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Editorial: Obesity – an opportunity not missed? – Ian Blair



The publication of the Healthy Weight, Healthy Lives report on the 23rd January 2008 marks a significant point in the recognition of the growing national public health obesity problem. This report has highlighted that if current trends continue, half the UK population could be obese within 25 years. The health care costs associated with the impending crisis when combined with the potential lost work hours has been estimated to reach £45bn a year by 2050.

It is not surprising then that the public health threat posed by obesity in the UK has been described as a "potential crisis on the scale of climate change", by the health secretary Alan Johnson. However he also said individuals had to take responsibility for their own health as part of a "cultural and societal shift". This message was reinforced by Prime Minister Gordon Brown who has thrown his weight behind the report with a carefully crafted forward in which he asserts that:

“There should be no doubt that maintaining a healthy weight must be the responsibility of individuals first – it is not the role of Government to tell people how to live their lives and nor would this work”.

The Prime Minister has backed a long-term action plan to fight obesity, funded by money in the latest Comprehensive Spending Review.

So it is clear that the Government is now fully aware of the potential significance of the problem and is prepared to fund the initiative appropriately but the old public health dilemma remains – whose responsibility is it? The Government recognises the scale of the problem but does not wish to implement ‘nanny state’ controls to reverse the trends – preferring to rely on the social conscience and self-determination of the individual. Governments seem able to identify issues that will cause significant public health improvements at an early stage but seem unwilling, or in many cases unable, to provide those at the coal face of public health protection and promotion with the tools to deliver the government long term aims. This has parallels with other public health issues that have presented themselves in the past.

I imagine many of you reading this are thinking this has little to do with ‘real public health’ – how can we as Environmental Health Practitioners control what the public choose to eat and how they choose to take exercise, if at all? Well, think back to the situation 50 years ago when the consumption of tobacco products was so ingrained in society that it was considered to be the norm to smoke.

Between 1950 and 1970 successive governments (heavily lobbied by pro-smoking groups) took the view espoused by the current government that this public health problem must be solved by empowering individuals to stop smoking. This policy singularly failed to make significant inroads and only by implementing significant financial penalties between 1970 and 1990 did any substantial downturn in the smoking related public health issues become apparent. Only in the last five years has the smoking issue been thoroughly addressed by legislation and genuine and

empowered action by public health professionals to the point where real public health benefits are now undeniably evident.

The lesson is clear – to accept the current position and place responsibility on the individual or collectively the public to address this issue is doomed to failure and will consign the health of the nation to 50 years of a downward spiral of health and an upward spiral of costs to a point where it may become unrecoverable. The only real option is to empower those with the ability to change the public perception of this issue and to adopt a multi-profession and multi-stranded approach to deliver the public health benefits that are so badly needed.

In some ways this Government is to be congratulated in that it has recognised this issue at an early stage and has identified a way forward. As it comments in the report:

“...It will bring together employers, individuals and communities to promote children's health and healthy food; build physical activity into our lives; support health at work; and provide incentives more widely to promote health.

It will also provide effective treatment and support when people become overweight or obese”. We as Environmental Health Practitioners must embrace this opportunity to ensure that we contribute to the debate and in the solutions to this impending crisis. We also need to ensure that our systems are sufficiently joined up to make a significant impact on the scale of the problem. In short we need to work with colleagues in education and within the Health Service to provide the public with the advice and access to the facilities they require to avert this crisis.

Thus I applaud the Government in the publication of this Healthy Weight, Healthy Lives – it is a clarion call for all public health professionals to work together in an unprecedented way to deliver measurable public health benefits. This is a real chance for like-minded professionals to work across boundaries for the tangible benefit of the health of the nation. It also must be sufficiently funded by central government.

Of course ‘the proof of the pudding will be in the eating’ but this is a genuine opportunity which must not be missed – to do so would be criminal for the health of our future generations.

The removal of *Giardia* spp. cysts by waste stabilisation ponds in Matsapha sewage treatment plant, Swaziland - Eng. Stanley J Nkambule¹ MSc BSc, Moses S Dlamini² BSc and Dr. Anthony M Grimason³ PhD BSc MREHIS MRSTM&H

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Abstract

Wastewater stabilisation pond treatment systems are generally viewed as an effective and low cost method of removing pathogens from wastewater. Their low operation and maintenance costs have made them a popular choice for wastewater treatment, particularly in developing countries since there is little need for specialised skills to operate the system. A study of a domestic and industrial wastewater treatment stabilisation pond system in Matsapha, Swaziland was conducted to determine the removal efficiency of *Giardia* spp. cysts from raw sewage and pond effluent. Cysts were detected using a combined immunofluorescence antibody technique and diamidino-2- phenylindole (DAPI) nuclear staining dye. Seventy two raw sewage and pond effluent samples were examined for the presence of *Giardia* spp. cysts. Cysts were detected in 16 of 18 (88%) raw sewage samples and anaerobic pond effluents, 8 (44%) facultative pond effluents and 5 (28%) maturation pond effluents. The results obtained showed a reduction of cysts from a maximum of 2,400 cysts/l in raw sewage to a maximum of 600 cysts/l in the final maturation effluent. The theoretical total retention time of the pond system was approximately 45 days; however the true retention time may have been reduced by as much as half due to hydraulic overloading. This study has shown that the wastewater stabilisation pond process under investigation is efficient at reducing the number of cysts by up to 83%. Further work is required to (i) improve the method used for the recovery and detection of cysts in wastewater and (ii) determine the species, viability and infectivity of cysts detected in the final effluent.

Key words: Environmental health; *Giardia*; sewage; waste stabilization ponds; Swaziland; Africa.

Introduction

Giardia is a protozoan parasite that infects a large range of hosts, including humans. At the present time, five species are currently recognised of which *G. duodenalis* is thought to be the species that causes disease in humans (Thompson, 2004). It is estimated to be responsible for 200 million symptomatic cases in Asia, Africa and Latin America, with some 500,000 new cases per annum reported predominantly among children (WHO, 1996). In Africa, up to 30% of certain populations are infected and similar percentages may be found in India, Mexico, western south America, south east Asia and the middle East (Davidson and Cerda, 1987). In Swaziland, a slightly fluctuating, but generally increasing trend in the annual number of cases of giardiasis reported to the Control of Communicable Disease (Swaziland) Unit, has been observed since 1985 (100-150 annually).

The reported figures are an undoubtedly an underestimate as not all stool samples from patients suffering from gastroenteritis are examined for *Giardia* spp. cysts. In addition, some people may not present themselves to a doctor because of the costs associated with transportation and treatment and the fact that periodic diarrhoeal illness is not uncommon. Modes of transmission include person-to-person (via the faecal-oral route), zoonotic and contamination of food and water (WHO, 1996; Thompson, 2004). The organism causes frequent foul smelling diarrhoea in addition to a variety of other symptoms. Humans acquire the infection through the ingestion of the cyst (transmissive stage) and as few as ten cysts have been shown to cause infection in humans (Rendtorff, 1954). Illness and cyst excretion patterns vary due to factors such as immune status, infective dose, host age, and possible variations in the virulence of the organism (Adam, 1991). Reported cyst excretion rates range from 0.5 to 10 million cysts/g faeces in young animals and children (Danciger & Lopez, 1975; Ralston et al., 2003). Thus, depending upon the prevalence of infection within the community, the potential exists for large numbers of cysts to challenge municipal sewage treatment processes.

A limited number of studies has been conducted on the effectiveness of conventional and natural sewage treatment processes (STPs) at removing cysts (Smith & Grimason, 2003). Cyst concentrations detected in raw sewage challenging STPs range from 10 to 500,000 cysts/l with estimated removal efficiencies ranging from 0 to 100%. Reported cyst concentrations and removal efficiencies depend upon the level of treatment and method used for the recovery and detection of cysts from wastewater effluents. Few studies have evaluated the effectiveness of natural wastewater systems like waste stabilisation ponds (WSPs) at removing cysts (Smith & Grimason, 2003). The purpose of this study was to determine the effectiveness of the Matsapha municipal sewage treatment plant at removing *Giardia* spp. cysts from raw sewage and waste stabilisation pond effluent.

The wastewater treatment plant Matsapha wastewater stabilisation treatment ponds plant is situated at the southern end of the Matsapha Industrial Estate and occupies approximately 30 hectares of land. The plant was commissioned in 1996 to cater for domestic (25%) and mainly pre-treated industrial estate effluent (75%) (Mr M Zwane, Treatment Supervisor, pers. comm.). The treatment plant consisted of 18 ponds arranged in three streams. Each stream comprised of 2 anaerobic ponds in parallel (retention time (RT) = 3.3 days) followed by 2 facultative ponds in series (cumulative RT = 16 days). The effluent from both streams underwent further treatment through a series of 6 maturation ponds (RT = 4.3 days/pond). While the cumulative retention time of each line was designed to be 45.1 days, at the time of sampling only stream 1 was operational and received 100% of the influent. The plant has a design maximum flow rate of 7500 m³/day and a maximum sewage strength of 600 mg/l BOD₅ loading rate.

Materials and methods

Samples of raw, primary and secondary treated sewage were collected from Matsapha wastewater stabilisation pond treatment plant over a period of 6 weeks from July to August. A maximum of 12 samples was collected per day. 1 litre of effluent was collected every 15 minutes at around 10.00am; 1.00pm and 3.00pm.

Samples were transported to the laboratory and transferred to 1 litre settlement containers (glass beakers) and allowed to settle unhindered for 48 hours. Thereafter, 90% (900ml) of supernatant was removed by aspiration. The remaining 100ml was re-suspended by swirling and carefully transferred to two 50ml centrifuge tubes. Samples were centrifuged at 2,500rpm for 5 minutes and the supernatant from each tube aspirated to approximately 1ml above the pellet. 50ml of tap water was added to the litre settlement container and swirled around to rinse the remaining contents from within the container. Equal volumes (25ml) of rinse water were transferred to each of the centrifuge tubes containing the centrifuge pellet.

The final volume in each tube was made up with tap water to the 50ml mark, centrifuged (as before) and the supernatant from each tube aspirated to approximately 1ml above the centrifuge pellet. Each centrifuge pellet was re-suspended by vortexing and pooled into one of the centrifuge tubes and labelled "Pooled Sample". To the remaining centrifuge tube 10ml of tap (rinse) water was added, the sample vortexed and the contents transferred to the centrifuge tubes marked "Pooled Sample". Tap water was added to the pooled sample tube to the total volume capacity of the centrifuge tube (50ml), vortexed and the supernatant aspirated to approximately 3ml. Each sample was resuspended by vortexing, transferred to a 5ml collection vial and labelled with a sample number, sample type and date of sample. Each centrifuge tube was rinsed with 1ml of tap water, vortexed and the contents transferred to the labelled 5ml vials. All concentrates were transferred to the University of Strathclyde, Glasgow for analysis.

To reduce the potential for cross-contamination between samples, all sampling bottles, settlement containers and centrifuge tubes were washed with liquid detergent between sampling and processing, thoroughly rinsed with tap water and allowed to air-dry before re-use. Sample bottles used for raw and treated effluent were kept separate.

