only 6% responses, adult changing tables drew the lowest number of additional facilities required by the respondents. Other facilities identified were: paper towels, less tightly packed paper dispensers, toilet brushes, mirrors, on site attendants, hot water, drinking water taps, door hooks and outward opening toilet doors. Figure 3.0 displays the percentage of additional facilities that respondents would like to see in the public toilets.

Only a small percentage of the respondents (4%) planned their journeys around the Island's public toilets, and a further 19% sometimes planned their journeys around them. The main emerging themes for planning their journeys were medical conditions such as bladder and bowel disorders, diuretic medication, dependant relatives/children, and participating in outdoor leisure activities such as running and walking.

The preferred choice of toilet facility when away from home was identified. Forty-six per cent respondents identified restaurant toilets as being their preferred choice of toilet, followed by public toilets with 31% preferring to use them. Four per cent of the respondents stated that they use the closest toilet facilities when in need. Two respondents stated that when a toilet was not available they would use hedges, gateways, fields and sometimes a quiet area of the park.

At present there are no 'pay to pee' toilets. Some respondents were happy to pay to use the toilets if they were of a high standard (61%), while others felt they had already paid for them in their taxes (39%). When asked if the respondents would pay to use a public toilet, if the money went towards the annual £500,000

required for the upkeep and cleanliness of the facilities, 61% respondents stated they would be happy to pay. Out of the 144 responses, 20p was the preferred choice of charge with 55% happy to pay this. Twenty-eight per cent were happy to pay 10p and 12% 50p. Only one person was happy to pay £1.00 to use a public toilet. The overall impression of the public toilets was good with a 48% response rate, and 12% very good. Two percent of the respondents felt the toilets were very poor and 29% gave a neutral response. Only 1% of the respondents' impression of the toilets was very poor.

The respondents were asked if they had any additional comments they would like to add in relation to Guernsey's public toilet provision. Over half (51%) of the respondents took the opportunity to make comments. Emerging themes were cleanliness (24%), closure of toilets (9%), opening times (8%), vandalism (11%), lack of public toilets in the main shopping area (18%), upgrading the current public toilets (5%), tightly packed toilet paper dispensers (7.6%), and payment to use the toilet facilities (19%).

Discussion

Recommendations made by the BSI (2010) and BTA (2000) on the number and type (male and female) of public toilet facilities per head of population show that the Island is more than adequately covered. Even with this information, only half of those surveyed were satisfied with the public toilet provision on the Island.

As found in many countries (Gerhenson and Penner, 2009) there are fewer female facilities compared to male facilities on the Island. There is a greater need for female facilities as they are more often out during the daytime, use public transport and are accompanied by children, the elderly and the disabled (Cavanagh and Ware, 1991; Booth *et al*., 1996). Historically, British public toilets were built in an age when more men were often out of the house compared to women. The BSI BS6465 Part 1 (2006) Code of Practice for the design of sanitary facilities has been updated to correct this historical inequality.

The BSI (2010) recommendations stated that:

- Local authorities should ensure public toilets can be easily found by users, and that they are situated on frequently used routes; the direct non-participant observation found that the three main town centre public toilets complied with this. Also the town centre public toilets were open 24 hours a day.
- Coastal and cliff-path public toilets are situated between 1.5-5 miles apart and the majority of the facilities are well signposted, have good access, good lighting and internal decoration. The Guernsey facilities complied with this.
- Adequate baby changing facilities should be provided in all public toilets, accessible for both able bodied and disabled men/women. Observation revealed that the Guernsey public toilets do not meet these recommendations as only one of the public toilets situated in the town had baby changing facilities which would be accessible to all, and only 74% of the female toilets, and 16% of the male toilets, had baby changing facilities. Forty per cent of the respondents identified baby changing facilities as one of the main additional facilities that they would like to see in all of the public toilets.
- The Environmental Protection Act (1990) recommends there should be a sanitary disposal bin in every women's and disabled toilet cubicle. Results revealed that a sanitary disposal bin was present in only one of the female toilets, and none of the disabled toilets and baby changing areas, therefore not complying with the Environmental Protection Act (1990).
- Hand washing should be able to be performed with minimal contact with fittings, using lever taps or automatic all-in-one hand washing facilities. The majority of the male and female public toilets offered the desired automatic all-in-one facility. For those that did not, they offered either paper towels, or electric hand dryers, accompanied by either liquid soap or a bar of soap. Worryingly, a bar was the majority type of soap, especially as scientific evidence suggests that a bar of soap following use has a high bacterial count (McBride, 1984; Kabara and Brady, 1984); however, studies have failed to show the transfer of these micro-organisms to the hands on subsequent use (Heinze,1985; Heinze and Yackovich, 1988).