Microscopy

Twenty-five micro-litres (0.5% total volume) of each pond effluent sample were transferred to labelled four-welled microscope slides (Hendley, Essex, UK). Raw sewage samples were made up to 10ml with 5ml of phosphate buffered saline (PBS) solution and 25l (0.25% total volume) transferred to the slides. Slides were left to air-dry, fixed in methanol (3min), removed and left to air-dry again. An equal volume (25l) of fluorescein isothiocyanate conjugated (FITC) anti-*Giardia* monoclonal antibody (Waterborne Inc., New Orleans, USA) was then overlaid onto each well and incubated at 37°C for 30 minutes in a humidified chamber. Thereafter excess antibody was washed off with PBS (pH 7.2) to remove unbound reagent and slides allowed to air-dry in the dark. An equal volume of 25l diaminido-2-phenylindole DAPI working solution (0.2 g/ml) was applied to each well (Grimason et al., 1994) and left at room temperature for 5 minutes in the dark. Finally, slides were washed with PBS, allowed to air-dry and 10l of mounting medium (60% phosphate-buffered saline and 40% glycerol) applied to each well and examined using an Olympus

epifluorescent microscope equipped with Nomarski differential contrast microscopy at x200 (scanning), x400 (examination) and x1000 (identification of internal organelles) magnification.

Criteria for *Giardia* spp. cyst detection

A Confirmed cysts: The criteria for *Giardia* spp. detection were based upon (i) shape (ellipsoid, oval to round shape), (ii) size (8- 14m wide by 8-15m long), (iii) peripheral binding with the monoclonal antibody and (iv) identification of internal organelles (e.g. 2 to 4 polar nuclei with the aid of the nuclear stain DAPI and/or nuclei, axonemes, median body with the aid of differential interference contrast microscopy).

B Cyst-like bodies (CLBs):

The criteria for CLB detection were based upon (i), (ii), (iii) above in the absence confirmatory internal organelles.

Results and discussion

In this study, *Giardia* spp. cysts were detected in raw sewage, various pond and final pond effluent samples from Matsapha waste stabilisation pond (WSP) system, Swaziland. While the pond system was designed with a cumulative hydraulic retention time (RT) of 45.1 days, the RT of the stream sampled may have been reduced by as much as half as it received 100% of the influent. Although hydraulically overloaded, it is estimated that approximately 83% of the cysts challenging the pond system were removed (Table 1.0).

Date	Raw Sewage		2 Anaerobic Ponds(in parallel)		2 Facultative Ponds (in series)		6 Maturation Ponds(in series)	
	No. of cysts detected	Concentration /litre	No. of cysts detected	Concentration /litre	No. of cysts detected	Concentration /litre	No. of cysts detected	Concentration /litre
17/7/98	6	2,400	5	1,000	5	1,000	1	200
17/7/98	1	400	4	800	1	200	1	200
17/7/98	5	2,000	3	600	-	-	3	600
24/7/98	6	2,400	1	200	-	-	-	-
24/7/98	4	1,600	5	1,000	-	-	-	-
24/7/98	1	400	-	-	-	-	-	-
31/7/98	4	1,600	2	400	-	-	-	-
31/7/98	1	400	1	200	1	200	2	400
31/7/98	3	1,200	2	400	2	400	-	-
7/8/98	3	1,200	3	600	-	-	-	-
7/8/98	-	-	-	-	-	-	-	-
7/8/98	3	1,200	2	400	1	200	-	-
21/8/98	2	800	1	200	-	ND	-	-
21/8/98	4	1,600	5	1,000	1	200	1	200
21/8/98	1	400	2	400	1	200	-	-
8/9/98	-	-	1	200	1	200	-	-
8/9/98	1	400	1	200	-	-	-	-
8/9/98	1	400	3	600	-	-	-	-
MC	-	1,200	-	500	-	200	-	200
MPR	-	-	-	58%	-	83%	-	83%
OCC	88%	-	88%	-	44%	-	28%	-
CLB	All samples	-	All samples	-	All samples	-	All samples	-
RT	-	-	3.3 days	-	16 days	-	25.8 days	-

Despite this, significantly high cyst concentrations were still detected in final effluent (max. 600 cysts/l) discharged to Usushwana river. Water from this river is used for washing, bathing, crop irrigation and is the

only source of potable water for many poverty-stricken individuals. With a design maximum flow rate of 7500 m³/day, this means that significantly large numbers of potentially viable and infective *Giardia* spp. cysts are discharged on a daily basis to the river. Given that as few as 10 cysts have been shown to be capable of initiating infection in human beings (Rendtorff, 1954), this presents a risk to the consumer and users of such water.

The occurrence of cysts in pond effluents decreased with retention time from 88% in anaerobic effluent (RT = 3.3 days) to 28% in final effluent. The occurrence and concentration of cysts detected in raw wastewater is similar to other Kenyan (Grimason et al., 1993 & 1996) and French (Wiandt et al., 1995 & 2000) studies that have evaluated the efficiency of WSP systems for the removal of *Giardia*. In this study, cyst concentrations detected in final effluent were occasionally higher than some raw and pond influent levels. Negative removal rates have been reported by other investigators evaluating the effectiveness of conventional sewage treatment processes for the removal of *Giardia* (Casson et al., 1990; Gassman and Schwartzbrod, 1991; Robertson et al., 2000; Medema & Schijven, 2001). The main reason for this is due to sampling and processing difficulties (e.g. time of sampling, sample volume and type, effluent type, clarification method, volume of concentrate analysed, detection method and efficiency of method used). Fluctuations in cyst concentrations in raw and treated effluent may also be due to operational factors (e.g. aeration, returned activated sludge) and shock loadings (e.g. slaughterhouse effluent, pit latrine tankers) (Smith & Grimason, 2003).

The difficulty in determining accurate removal efficiencies by pond systems is epitomised by a study of a four-celled lagoon system in Canada (Roach et al., 1993) whereby final effluent from the pond series of unknown retention time was shown to contain higher cyst concentrations (17 cysts/l) compared with the levels detected in raw wastewater (1 cyst/l). Levels detected in the primary pond effluent (27 cysts/l) and secondary pond effluent (47 cysts/l) appeared to be increasing compared with the levels detected in tertiary pond effluent (8 cysts/l) and final pond effluent. Levels detected in final effluent ranged from 2 to 3,511 cysts/l over the course of the study. Lagoon treatment (RT unknown) of trickle filtration effluent in the UK was found to reduce the percentage of cysts by 95.5% with 94.4 to 201.9 cysts/l detected in final effluent (Bukhari et al., 1997).

A number of studies have assessed the removal of *Giardia* cysts from conventional and natural sewage treatment processes using either small or large volume sampling methods and brightfield or immunofluorescence antibody techniques (IFAT) for detection (Smith & Grimason, 2003). However very few have looked at WSPs using IFAT (Grimason et al., 1993; Wiandt et al., 1995; Grimason et al., 1996; Wiandt et al., 2000). These studies have shown that cysts can be detected in a variety of pond effluents examined from anaerobic, facultative and maturation ponds. Whereas data from the Kenya study indicated that an RT of 38 days may be required to ensure complete removal of cysts (Grimason et al., 1993), data acquired in France (Wiandt et al., 1995) refuted this, as cysts could be still be detected in final effluent after a RT of 40 days. In both studies, cysts were detected in final maturation pond effluents with removal efficiencies estimated to be between 99.1% and 99.7%. In a later study of three French WSPs with cumulative RTs of 44, 103 and 142 days, *Giardia* cysts were detected only in the final effluent from the WSP with the shortest retention period (Wiandt et al., 2000). In this study, cysts were also detected in the effluent from the final maturation pond (cumulative RT unknown).

It has been postulated that the primary removal mechanism of cysts in WSPs and surface water reservoirs is by attachment to particulate matter (faecal, environmental) (Grimason et al., 1993; Medema et al., 1998). However, not all cysts that enter WSPs are attached to faecal solids and therefore settle out of suspension quickly. Giardiasis is a diarrhoeal disease and therefore a combination of attached and freely suspended cysts will be contained in liquefied faeces. Based upon the cyst-settling rate in water, calculated to be 1.4 m/s by Medema et al., (1998), it may be impossible to obtain complete cyst removal depending upon the RT of a particular pond. Cysts that remain or become attached to faecal or other organic solids will settle out of suspension quicker. Medema et al. (1998) found that cyst attachment to sewage particles (range 20 to 160µm) increased their settling rate (from 2 to 70 m/s). This would enhance their removal within WSPs given sufficient retention time. However, studies conducted on open surface water reservoirs with RT's far in excess of those of WSPs (up to 6 months) have shown that cysts can still be detected in abstracted water (LeChevallier et al., 1997; Bertolucci et al., 1998; Lambert et al., 1998). This may be due to repeated contamination from surface run-off, animal and avian sources.

Cysts detected in raw and treated effluents in this study may have come from a variety of human, animal and avian sources. As 25% of the influent is derived from domestic sources, it is expected that the majority of cysts detected were probably of human origin. The remaining 75% of raw sewage was derived from industrial sources including slaughterhouse effluent and therefore it is envisaged that raw sewage will contain a mixture of human and animal-derived cysts. The potential also exists for open ponds, such as the facultative and maturation ponds, to become contaminated with cysts from avian sources that frequent the ponds from time to time. Unfortunately, the IFAT used in this study does not differentiate between human,

animal or avian cysts limiting our interpretation of the public health significance of these findings. Species-specific IFATs and molecular techniques that can differentiate between the species detected in sewage samples are required (Paton et al., 1995; Rimhanen-Finne et al., 2001; Caccio et al., 2003; Bertrand et al., 2004).

Problems with cyst detection are compounded as the IFA can bind to cyst-like organisms (e.g. algae sp. cells) of a similar size and shape to *Giardia* (Rogers et al., 1995). Thus, identification of internal organelles is essential to confirm the presence of *Giardia* spp. cysts. This process is enhanced using differential interference contrast microscopy but can be difficult due to the presence of organic matter and other environmental debris and deterioration in the morphologic appearance of cysts (DeRegnier et al., 1989; Smith & Grimason, 2003). Deterioration of morphologic appearance occurs as a result of a number of factors e.g. cytoplasmic lyses, bacterial degradation, predation and DNA breakdown within the pond environment. In this study, cyst-like bodies were detected in every sample analysed (Table 1.0). Autofluorescent particles of a similar size and shape to *Giardia* cysts were also observed in some samples but not recorded.

The use of DAPI, a fluorescent nuclear dye, has been shown to be a useful adjunct for the detection of *Cryptosporidium* spp. oocysts and *Giardia* spp. cysts in water and wastewater concentrates (Grimason et al., 1994; Bhukari et al., 1997; Robertson et al., 1999 & 2000). The dye highlights the position of the polar nuclei within the cyst, which, in conjunction with the peripheral binding of the IFA helps confirm the presence of cysts. Both the UK Drinking Water Inspectorate and US Environment Protection Agency advocate the combined use of the IFAT and DAPI for the detection of *Cryptosporidium* and *Giardia* in water and water-related samples (DWI, 1999; USEPA, 1999).

Methods are required to improve the clarification of cysts from the considerable variety of organisms, organic matter and debris that exists in wastewater concentrates to improve detection. To date, only Grimason et al. (1993; 1996) has utilised a clarification step (sucrose flotation) to recover cysts from WSP concentrates. While sucrose flotation can improve cyst detection and identification by the removal of heavier organic and environmental debris, the degree of clarification is dependent upon the sample type and is highly variable. Furthermore, depending upon the experience of the investigator and cyst attachment to heavier wastewater particulates, significant losses can occur during processing (Gilmour, 1990; Grimason, 1992; McCuin et al., 2001; Smith & Grimason, 2003). A recent technique that has been applied to the separation of cysts from turbid matrices involves using magnetised particles that are conjugated to anti-*Giardia* spp. antibodies. Immunomagnetic separation has been shown to consistently recover between 60–80% of cysts from artificial turbid matrices (50–500 ntu) (McCuin et al., 2001). This technique needs to be evaluated for the recovery of cysts from WSP concentrates.

Cyst concentrations reported in final WSP effluents in the above studies are slightly lower than found in this study where no clarification step was included. This may explain why higher cyst concentrations were recorded in this study compared with other studies. Alternatively, it may be that this particular pond system is constantly challenged with high cyst loads due to the prevalence of infection within the human and indigenous animal population or because it was hydraulically overloaded. With or without clarification procedures, the cyst concentrations reported using IFAT are extrapolated from the analyses of a small volume of concentrate. Thus, the detection of a single cyst from an aliquot (e.g. 25 to 100l) of the concentrate (e.g. 1 to 50ml) can lead to very high concentrations being recorded. Equally, the potential exists to underestimate the occurrence and concentration of cysts when analysing such a small proportion of the concentrate, which in this study was equivalent to 5ml of effluent. Given the difficulties associated with the concentration, clarification and detection of cysts from concentrates generated by large volume sampling, recent investigators have resorted to small volume sampling (100ml) using either centrifugation (Robertson et al., 2000) or IMS (Hanninen et al., 2005) to concentrate cysts. Analysis of small volumes of wastewater would be less time consuming and probably more efficient. While the recovery efficiency of the method used in this study was not determined, the occurrence and concentration of cysts reported in raw sewage and pond effluents is undoubtedly an underestimate.

Information on cyst survival during sewage treatment process is lacking, especially within the WSP environment with fluctuating temperatures, pH ranges and exposure to UV, bacterial degradation and predation. Most studies have assessed the survival of *Giardia* spp. cysts either at low (10°C) or high temperatures (55°C) under laboratory conditions. However, one study by DeRegnier et al., (1989) determined the viability (vital dye exclusion) and infectivity (in mice) of *G. muris* cysts stored in river and lake water at similar temperature and retention times to those observed in this study (i.e. 20-22°C, pH 4-7). These investigators found that 12% of cysts stored in lake water for a period of 7 days remained viable at temperatures ranging between 17-20°C, with complete loss of viability after 28 days of exposure. This was reflected in the infectivity data whereby 80% of mice became infected with cysts after 7 days exposure and none after 28 days exposure. However, cysts stored in river water at temperatures ranging from 19-27°C appeared to be slightly more resilient. While the majority of cysts were determined to be non-viable after 7

days (99%) and 28 days (100%), cysts still remained infective to mice (80% after 7 days and 17% after 28 days). Thus, it is conceivable that a proportion of cysts detected in the final effluent of this study remain viable and infective.

Conclusion

In conclusion, *Giardia* spp. cysts were detected in raw sewage and wastewater stabilisation pond treatment effluents with an estimated removal efficiency of 83%.

The presence of viable and potentially infective cysts in the final effluent discharged to Usushwana river constitutes a potential risk to the communities using the river for domestic purposes. The species detected in raw and treated effluents could not be determined using the IFAT, as it does not distinguish between *Giardia* spp. cysts. Therefore, species-specific IFATs and molecular techniques need to be developed to determine the public health significance of *Giardia* spp. cysts detected in raw sewage and final effluent. At the present time the occurrence and concentration of *Giardia* spp. cysts in sewage samples is largely underestimated due to the inherent limitations associated with sampling, concentration, clarification and detection of cysts from wastewater samples. These problems need to be overcome before more meaningful data can be obtained. Further research into the survival and detection of *Giardia duodenalis* cysts in waste stabilisation ponds is required.

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References

- Adam R D (1991). The biology of *Giardia* spp. *Microbiol Rev*, 55, 706-732.
- Bertolucci G C, Gilli G, Carraro E, Giacosa D and Puppo M (1998). Influence of raw water storage on *Giardia*, *Cryptosporidium* and nematodes. *Wat Sci Technol*, 37, 261-267.
- Bertrand I, Gantzer C, Chesnot T and Schwartzbrod J (2004). Improved specificity for *Giardia lamblia* cyst quantification in wastewater by development of a real time PCR method. *J Microbiol Meth*, 57, 41-53.
- Bukhari Z, Smith H V, Sykes N, Humphreys S W, Paton C A, Girdwood, R W A and Fricker C R (1997). Occurrence of *Cryptosporidium* spp. oocysts and *Giardia* spp. cysts in sewage influents and effluents from treatment plants in England. *Wat Sci Technol*, 35, 385-390.
- Caccio S M, DeGiacomo M, Alicino F A and Pozio E (2003). *Giardia* cysts in wastewater treatment plants in Italy. *Appl & Environ Microbiol*, 69, 3393-3398.
- Casson L W, Sorber C, Sykora J L, Gavaghan P D, Shapiro M A and Jakubowski W (1990). *Giardia* in wastewater – effect of treatment. *Wat Pollut Control Fed Res J*, 62, 670-675.
- Danciger M and Lopez M (1975). Numbers of *Giardia* in the feces of infected children. *Amer J of Tro Med & Hyg*, 24, 237-242.
- DeRegnier D P, Cole L, Schupp D G and Erlandsen S L (1989). Viability of *Giardia* cysts suspended in lake, river and tap water. *Appl and Environ Microbiol*, 55, 1223-1229.
- Davidson R A and Cerda J J (1987). *Giardiasis*. Medical Microbiology, 5, 111-120. Academic Press Inc (London) Ltd. ISBN 012 2280059.
- DWI (1999). Isolation and identification of *Cryptosporidium* oocysts and *Giardia* cysts in waters 1999. Methods for the examination of waters and associated materials. HMSO, London.
- Gassman L and Schwartzbrod J (1991). Wastewater and *Giardia* cysts. *Wat Sci Technol* 24, 183-186.
- Gilmour R A (1990). *Giardia* spp. cysts and the aquatic environment. University of Strathclyde, PhD Thesis. 226 pp.
- Grimason A M (1992). The occurrence and removal of *Cryptosporidium* spp. oocysts and *Giardia* spp. cysts in surface, potable and wastewater. University of Strathclyde, PhD Thesis. 238 pp.

Grimason A M, Smith H V, Thitai W N, Smith P G, Jackson M H J and Girdwood R W A (1993). Occurrence and removal of *Cryptosporidium* spp. oocysts and *Giardia* spp. cysts in Kenyan waste stabilisation ponds. *Wat Sci Technol*, 27, 97-104.

Grimason A M, Smith H V, Parker J F W, Bukhari Z, Campbell A T and Robertson L J (1994). Application of DAPI and immunofluorescence for enhanced identification of *Cryptosporidium* sp. oocysts in water samples (1994). *Wat Res*, 28, 733-736.

Grimason A M, Wiandt S, Baleux B, Thitai W N, Bontoux J and Smith H V (1996). Occurrence and removal of *Giardia* sp. cysts by Kenyan and French waste stabilisation pond systems. *Wat Sci & Tech*, 33, 83-89.

Hanninen M-L, Horman A, Rimhanen-Finne R, Vahtera H, Malmberg S, Herve S and Lahti K (2005). Monitoring of *Cryptosporidium* and *Giardia* in the vanta river basin, southern Finland, *Int J Hyg & Environ Health*, 208, 163-171.

Lambert W C A, van Breeman L W C A, Ketelaars H A M, Hoogenboezem W and Medema G (1998). Storage reservoirs – A first barrier for pathogenic micro-organisms in the Netherlands. *Wat. Sci. Technol*, 37, 253-260.

LeChavallier M W, Norton W D and Atherholt T B (1997). Protozoa in open reservoirs. *J Amer Wat Works Assoc*, 89, 84-96.

McCuin R M, Bukhari Z, Sobrinho J and Clancy J L (2001). Recovery of *Cryptosporidium* oocysts and *Giardia* cysts from source water concentrates using immunomagnetic separation. *J Microbiol Meth*, 45, 69-76.

Medema G J, Schets F M, Teunis P F M and Havelaar A H (1998). Sedimentation of free and attached *Cryptosporidium* oocysts and *Giardia* cysts in water. *Appl & Environ Microbiol*, 64, 4460-4466.

Medema G J and Schijven JP (2001). Modelling the sewage discharge and dispersion of *Cryptosporidium* and *Giardia* in surface water. *Wat Res*, 35(18), 4307-4316.

Paton C A, Campbell A T, Robertson L J, Stibbs H H and Smith H V (1995) *Giardia* cysts in sewage: distinguishing between species. In: *Protozoan Parasites and Water* (W B Betts, D Casemore, C Fricker, H Smith and J Watkins, eds.) Cambridge UK: pp. 172-5. The Royal Society of Chemistry.

Ralston B J, McAllister T A & Olson M E (2003). Prevalence and infection pattern of naturally acquired giardiasis and cryptosporidiosis in range beef calves and their dams. *Vet Parasitol*, 114, 113-122.

Rendtorff R C (1954). The experimental transmission of human intestinal protozoan parasites II. *Giardia lamblia* cysts given in capsules. *Amer J Hyg*, 59: 209-220.

Rimhanen-Finne R, Ronkainen P and Haenninen M L (2001). Simultaneous detection of *Cryptosporidium parvum* and *Giardia* in sewage sludge by IC-PCR *J Appl Microbiol*, 91, 1030-1035.

Robertson L J, Smith P G, Grimason A M and Smith

H V (1999). Removal and destruction of intestinal parasitic protozoans by sewage treatment processes. *Int J of Env Health*, 9, 85-96.

Robertson L J, Paton C A, Campbell A T, Smith P G, Jackson M H, Gilmour R A, Black S E, Stevenson D A and Smith H V (2000). *Giardia* cysts and *Cryptosporidium* oocysts at sewage treatment works in Scotland, *UK Wat Res*, 34, 2310-2322.

Rogers M R, Flanigan D J and Jakubowski W (1995). Identification of algae which interfere with the detection of *Giardia* cysts and *Cryptosporidium* oocysts and a method for alleviating this interference. *App and Env Microbiol*, 61, 3759-3763.

Smith H V and Grimason A M (2003) *Giardia* and *Cryptosporidium* in water and wastewater. In: *Problem Organisms in Water and Wastewater. Handbook of Water and Wastewater Microbiology* edited by Profs D D Mara and N J Horan (Univ. of Leeds). Academic Press, London, UK. Chapter 40, 695-756.

Thompson R C A (2004). The zoonotic significance and molecular epidemiology of *Giardia* and giardiasis. *Vet Parasitol*, 126, 15-35.

Thurston J A, Gerba C P, Foster K E & Karpiscak M M (2001). Fate of indicator microorganisms, *Giardia* and *Cryptosporidium* in subsurface flow constructed wetlands. *Wat Res*, 35, 1547-1551.