Since 1979, purpose-designed unisex public toilets have been available under the RADAR (The Royal Association for Disability Rights) key scheme, in which specifically adapted toilets for people with disabilities are locked, and can only be used by those who have access to the appropriate key (Blackman *et al*., 2003; Brawley, 1997). An advantage of these purpose-built disabled toilets are that they are unisex, which is helpful for the user, because they may be accompanied by a carer (often a spouse or relative), of the opposite sex.

The adequacy and public perception of the public toilet provision on Guernsey

Out of the 30 toilet blocks visited, only 18 of them had a disabled toilet which was accessible with a RADAR key and out of the 237 responses to the Guernsey questionnaire only one (0.4%) had a RADAR key. Under the terms of the 1995 Disability Discrimination Act (DDA), disabled toilet provision should be equal to that for the 'abled' bodied toilets (Office of the Deputy Prime Minister, 2004). Unfortunately in Guernsey there is no Disability Discrimination Act and the States are not legally obliged to adhere to the UK guidelines and recommendations.

The direct non-participant observation of the toilet facilities was undertaken during the first two weeks of November 2010, which is the lowest month of the tourist season. It may not have portrayed a true representation of the toilets, as they may have experienced 'low use' whereas in the summer months their usage increases to that of 'heavy use' (BSI, 2010). Also 10% of the female toilets and 13% of the male toilets located in the areas of 'low use' were closed for maintenance and to save money. (These toilets were reopened at the end of February).

The response rate to the questionnaire survey (of 48%) was satisfactory, considering the type and topic of the survey. The majority of respondents were in the 40-49 age group. Female responders were in the majority; women have a vested interest in this subject, as they have been identified as the group most regularly out and about in the daytime, they travel on public transport more than men, and often are accompanied by children or elderly or disabled relatives (Cavanagh and Ware, 1991 and Booth *et al*., 1996).

The survey findings reflect the results of similar questions asked as part of the Bournemouth Borough Council Seafront Survey (2005). The respondents noted the following:

- The public toilets based at the bus terminus as the most frequently used, citing their convenient location, cleanliness and their 24-hour availability
- Highest satisfaction with the location of the public toilets, followed by their personal safety and number
- Least satisfied with sign posting and toilet opening times
- Concerns about the type and quality of the toilet paper. Tightly packed toilet paper dispensers caused a mess as the paper ripped on removal and fell on the floor
- The main choice of public toilet facility when away from home was identified as a restaurant toilet followed by a public toilet facility.
- Thirty-nine per cent of the respondents were not willing to pay to use the public toilets. An explanation for this was that they felt they had already paid for them through their taxes. Over half of the respondents were happy to pay to use the toilet facilities, with 55% of the respondents, indicating 20p as being the preferred amount. This explanation is similar to that of Edwards (1998), who argued that payment at source through the rates and taxation, rather than point of delivery at the toilet door, is more equitable (in the same way one does not pay to walk on the pavement or to sit on a park bench). Some authorities feel that charging the individual end users at the point of delivery brings in very little revenue and is ineffective. Charging for toilets can cost more than not charging as local authorities have to pay for the installation, maintenance, cleaning and security of toilet facilities.
- The main concerns expressed included closure, vandalism, cleanliness, and lack of a public toilet in the centre of the main shopping town. While these concerns were expressed in the comments' section of the questionnaire, they reflect the findings of the Bournemouth Borough Council (2005), Oxford City Council (2009) surveys and a UK study undertaken by Greed and Daniels (2002). As there is no legal requirement stating that local authorities 'must' provide public toilets only that they 'may' if they choose, the result is public toilets are becoming an easy target for cutbacks in public expenditure (Greed and Daniels, 2002). Research argues that adequate provision of public toilets, is vital to the local economy (Greed and Daniels, 2002); therefore these closures may have a deleterious effect on the health, dignity and lifestyle of millions of people, directly or indirectly. It is now the 21st century and we all deserve readily accessible, clean, well-maintained public toilets as one of our basic human rights (Greed, 2005). However, the overall impression of the Guernsey public toilets was good/very good.

Conclusions

- There are an adequate number of public toilet facilities for the Island's population, in accordance with the BSI (BS6465) recommendations.
- Concerns were expressed regarding availability in

terms of: the reduction of the number of public toilets; times when the winter openings are implemented; and closure of toilets, in an effort to save money. The need for additional public toilets in the centre of the town was highlighted.

- The respondents want to see more in the provision of baby-changing tables, better quality paper, pushchair accessible toilet cubicles and sanitary provision. Access was also seen as a difficulty in some observations.

- There is a lack of disabled toilets and all the disabled toilets were only accessible with a RADAR key, thus excluding some users, as there is no guarantee that everybody who needs a 'disabled' toilet will have a key.

It may be concluded that overall, the adequacy, provision and impression of the public toilets is good, but more attention needs to be given to the additional facilities provided in them.

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