USEPA (1999). Method 1623 Cryptosporidium in water by filtration/IMS/FA. United States Environmental Protection Agency, Office of Water, Washington. Consumer confidence reports final rule. Federal Register 63, 160.

Wiandt S, Baleux B, Casellas C and Bontoux J (1995). Occurrence of *Giardia* sp. cysts during a wastewater treatment by a stabilization pond in the South of France. *Wat Sci Technol*, 31, 257–265.

Wiandt S, Grimason A, Baleux B and Bontoux J (2000). Efficiency of wastewater treatment plants at removing *Giardia* sp. cysts in the south of France. In: I Chorus I, Ringelbrand U, Schlag G and Schmolli O (eds) *Water, Sanitation and Health: Resolving conflicts between drinking-water demands and pressures from society's wastes*. Proceedings of the World Health Organisation Conference in Bad Elster, Germany, 24-28 November 1998, p.35-42.

WHO (1996). *The World Report, 1996 – fighting disease, fostering development*. Chapter 1. The state of the world health. World Health Organisation, Geneva.

Ambient carbon monoxide and carboxyhaemoglobin levels in Ibadan City, Nigeria: A source of health inequality between developed and developing nations? - Sunny O Banjoko¹ MSc MPH, Olatunde O Masheyi² BMLS, Isaiah O Ogunkola² BMLS, Professor Mynapelli K C Sridhar³ PhD FRSH

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Abstract

Carbon monoxide (CO), a colourless, odourless gas is the product of incomplete combustion of organic substances and is one of the most common widely distributed ambient air pollutants. While emission levels are expected to continue falling in the developed countries there is reason to believe that they will rise in developing nations. It is argued that this is an important current source of health inequality between the developed and developing nations created partly by the massive importation of used automobiles.

Ambient carbon monoxide concentrations were measured in selected parts of Ibadan, Nigeria over a six week period using portable CO personal monitors. Carboxyhaemoglobin levels were determined by the differential spectrophotometric method in the blood of one hundred healthy volunteers. Eighteen (18%) of these were smokers while the remaining eighty-two (82%) were non smokers. Results showed that ambient carbon monoxide levels in Ibadan city were between 3.0 and 55.0ppm with a mean value and standard deviation of 20.12 ± 1.40 ppm. The highest value of 55 ppm was observed on the highways. Carboxyhaemoglobin (COHb) concentrations were between 0.7 and 6.5% with a mean value and standard deviation of 2.0 ± 0.68 %.

The range for smokers was between 2.4 ± 6.8 with a mean value and standard deviation of 4.7 ± 0.69 %. The difference in COHb between smokers and non smokers was significant at $p = 0.002$. This scoping study indicated that Ibadan city dwellers were generally exposed to higher levels of CO than the World Health Organisation (WHO) permitted international standard of 10ppm over an 8 hour period with resultant higher COHb concentrations which could be detrimental to health. Vocations and occupations requiring workers to spend long periods on the highways are at higher risk of exposure.

Key words: Carbon monoxide, carboxyhaemoglobin, developing nations, environmental health, health effects, health inequalities, Nigeria.

Introduction

Carbon monoxide (CO) a colourless, odourless, tasteless, non irritant flammable and poisonous gas is slightly lighter than air and reacts with haemoglobin to form carboxyhaemoglobin (COHb). The gas is one of the most commonly widely distributed air pollutants. CO is a product of the incomplete combustion of carbon containing materials but it is also produced by some industrial and biological processes. Natural background levels of carbon monoxide range between 0.009–0.0198ppm. At 20°C and 101.3kPa, 1ppm = 1.16 mgm⁻³.

Concentrations in urban areas like Ibadan city with a population of 3.5 million people depend on weather and traffic density. However, motor traffic is responsible for about 60% emission of the gas (WHO, 1999, Von Burg, 1999). Global concentrations of carbon monoxide were reported to be increasing during the late 1970s and 1980s because some 60% of the global emissions of CO came from anthropogenic sources which had increasing emissions over this period. Direct atmospheric observations between 1979 and 1982 in Cape Meares in Oregon U.S.A showed an increasing trend (Khalil and Rasmussen, 1984) similar data from other sites distributed world wide showed a global increase of about 1% per year (Khalil and Rasmussen, 1988). The likely future global-scale concentrations of carbon monoxide are completely unknown at present.

It is however possible that there will be a gradual decline. It is hard to assess global carbon monoxide emission trends; however, as an indicator within the UK road transport emissions fell by 79% between 1990 and 2005, mainly due to the increased use of catalytic converters, but also to a lesser extent an increase in the proportion of diesel cars. Furthermore, emissions from residential fossil fuel use fell by 57% between 1990 and 2005 mainly due to the continued decline in the use of solid fuels in favour of gas and electricity. Emissions from automobiles are likely on the decline world wide due to improved car engines and the use of catalytic converters designed to reduce emissions. CO sources from biomass burning may be stabilising or even declining and the contribution from methane oxidation may no longer be increasing as rapidly as before (WHO 1999). However, in developing economies like Nigeria, reduction of CO emissions is quite unlikely due to the massive importation of used automobiles and poor domestic and industrial waste management practices.

Occupational exposures in industries or settings with carbon monoxide production represent some of the highest individual exposures observed in field monitoring studies. Such occupations include vehicle driving, maintenance, parking and traffic controls. Constant commuting by automobiles and the spending of long hours out of doors results in increased exposure to ambient levels. Cigarette smoking has been shown to have a dominant influence on increased carbon monoxide exposure (Whincup et al., 2006, Fidan and Cumrin, 2007). Adverse effects of ambient CO exposure The adverse effects of exposure to increased ambient levels of CO include its reaction with haemoglobin causing a reduction in the oxygen carrying capacity of the blood. Quite low levels of carbon monoxide have been shown experimentally to induce myocardial ischaemia in subjects with coronary artery disease (CAD) (Adams et al. 1988, Wickramatillake, 1988).

In addition, in individuals with cardiovascular diseases, COHb levels of 2-6% may impair the delivery of oxygen to the myocardium causing hypoxia and increasing coronary blood demand by nearly 30%. (Wickramatillake et al., 1998). When myocardial oxygen demands are increased as in exercise, the hypoxic effect of CO may exceed the limited coronary reserve producing adverse health effects such as the onset of myocardial ischaemia, reduced exercise tolerance in persons with stable angina pectoris, increased number and complexity of arrhythmias and increased hospital admissions for congestive heart failure (Alfred 1991, WHO 1999, Maynard and Waller 1999, Hoppenbrouwers et al.1981). The combined effect of increased atmospheric temperature, as experienced in the tropics, and carbon monoxide can impair exercise performance and make daily chores like driving, climbing of stairs and long walks, a great task.

Furthermore, a significant decrease in psychomotor performance has been shown with heat and carbon monoxide co-condition (Walker et al. 2001). A relationship between increased exposure to CO and hospital admissions for congestive heart failure (CHF) had been demonstrated (Burnett et al., 1997, Morris and Naumora, 1998). Foetuses and young infants are more susceptible to CO exposure for several reasons and these include: CO crossing the placenta and foetal haemoglobin having greater affinity for CO than maternal haemoglobin. In addition, the half life of COHb in foetal blood is three times longer than that of maternal blood and the foetus has a high rate of oxygen consumption and lower oxygen tension in the blood than adults (Maynard and Waller, 1999). Pregnant women on the other hand have increased alveolar ventilation resulting in increased CO uptake from inspired air.

Pregnant women also produce nearly twice as much endogenous CO (WHO, 1999, Von Burg 1999, Maynard and Waller, 1999). Increased CO exposure in pregnant woman has also been associated with low birth weight of their infants (Martin and Bracken, 1986). A statistical association between the daily incidence of sudden infant death syndrome (SIDS) and levels of ambient CO level has been demonstrated (Hoppenbrouwers et al. 1981). Children are at risk of health effects of ambient CO exposure because they spend a great deal of time outdoors and their pulmonary ventilation is greater than in adults. Young healthy individuals who spend a lot of time on the streets doing exercises or heavy work may have increased COHb levels and experience decreased maximal exercise duration and impaired psychomotor task performance .

During exercise, after the anaerobic threshold is reached, both lactate levels and the lactate/pyruvate ratio increase as an index of anaerobic metabolism. Concentrations of COHb between 2% and 6% decreased the anaerobic threshold and anaerobic metabolism appears earlier causing early fatigue of skeletal muscle and decreased maximal effect capability (Hoppenbrouwers et al. 1981, WHO 1999, Adir et al. 1999). CO is known to disrupt energy metabolism by inhibiting the cytochrome system and oxidative phosphorylation (Hopkins 1972) and increased exposure to the gas was observed to cause rhabdomyolysis (Durocher et al., 1980). Ambient carbon monoxide and carboxyhaemoglobin levels in Ibadan city were unknown before this study. This underscored the relevance of this study, which could be regarded as a pilot for future expanded studies.

Materials and methods

Ethical approval

Ethical approval for this study was sought and obtained from Oyo State Ministry of Health Ethical Committee on Human Experiments.

Materials

0.1% ammonia solution from BDH chemicals; EDTA Ethylenediamine tetra-acetic acid anticoagulated bottles from – Labequip; 20mg sodium thiosulphate from; BDH chemicals; Conical flasks from Labequip; Standard CO gas from Gowncon; Formic acid (BDH chemicals); Concentrated sulphuric acid (BDH chemicals); UV/Visible spectrophotometer (Unipath); Needles and syringes Labequip; Bunsen burner gas; Rubber tubing, glass tubing.

Sampling areas for CO measurement

1. Molete (South West Local Government)
2. Dugbe (North West Local Government)
3. Eleyele (North West Local Government)
4. Eleta (South East Local Government)
5. University College Hospital, Mokola (North Local Government)
6. Ojoo Expressway (North Local Government)

Ambient carbon monoxide estimation

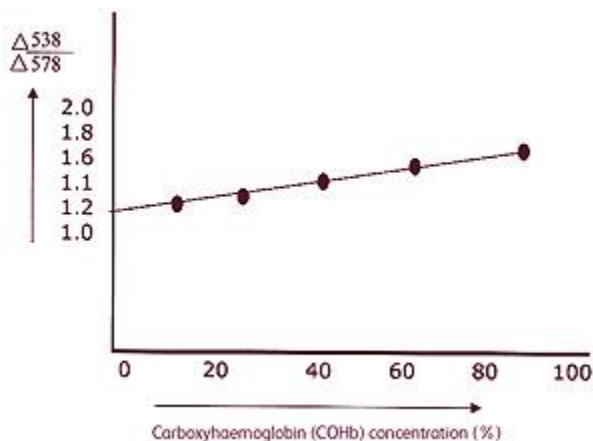
Ambient CO levels were determined in the stated sampling areas over 6 weeks within a five-hour period from 09.00hrs to 14.00 hrs.

The determinations were carried out using digital battery operated personal CO monitors. The zero knob was depressed to erase any previous reading and to activate its use. It was then placed in the desired environment for between one and three minutes at which time the readings had stabilised. The stable readings, which were direct CO concentrations, were recorded. The instrument was zeroed before any fresh reading was taken.

Determination of carboxyhaemoglobin levels

Healthy volunteers for this study were recruited from the different local government areas. The purpose of the study was explained to them and their consent obtained.

5.0ml of blood samples were withdrawn by venepuncture from all the test subjects and placed in EDTA anticoagulated bottles. Carboxyhaemoglobin levels in the blood samples were determined by the differential spectrophotometric method of Zijlstrar and Van Kampen (Zijlstrar and Van Kampen, 1965). Preparation of calibration curve (Figure 1.0). 0.1ml of blood from a control subject was mixed with 20ml of 0.1% ammonia solution and divided into two equal lots.



To each lot, 20mg, Sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_4$) was added to achieve 100% Hb saturation. Through one of the lots pure CO formed by heating HCOOH (formic acid and H_2SO_4 was allowed to bubble slowly for 2 minutes to give 100% HbCO solutions. To two 5ml aliquots of the 100% Hb solution, 30% and 50% CO gas were bubbled from the gas standard cylinders for about 5 minutes to reach saturation through glass tubes to achieve 30% and 50% COHb concentrations respectively. All solutions were then measured

at wavelengths of 538nm and 578nm, using 1.00 cm cuvettes and a slit width of 0.02 mm spectrophotometer. The readings were carried out within 10 minutes of the addition of Na₂S₂O₄. Calibration curve of absorbance ratio: A₅₃₈/A₅₇₈ against percentage of COHb saturation was plotted on the graph (figure 1.0).

Procedure used for COHb estimation.

0.1ml of blood was mixed with 20mls of 0.1% ammonia solution in a conical flask (haemolysate). 3.0ml of ammonia solution was transferred into three 1.0cm cuvettes (blank). 3.0 mlf the hemolysate (test) was also transferred into another three 1.0cm cuvettes (to analyze the sample in triplicate). 20mg of sodium thiosulphate (Na₂S₂O₄) was added to each of the six cuvettes. All the cuvettes were then covered with parafilm and inverted gently ten times. Exactly 5 minutes after the addition of thiosulphate to the sample, the absorbances were recorded at 538nm and 578nm against the ammonia solution blank. The ratio of the absorbance at 538nm and 578nm were calculated and the average of the three values determined.

The percentage carboxyhaemoglobin were determined from the calibration curve. Results The Statistical Package for Social Sciences (SPSS) software programme was used to produce frequency tables and the statistical tests of Mann Whitney U and Kruskal Wallis were applied. Ambient carbon monoxide levels in the selected parts of Ibadan city ranged between 3.0 and 55.0ppm with a mean value and standard deviation of 20.12 ± 1.40. The lowest value of 3.0ppm was observed in the premises of University College Hospital and the highest of 55.0ppm was observed on Ojoo expressway (Table 1.0).

No	Site	LGA	1st week	2nd week	3rd week	4th week	5th week	6th week	Mean	Std. Dev.
1	Molote	S.E.	16.0	18.0	15.0	17.0	14.0	16.0	16.0	1.2910
2	Dugbe	NW I	17.0	16.0	18.0	14.0	13.0	15.0	15.5	1.7078
3	Eleyele	NW II	11.0	12.0	10.0	11.0	12.0	10.0	11.0	0.8165
4	Mokola	NI	24.0	23.0	25.0	21.0	21.0	24.0	23.0	1.5275
5	Ojoo	N II	55.0	49.0	49.0	49.0	51.0	54.0	51.2	2.4766
6	UCH	N III	5.0	4.0	4.0	3.0	4.0	4.0	4.0	0.5773

Range: 3.0 – 55.0ppm, Mean 20.12 ± 1.40 ppm

Carboxyhaemoglobin levels ranged between 1.2-4.8% and the mean value and standard deviation was 2.7 ± 0.92 (Table 2.0).

Range of Ambient CO (ppm)	3.0 – 55.0
Mean and SD of CO (ppm)	20.12 ± 1.40
Range of Ambient COHb %	1.2 – 4.8
Mean and SD of COHb %	2.7 ± 0.92

A significant different was observed in the levels of COHb of smokers and non smokers with mean values and standard deviation of 4.1 ± 0.99 and 2.0 ± 0.89 respectively p= 0.002 (Table 3.0).

	Smokers n = 18	Non smokers n = 82
Range COHb (%)	2.4 – 6.3	0.8 – 2.9
Mean ± SD %	4.1 ± 0.99	2.0 ± 0.89
	T = 0.483	P = 0.002

Discussion and conclusions

Ambient carbon monoxide (CO) levels in Ibadan city were observed to be higher than the internationally permitted standard of 10 parts per million (ppm) over an 8 hour average period (WHO 1992). In this study the monitoring process took place from 9.00 and 14.00 hours representing a 5 hour period. However, the observed values were not likely to reduce for a further three hours but expected to increase due to increased traffic density between 15.00 and 17.00 hours, which represented the closing times of most offices.

The increased CO levels was not surprising due to the unwholesome practices of importation of used cars from Europe for personal and commercial transportation. Indiscriminate burning of household refuse in many homes and localities as a means of refuse disposal, bush burning for agricultural purposes, firewood,

kerosene, coal, sawdust as cooking fuels in poor urban city dwellers also result in significant ambient CO contributions. The COHb concentration of 2.7%, which was the weighted average for our test subjects was higher than the permitted international standard of 1.5% (WHO/UNEP 1990). This could be aggravated by commercial driving and smoking. In reality, high air exchange rates when vehicles are moving generally make road transport a major source of personal exposure. Ibadan city dwellers may therefore be at risk of several adverse health conditions associated with constant exposure to increased CO levels and these include shortness of breath with little exercise, asthma, rhabdomyolysis and angina pectoris (Durocher 1980, Alfred 1991).

There could be increased incidence of low birth weight of infants (Martin and Bracken, 1986, Ritz and Yuf, 1999) poor performance of athletes (Adir et al. 1999) and predisposition to myocardial ischaemia in subjects with known cardiac conditions (Wickramatillake, 1998). Furthermore, the high resting level of COHb in Ibadan city should be of great concern in a nation with the highest prevalence of sickle cell disease in the world (Ogunbiyi et al., 2003, Akinyanju, 1989). Blood with a high resting level of COHb donated for transfusion purposes may not readily improve the delivery of oxygen to the tissues in sickle cell emergencies. It had been suggested that blood for transfusion, particularly multiple transfusion, should be screened for COHb since COHb in blood stored for transfusion had been observed to be stable (Aronow et al., 1984, Freeman and Perks 1990).

The results of this scoping study suggests that the ambient CO levels in Ibadan City are high and probably increasing. At the same time CO levels in the developed nations are falling and expected to continue falling. It is argued that this is an important source of health inequality between the developed and developing nations. It is imperative that there should be continued monitoring of urban cities like Ibadan for ambient concentrations of noxious gases like carbon monoxide and concerted efforts should be made through health education, legislation and the enforcement of existing and new pollution laws to address and check the increasing CO emissions. The education of the population about the disbenefits of smoking in terms of increased exposures to carbon monoxide is also relevant in Nigeria and other developing nations.

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References

- Adams K F, Koch G, Chalteejee B, Goldstein G B, O'Neil J J, Bromberg P A, Sheps D S, McAlhster S, Price C J, Busette J (1988). Acute elevation of carboxyhaemoglobin to 6% impairs exercise performance and aggravates symptoms in patients with Ischaemic heart disease. *J Am Coll Cardiol*, 12, 900-909.
- Adebola Ogunbiyi, Adekunle O George, Olaniyi O M, Daramola (2003). A revisit of sickle cell diseases and the extra transverse digital crease on fingers. *International Journal of Dermatology*, 42(12), 936-937.
- Adir Y, Merdler A, Ben Haim S, Front A, Haurdur F R, Biller Man H (1999): Effects of low concentrations of carbon monoxide on exercise performance and myocardial perfusion in young healthy men. *Occup & Environ Medicine*, 56(8), 535-8.
- Akinyanju O (1989). A profile of sickle cell disease in Nigeria. *Annals of the New York Academy of Sciences*, 565(1), 126-136.
- Alfred E N (1991). Effects of carbon monoxide on myocardial ischaemia. *Env Health Perspec*, 91, 89-132.
- Burnett R T, Dales R E, Brook J R, Ravzenn M E and Krewski D (1997). Association between ambient carbon monoxide levels and hospitalization for congestive heart failure in the elderly in ten Canadian cities. *Epidemiology*, 8(2), 182-187.
- Durocher A, Chopin C, Gossehin B, et al. (1980): Toxic and drug induced rhabdomyolysis. *Rev Med Intern*, 1, 223-326.
- Fatima Fidan and Arif Cumrin (2007): Tobacco smoke exposure in coffee house can be a potential threat for public health. *Turkish Respiratory Journal*, 8(3), 81-84.
- Freeman R and D Perks (1990). Incidence and range of carboxyhaemoglobin in blood for transfusion. *Anaesthesia*, 45(7), 581-583.
- Hoppenbrouwers T, Calurb M, Arakawa K and Hodgman J (1981). Seasonal relationship of sudden infant death syndrome and Environmental pollutants. *A J Epidemiol*, 113, 623-625. Khalil M A K and Rasmussen R A (1984). Carbon monoxide in the earth's atmosphere: increasing trend. *Science*, 224, 54-56.

- Khalil M A K and Rasmussen R A (1988). Carbon monoxide in the earth's atmosphere: indications of a global increase. *Nature* (Lond), 332, 342-245.
- Martin T R and Bracken M B (1986). Association of low birth weight with passive smoke exposure in pregnancy. *Am J Epidemiology*, 124, 635-642.
- Maynard R L and Waller R (1999). Carbon monoxide. In: Holgate S T Saret J M, Koren, H S and Maynard R L (eds). *Air Pollution and Health*. Academics Press: Harcourt Brace & Company publishers, pp 749-796.
- Morris R D, Naumora E W (1998). Carbon monoxide and hospital admissions for congestive heart failure: evidence of an increased effect at low temperature. *Env Health Perspectives*, 106(10), 649-53.
- Ritz B and Yu F (1999). The effect of ambient carbon monoxide on low birth weight among children born in Southern California between 1989 and 1993. *Environ Health Perspect*, 107, 17-24.
- Van Kampen E J and Zijlstra W G (1965). Determination of haemoglobin and its derivatives: *Advances in Clin Chem*, 86, 141-187.
- Von Burg R (1999): Toxicology update. *J Applied Toxicol*, 49, 379-386.
- Walker S M, Ackland T R, Dawson B (2001). The combined effects of heat and carbon monoxide in the performance of motor sport athletes comparative Biochemistry and Physiology Part A Molecular and Integrative Physiology, 128 (4), 709-18.
- Whincup Peter, Papacosta Olis, Lennon Lucy, Harnes Andrew (2006): Smoking cigarette is the dominant influence on COHb. *BMC Public Health*, 6(1), 189.
- World Health Organisation (1999): Carbon monoxide, Environmental Health Criteria 213. Geneva: World Health Organisation.
- World Health Organisation/United Nation Environment Programme (WHO/UNEP) (1992). Urban air pollution in megacities of the world.
- Wickramatillake H D, Grum R T, Ryan P (1998). Carbon monoxide exposures in Australian work places could precipitate myocardial ischaemia in smoking workers with coronary artery diseases. *Australian and New Zealand Journal of Public Health*, 22(3 Suppl.), 389-93.
- Aronow W S, O'Dunohue Jr W J, Freyang F and Sketch M H (1984). Carboxyhaemoglobin levels in banked blood chest, *Chest*, 85, 694-695.

Challenges of urban housing quality and its associations with neighbourhood environments: insights and experiences of Ibadan City, Nigeria - Dr A O Coker^{1,3}, Mr O S Awokola², Professor P O Olomolaiye³ and Dr C A Booth³

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Abstract

A survey of housing quality and neighbourhood environments of Ibadan City, Nigeria was conducted to evaluate the housing infrastructure and to identify those areas where there is a likelihood of future incidences of disease and epidemics. Based on existing demographic and land use characteristics, the city can be divided into high, medium and low-density zones.

Penalty scoring, rather than positive scoring, was used to assess the conditions and quality of houses and the neighbourhood environment in each of the zones. Houses in the high-density area have the worst property and environmental characteristics followed by houses in the medium-density area. Based on housing condition alone, approximately half of all the dwellings surveyed ($n = 172$) in the three zones are categorised as either substandard or unfit for human habitation. Based on neighbourhood environment, none of the high and medium-density housing areas and only one of the lowdensity areas attained the good-scoring grade.

This is attributed in part to many residents being polygamists which means the houses are overcrowded with perhaps up to eight persons per room and to tenant abuse by internal conversion to increase the occupancy rate. More than half of the houses surveyed have at least or more major defect. Recommendations include government directed infrastructure improvements; a regeneration-drive by private investors with possible displacement of residents from the high-density zone to new towns; a vigorous programme of housing and health education; enhanced collaboration between stakeholders to develop enforceable standards for existing housing stock and future builds.

Key words: Environmental health; housing infrastructure; overcrowding; Nigeria; public health; urban development.

Introduction

Housing is one of the most important basic necessities of mankind is known to tremendously affect human health and well-being. It is wisely acknowledged that adequate housing is essential for good life, is a key requirement for an efficient and satisfied labour force and the foundation of satisfactory community life. Furthermore, researchers have shown that housing can affect mental and physical health, both positively and negatively (Fanning, 1967; Macpherson, 1979; Riaz, 1987).

The study by Page (2002) established linkages between poor housing and its detrimental effects on health with particular emphasis on the mental health of residents. The same study also provides evidence to support the view that poor housing can exacerbate existing health problems. In the Nigerian situation, Oluwande, back in 1983, concluded that children's progress is stunted by damp, overcrowded, ill-ventilated and poorly lit accommodation. Most Nigerian cities, with the exception of the newly developed Federal capital city of Abuja, have experienced decay in both housing and physical infrastructural facilities over the past few decades, possibly due to economic downturn in the nation. Unlike developed nations, the mortgage industry is still in its infancy in Nigeria with the real estate sector contributing less than one percent to the nation's GDP (Punch Newspapers, 5th September 2007).

In a recent development, 25 slums in Port Harcourt have been earmarked for demolition and replacement with new housing units by the Rivers state government (Guardian Newspapers, 24th August, 2007). However this move is being strongly resisted by those affected. It appears that residents of slums are not always willing to relocate to less crowded accommodation. Similar problems occur in developed nations. For instance, only 5 per cent were ready to be re-housed into the London County Council's Becontree Estate under England's post-first world war street improvement or slum clearance scheme (Olechnowicz, 1997). Residential land accounts for the largest proportion of total urban land uses in many African cities.

The zoning regulations in many of these cities arbitrarily determines the quality of land supplied to the urban land market and not by the laws of supply and demand, which Egbu et al. (2006) found out fails to meet the demand. Normally, a property developer in a Nigerian city first has to secure a 'location permit' (land right) and then a development right (planning permission). This is a process that has been made very cumbersome by government bureaucrats who, it is claimed, use it to gain some personal financial advantage. Most housing developments are executed by private developers, taking the form of flats and rooming-accommodation, which are popularly called 'face me, I face you'. These account for between 60 and 80 percent of urban housing in Nigeria (Ogu and Ogbuozobe, 2001). Egbu et al. (2007) devised a model for three Nigerian cities and concluded that properly monitored land use planning has a positive bandwagon effect on housing quality.

The quality of a residential area not only mirrors the city development, planning and allocation mechanisms between socio-economic groups, but also shows the quality of life of the urbanites. The realisation of a decent home in a suitable living environment requires the availability of clean air, potable water, adequate shelter and other basic services and facilities. The present study was aimed at investigating housing quality as well as the quality of the environment in which such houses are sited. This is pertinent in view of the increasing incidences of disease and epidemics in Ibadan confirmed by the studies of Sangodoyin and Coker (2005) and Aluko (2006).

The study area

Ibadan is situated in south-western Nigeria (3° 45" to 4° 00" E; 7° 15" to 7° 30" N). It has two distinct seasons; dry (October – March) and wet (April – September). Initially, the city began as a war camp (1829) and since the 1960s has grown to become the nation's largest urban centre.

This is attributed to its location in the heart of the Yoruba ethnic territory and its close proximity to Lagos, Nigeria's economic nerve-centre and her immediate past federal capital. The importance of the city was further acknowledged in Nigeria's post-independence era from 1960 onwards when it was made the capital of the western region, one of the three regions to which Nigeria was sub-divided at that time. Ibadan is currently the capital city of Oyo State and there has been agitation since 2006 for it to constitute a state on its own. It occupies a land area of 634.3 km² and has a population of ~3.5 million (Nigerian National Population Commission in 2006). The city is home to the University of Ibadan established in 1948, the first teaching hospital, the University College Hospital established in 1957 and the first television broadcast station in Africa, the Nigeria Television Authority which was set up in 1959. The presence of all these establishments, among others, has attracted many people to the city. Rapid population growth has posed great problems for urban management, employment, social infrastructural provision and liveability in Nigeria (Mabogunje, 1985) and has made the provision of quality housing a sizeable difficulty.

It is against this background that this study has investigated the quality of housing and the neighbourhood environment in the City. Ibadan is considered to be a typical Nigerian city and it is thus suggested that the findings and recommendations of this study may be relevant to other cities in the country and those of other developing countries in Africa.

Housing standards

The statutory standard of fitness was first introduced as a concept in the UK around 1919 and remains in use as the key legal standard for the assessment of housing conditions. Stewart (2002) identified the main defect of fitness standard as merely providing for a pass or fail checklist for some housing parameters. Part 1 of the UK Housing Act 2004 now provides for the Housing Health and Safety Rating System (HHSRS), a health and safety based system for local authorities to adopt as the basis for enforcement against poor housing conditions (ODPM, 2004).

Housing standards vary from one nation to another and also within a particular country; variations in climate, culture, degree of urbanisation, and socio-economic progress affect standards. The UNO (1969) stated that standards derive from a people's cultural level of attainment. It has been argued that standards should combine the best features of traditional practice with the economy and rationality of modern techniques. The Nigeria's Federal Ministry of Housing and Environment has yet to come up with a definite housing standard for the country. However, in a study on Benin City, Onokerhoraye (1985) empirically classified housing standards in Nigeria into two categories: first, space standard, which defines housing intensity development in terms of plot sizes, number of buildings per unit area of land and occupancy sizes. The second relates to performance standard, which describes the quality of the environment.

This approach is a modified form of the housing standard specified by the American Public Health Association (APHA) in 1945, 1946 and 1950. The APHA method minimises individual opinions so as to arrive at numerical values of the quality of housing that are comparable with results from other cities and

can be reproduced in the same city by different evaluators using the same system. The APHA method, used in the present study, measures the quality of the dwelling units and the environment in which they are located. The method uses a system of penalty scoring rather than positive scoring, that is, the higher the arithmetic score of a condition being judged, the more substandard is the situation.

Study Methodology

Permission was obtained from the Oyo State Ministry of Lands and Physical Planning, who supported the data collection team with staffing. The presence of these staff in their uniforms throughout the field survey, in most cases, enhanced the involvement and co-operation from the residents in many of the surveyed houses. Based on existing demographic considerations and land use characteristics, Ibadan city ([Figure 1.0](#)) is divided into three major residential zones as follows:

- High-density residential district With a density of over 300 persons per hectare. Wards in this zone include Mapo, Oje, Beere, Inalende, Oke-Padi, Yemetu, Oniyanrin, Agbokojo.
- Medium-density residential district With a population density of 100 – 300 persons per hectare. Wards in this zone include Ojoo, Agbowo, Sango, Mokola, Ore-Meji, Oke-Bola, Oke-Ado, Molete, Challenge.
- Low-density residential district With less than 100 persons per hectare and encompasses such wards as Bodija, Basorun, Iyaganku, Jericho, Akobo, Ashi, Idi-Ishin, Total Garden.

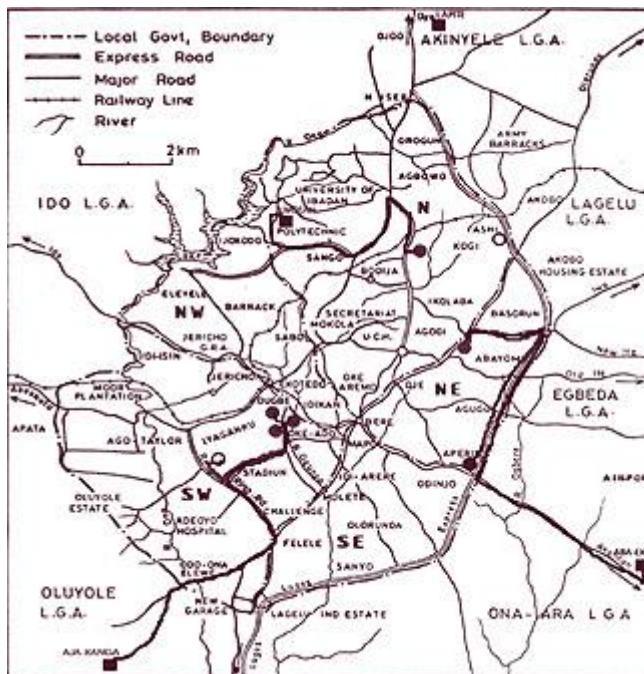


Figure 1.0
Map of Ibadan showing the wards in the surveyed zones

Based on ethical considerations, residents in each of the three zones were initially visited to seek their voluntary cooperation with the study team. The greatest co-operation was obtained in the medium-density zone where many residents occupy the houses on a rented basis. The majority of the houses in the low-density zones are owneroccupied and some of those approached declined to participate. The least co-operation was given to the study in the high-density zone. In this zone, houses are passed down from one generation to the next by inheritance and are largely owner-occupied. However, houses surveyed in the high ($n = 36$), medium ($n = 83$) and low-density ($n = 53$) zones are considered to be representative of the general situation in the zones (Table 1.0).

Table 1.0
Total number of houses surveyed in each of the three Residential Zones of Ibadan

Wards in each zone	Number of houses surveyed		
	High-density zone	Medium-density zone	Low-density zone
Mapo	7	–	–
Oje	9	–	–
Beere	10	–	–
Inalende	10	–	–
Ojoo	–	20	–
Agbowo	–	24	–
Sango	–	17	–
Mokola	–	22	–
Bodija	–	–	14
Basorun	–	–	13
Iyaganku	–	–	13
Jericho	–	–	13
Total	36	83	53

Data was collected from each zone by trained survey team members using two specially designed inspection forms namely: (i) a housing quality survey form (HQSF) and (ii) an environmental survey form (ESF). The former measures the quality of the dwelling unit while the latter was used to appraise the neighbourhood environment. The HQSF has three components – facilities, maintenance and occupancy. The maximum ascribable dwelling score in any surveyed house is 600 broken down into: facilities – 360, maintenance – 120 and occupancy – 120 (APHA, 1946).

The HQSF form captures basic deficiencies with respect to water supply, means of sewage disposal, toilet facilities, bathing facilities, electricity supply, ventilation facilities, safety, susceptibility to weather and degree of occupancy. Houses were classified into five groups: Good (0–29); Acceptable (30–59); Borderline (60–89); Substandard (90–119); Unfit (120 or above). (APHA, 1946).

Six items were examined in each surveyed house using the ESF. The maximum environmental score of 368 (APHA, 1950) is shared among the six items as follows: Land crowding – 70; Non-residential land areas – 72; Hazards and nuisances from transportation system – 64; Hazards and nuisances from natural causes – 60; Inadequate utilities and sanitation – 54; Inadequate basic community facilities – 48.

Similarly, the class of each surveyed house was determined using the environmental score as below: Good (0–19); Acceptable (20–39); Borderline (40–59); Substandard (60–79); Unfit (80 or above) (APHA, 1950).

Results and Discussion

Quality of the dwellings

The results of the HQSFs administered in the three residential zones are presented in Table 2.0.

House classification	Percentage of houses surveyed achieving a particular score			
	High-density (n = 36)	Medium-density (n = 83)	Low-density (n = 53)	Total percentage
A – good (0 – 29)	0.0	9.6	15.1	9.3
B – Acceptance (30 – 59)	5.6	28.9	47.2	29.7
C – Borderline (60 – 89)	2.8	10.9	24.5	13.4
D – Substandard (90 – 119)	19.4	25.3	7.5	18.6
E – Unfit (120 or >)	72.2	25.3	5.7	29.0
Total	100.0	100.0	100.0	100.0

Table 2.0
Classification of houses in Ibadan considering the HQSF only

These show that none of the 36 houses surveyed in the high-density zone satisfied the conditions required for good housing. About 72% (26 homes) of the houses surveyed are classified as unfit for human habitation. The occupancy rate in some cases is up to eight persons per room. Most rooms are not more than 9.3m² (100ft²) in area. Generally, residents of this zone are accustomed to having a minimum of four children per couple. However, this is exacerbated because it is customary for the man to have more than one wife, which may result in more than 10 children being fathered by him.

This part of the city constitutes the inner core region occupied by the city's indigenous early settlers who have a deep emotional attachment to the area. The houses are in most cases very old and dilapidated.

Some of them were built well over a hundred years ago, according to the history volunteered to the survey team. They are generally one-storey buildings with interlocking compound structures with little or no drainage plan. The team met with resistance in the high-density zone, in some cases, because some residents felt the presence of staff from the Oyo State Ministry of Lands and Physical Planning indicated that the Government would soon demolish their houses.

The same line of thinking, coupled with the general low literacy level in this zone, probably explains the lowest number (compared to the other two zones) of house owners willing to have their houses surveyed. In contrast, some of those who did agree to participate in the survey later confessed that their involvement was because they thought the Government was trying to assist them to improve their dwellings. Dwellings in this zone generally lack potable water, toilet facility, bathing facility, solid waste disposal facility and electricity supply. In the case of the medium-density residential district, the range of values for the dwellings surveyed is 9.6% for houses whose condition can be regarded to be good and 28.9% for those classified as acceptable. However, about a quarter (25.3%) of the houses were classified as unfit for human habitation. This part of the city is fairly heterogeneous in terms of the socio-economic status of the residents, age of buildings and availability of social infrastructure. Some of the houses, which are two-storey, do not have proper stairways to facilitate movement between floors.

Consequently, some respondents reported injuries sustained from falls, particularly by young children, but no deaths. The results show that nearly half (47.2%) of the surveyed houses in the low-density residential districts qualify as acceptable, with only 15.1% assessed as good. Houses in this zone are relatively modern in the main and better equipped. Generally, top civil servants, and other middle to high income people occupy them. However, that said, some houses (5.7%) are classified as unfit. It is noteworthy that some of these houses are in the government-owned Bodija estate, where there has been tenant abuse by conversion to increase the occupancy rate, up to six persons per room. Formerly, some of these houses were officially allocated to government workers who have subsequently hired out (sub-let) part of them for pecuniary gains. It is also noteworthy that this is not an unusual practice because a study of house sharing and problems of occupation density in Abuja, Nigeria, Ikejiofor (1998) observed high incidences of sharing to new tenants even amongst middle-income households.

There is no sound maintenance culture in place in any of the three survey zones supporting the findings of studies by Ayininuola and Olalusi (2004) and Mijinyawa et al. (2007). This is a notable contributing factor for the downturn in housing quality.

Quality of neighbourhood environments

Table 3.0 summarises the results of the ESFs. None of the houses surveyed in both the high-density and medium density zones met the requirements of being classified as good, from the neighbourhood environment perspective. Furthermore, only one of the fifty-three houses surveyed in the low-density zone satisfied the survey requirements. This gives an average of a negligible 0.6% of surveyed houses being well sited painting a gloomy picture of the City. One of the main contributors to this is the high floor-to-area ratio (FAR) of many of the houses, even in the low density zone. While the high-density wards are generally noted for overcrowding and congestion, the low-density zone in a bid to maximise the usually expensive land, generally, tends to exceed the maximum FAR value of 0.4, recommended for houses in the middle-income areas of sub-sahara Africa (Njoh, 1995 and 1999).

Table 3.0
Classification of houses in Ibadan considering the ESF scores only

House classification	Percentage of houses surveyed achieving a particular score			
	High-density (n = 36)	Medium-density (n = 83)	Low-density (n = 53)	Total percentage
A – good (0 – 19)	0.0	0.0	1.9	0.6
B – Acceptance (20 – 39)	2.8	21.7	24.5	18.6
C – Borderline (40 – 59)	5.6	24.1	24.5	20.3
D – Substandard (60 – 79)	16.6	24.1	34.0	25.6
E – Unfit (80 or >)	75.0	30.1	15.1	34.9
Total	100.0	100.0	100.0	100.0

In a similar study of Ibadan, Arimah and Adeagbo (2000) noted that 83% of developments in middle-income neighbourhoods contravene some aspects of planning legislation. In many of the surveyed houses, particularly in the high and medium-density zones, even the basic zoning of having houses sited a minimum setback distance from the road was not complied with.

Many houses in both of these zones have no external drainage, which is always a major concern when there is a torrential downpour. Moreover, almost all houses in the high-density zone have no provision for disposing of solid waste, which is usually dumped into any nearby stream or river. This issue has been highlighted by Sangodoyin and Essien (1996) who identified the haphazard dumping of wastes into the Ogunpa stream (which traverses the majority of the wards covered by the high-density residential district) as one of the factors responsible for the disastrous flood incidences (in 1980 and 1988), together with associated disease and epidemics. The Federal Government of Nigeria, in cooperation with Oyo State Government, in the past few years has embarked on a re-channelisation project of Ogunpa stream.

It is hoped that this will halt any future flooding of houses in the high-density zone. Investment by the Oyo state government has recently paid to renovate the ancient and historic Mapo Hall in the city centre, located in the middle of the high-density zone. However, the appalling state of the immediate neighbourhood environment, coupled with the poor transport network, means the project has had a minimal impact and has taken the shine off the beauty and essence of the renovation exercise. To have a noticeable impact, based on this example, it is apparent that there is a need for widespread improvements to housing and the infrastructure, which will probably require investment from the private-sector. Of all the houses surveyed, 60.5% are either substandard or unfit considering their neighbourhood environment. Collectively, less than 40% achieve at least a borderline classification requirement.

These findings follow the evidence of Egbu et al. (2007) who identified a chronic shortage of land in African cities as one of the primary factors responsible for overcrowding. This means that basic community recreational facilities have no place to be built and are practically non-existent in the high-density and medium-density zones. In the lowdensity Bodija area, the survey team found that a site reserved for recreation had been taken over by a notable community leader, who regularly rents it out for party receptions. The generally increasing poverty level in the city seems to have created new and competing pressures on urban space, largely due to the increase in informal sector business and trading, much of which occurs in the street or on undeveloped land.

The classification of houses based on the dwelling scores was considered to have a fundamental relationship with the environmental scores as shown in our regression analysis (Figure 2.0).

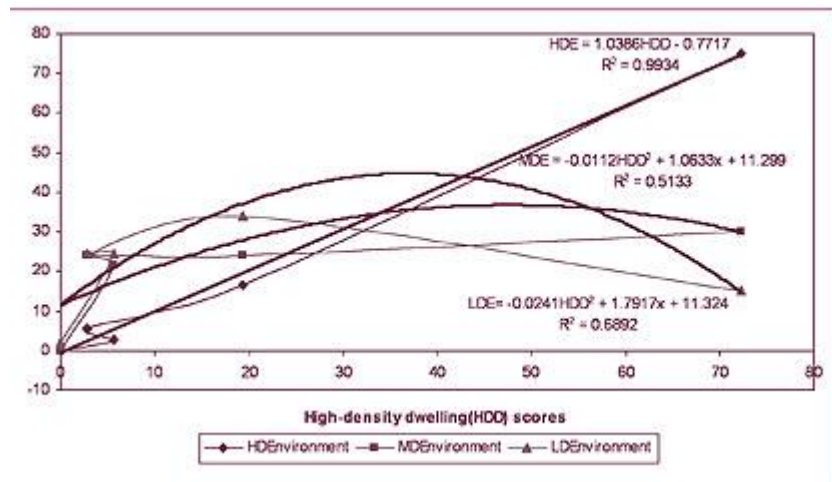


Figure 2.0
Comparison of % of houses surveyed achieving a particular score in dwelling and environment

The percentage of houses surveyed achieving a particular score in high density dwelling (HDD) area was selected as the independent variable while the scores in the high density environment (HDE), medium density environment (MDE) and low density environment (LDE) were the dependent variables. The derived equations for HDE is linear while others follow the second degree polynomial with the coefficient of determination (R^2) of 99%, 51% and 69% which is a measure of the goodness of fit of the models.

Conclusions and recommendations

Nearly half (47.6%) of the houses surveyed in Ibadan are either sub-standard or unfit for human occupation. Nearly three out of every five houses (60.5%) surveyed has one defect or another with respect to the neighbourhood environment. Houses located in the more recently-developed areas of the city (low-density zone) tend to fare best compared to those in the high and medium-density zones from perspectives of both housing conditions and neighbourhood environment. The inner core region, occupied by early settlers in the city, presents the worst scenario with respect to both quality of dwelling and neighbourhood environment. The quality of housing and neighbourhood environment reduces as the degree of density or level of crowdedness increases.

Since housing affects the state of health of people, the quality of life of the majority of the people living in the residences sampled in Ibadan is suspect. The high-density zone has been particularly noted for high incidence of typhoid, cholera, dysentery, infectious hepatitis and guinea worm (Sangodoyin, 1995). The recommendation of Coker and Olutoge (2006) in a previous study on prevention of guinea worm infection, that new sources of potable water be developed might be pertinent here. The general lack of environmental infrastructures such as roads, drains, sanitation waste disposal and recreational facilities is an issue that will require governmental and institutional intervention.

The majority of the urban poor living in the surveyed houses can least afford the provision of these. Moreover, there is a need to raise the level of personal hygiene, particularly of the people living in the high-density zone. We, therefore, recommend a vigorous health education programme, possibly through the mass media and other locally accessible fora, for all the residents in the city. The general lack of a sound maintenance culture among residents needs to be addressed. There is a need for all stakeholders to collaborate towards enforceable standards for houses already built and future builds. There is certainly a necessity for a complete rethink that will go some way towards guaranteeing the sustainable development of the city. There is a dire need to consider a general demolition of some of the houses in the high-density zone with the aim of regeneration of the zone.

The displaced people could be resettled in the sub-urban new Ajoda Town (under construction), which more than ever should be quickly completed. The land in the high-density zone is worth far more than the houses, as the zone largely constitutes the city centre. We, therefore, recommend a Marshall Plan for Ibadan, which will be private-sector-driven. Multinational companies and other mega corporations can have their offices sited in this zone. They may do it as part of their social responsibilities to a zone populated largely by the poorest of the poor. Of course this will also entail a general reconstruction of infrastructure in the area. Vigorous public enlightenment via various media is required to overcome the likely protests of those to be relocated from the high-density zone due to their well-known deep emotional and cultural attachment to the area.

A media campaign against polygamy coupled with incentives to families opting for a maximum of three children may also be useful. Acknowledgements The authors acknowledge the support of the Oyo State Ministry of Lands and Physical Planning, Ibadan, Nigeria, for granting formal government approval for this study and by supporting the field survey with the release of personnel to assist data collection. The first author gratefully acknowledges receipt of a Lady Wulfrun visiting research fellowship awarded by the School of Engineering and the Built Environment at the University of Wolverhampton, UK.

References

- Aluko M A O (2006). Illness: causes and their meaning among the Yoruba, In: Falola, T. and Heaton, M.M.(Eds). *Traditional and Modern Health Systems in Nigeria*, Africa World Press, Trenton, NJ, pp 399-410.
- American Public Health Association (APHA) (1945). *An appraisal method for measuring the quality of housing: a yardstick for health officers, housing officials and planners. Part I: Nature and uses of the method.* Committee on the Hygiene of Housing, APHA, New York.
- American Public Health Association (APHA) (1946). *An appraisal method for measuring the quality of housing: a yardstick for health officers, housing officials and planners. Part II: Appraisal of Dwelling Conditions.* Committee on the Hygiene of Housing, APHA, New York.
- American Public Health Association (APHA) (1950). *An appraisal method for measuring the quality of housing: a yardstick for health officers, housing officials and planners. Part III: Appraisal of Neighbourhood Environment.* Committee on the Hygiene of Housing, APHA, New York.
- Arimah B and Adeagb D (2000). Compliance with urban development and planning regulations in Ibadan, Nigeria, *Habitat International*, 24, 279 – 294.
- Ayinuola G M and Olalusi O O (2004). Assessment of building failures in Nigeria: Lagos and Ibadan case study. *African Journal of Science and Technology*, Vol 5, No.1, 73-78.
- Coker A O and Olutoge F A (2006). Combating the guinea worm scourge in Nigeria: An Engineering approach in: Falola, T and Heaton, M M (Eds.). *Traditional and Modern Health Systems in Nigeria*, Africa World Press, Trenton, NJ, pp. 417 – 427.
- Egbu A, Antwi A and Olomolaiye P (2006). An economic assessment of the institution of land use planning in the cities of sub-Saharan Africa. *RICS Research paper series*, Volume 6, No. 9, pp.1-36.

- Egbu A U, Olomolaiye P and Gameson R (2007). A quantitative model for assessing the impact of land use planning on urban housing development in Nigeria. *IDPR*, 29 (2), 215 – 239.
- Fanning D M (1967). Families in flats. *British Medical Journal*, 18, 382 – 386.
- Guardian Newspaper (2007) Rivers to demolish PH shanties, plans 6,000 houses, 24th August.
- Ikejiofor U (1998). Access to land, development control and low-income housing in Abuja, Nigeria: policy and bureaucracy. *Planning Practice and Research*, 13, 229 – 309.
- Mabogunje A L (1985). Towards an urban policy in Nigeria. In : Onibokun, P. (ed.) *Housing in Nigeria: A book of Readings*, NISER, Ibadan, Nigeria, pp.19 – 35.
- Macpherson R (1979). Housing and Health: Some Basic Principles. In: Marrison, H. S and Lea, J. P. (eds.), *Housing in Third World Countries: Perspectives on policy and practice*, Macmillan, London, pp. 67 -73.
- Mijinyawa Y, Adesogan S O and Ogunkoya O G (2007). A survey of roof failures in Oyo state of Nigeria. *Journal of Building Appraisal*, Vol. 3, No.1, 52-58.
- Njoh A (1995). Building and Urban Land Use Controls in developing countries: A Critical Appraisal of the Kumba (Cameroun) Zoning Ordinance. *Third World Planning Review*, Vol. 17, 3, 337 – 356.
- Njoh A (1999). *Urban Planning, Housing and Spatial Structures in sub-Saharan Africa: Nature, Impact and Development Implications of Exogenous Forces*. Ashgate Publishing, Aldershot, England.
- Office of the Deputy Prime Minister (ODPM) (2004). *Housing Health and Safety Rating System Guidance (Version 2)* London, ODPM. Available online at www.communities.gov.uk [Accessed 16/08/07].
- Ogu V I and Ogbuozogbe J E (2001). Housing policy in Nigeria: towards enablement of private housing development, *Habitat International*, 25, 473 – 492.
- Olechnowicz A (1997). *Working-class housing in England between the wars: The Becontree Estate*, Oxford University Press.
- Oluwande P A (1983). *Guide to Tropical Environmental Health Engineering*, NISER, Ibadan, Nigeria.
- Onokerhoraye A G (1985). *Benin, a Traditional African City in Transition*, Ahmadu Bello University Press, Zaria, Nigeria.
- Page A (2002). Poor Housing and Mental Health in the United Kingdom: Changing the focus for intervention. *Journal of Environmental Health Research*, 1, (1), 31 – 40.
- Punch Newspaper (2007). Mortgage industry in Nigeria is still in its infancy, 5th September.
- Riaz H (1987). Singapore children in high rise flats. *Ekistics* 272, 374 – 375.
- Sangodoyin A Y (1995). Assessment of the adequacy of a water treatment process by in-plant monitoring. *International Journal of Environmental studies*, 48, 257 – 262.
- Sangodoyin A Y and Coker A O (2005). Case study evaluation of health-care solid waste and pollution aspects in Ibadan, Nigeria. *Journal of Applied Science, Engineering and Technology*, Vol. 5, Nos.1&2, 27-32.
- Sangodoyin A Y and Essien O E (1996). Effect of Urbanization, Waste and Disposal and Hydrological Factors on Flooding of Ogunpa stream in Nigeria. *Discovery and Innovations*, 8 (I), 11 – 19.
- Stewart J (2002). The Housing Health and Safety Rating System – a new method of assessing housing standards reviewed. *Journal of Environmental Health Research*, 1, (2), 35 – 41.
- Tribune Newspaper (2007). Affordable housing scheme: Ogun State example, 4th September.
- Turner J F C (1972). Housing issues and the standards question. *Ekistics*, 216, 318 – 321.
- United Nations Organisation (UNO). Centre for Housing Building and Planning (1969): *Methods for establishing targets and standards for housing and environmental development*, *Ekistics*, 27, 3 – 14.

An assessment of the effectiveness of a five-star 'Scores on the Doors' scheme for improving food hygiene compliance amongst Norwich catering businesses - Jaan Stanton¹ BSc Grad CIEH, Yvonne Burton¹ Dip HE and Dr Christopher Gooding¹ PhD MCIEH

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Abstract

Food safety compliance in a sample group of catering businesses in Norwich improved significantly following the introduction of the Norwich Safer Food Award and Star Rating Scheme. The Norwich Safer Food Award was launched in March 2005 and was the first Scores on the Doors (SOTD) initiative in the country to be based on nationally recognised risk rating criteria.

The food business operator (FBO) is given a certificate (showing their rating of up to 5 stars). Details of their award and the food inspection report are published on-line. This study charted the food safety compliance of 121 catering premises over the course of three, consecutive, food hygiene inspections (one before the scheme was launched and two after). On average, the premises in the study showed a significant improvement in food safety compliance at their second, star-rated, inspection when compared to the pre-launch compliance scores for the group. No such improvement was seen at their first, star-rated, inspection when the same comparison was made.

The star rating scheme was a cost effective way of improving food hygiene compliance and was achieved without FBOs being required to display their certificates. The publication of information on the Norwich City Council website was seen as fundamental to the success of the scheme. Authorities wishing to launch, evaluate or compare schemes must take account of an initial delay as improvements were not seen until after the publication of the first award. Evidence suggested that the fear of bad publicity and the opportunity for good publicity (show and glow) was a driver for changing behaviour and that extra information provided at an inspection helped the FBO improve their star rating.

Key words: Environmental health; food safety; food hygiene; Norwich; inspection; show and glow; scores on the doors.

Introduction

Scores on the Door (SOTD) schemes are a means of communicating the results of a food hygiene inspection to the public and to businesses. They require a summary of the inspection to be displayed where the public can see it and/or the results of an inspection to be published. How this is done can vary but most local authorities (LAs) with such schemes publish this information on their website. The information may be presented in different ways i.e. 5 stars, 3 stars, gold/silver/bronze, pass/fail etc. SOTD schemes operate in Singapore, Denmark, and parts of the United States, Australia and New Zealand (FSA, 2006a). Lately the Food Standards Agency (FSA) has commissioned research into the effectiveness of SOTD schemes (FSA, 2006a).

SOTD schemes are believed to have a number of advantages over traditional approaches to food hygiene law enforcement:

- Greater transparency
- Inexpensive
- The prospect of better standards
- Better targeting of LA resources
- Rewarding excellence
- Consumer's choice based on food safety
- Greater consumer confidence
- Reducing the administrative burden on small businesses in line with the Hampton Review (Hampton, 2005)

In the last two years there has been a rapid increase in the number of LAs using SOTD schemes in the UK. Many of these take advantage of the hazard score given to a premises following a food hygiene inspection. This score normally determines the frequency of subsequent inspections (the greater the hazard score, the higher the food safety risk and the more frequently a premises is inspected). The method by which a food premises is rated is determined by the Food Standard Agency's Food Law Code of Practice (Food Standards Agency, 2006b soon to be revised) and before this by Code of Practice No. 9 (Ministry of Agriculture Fisheries and Food, 1991). All food authorities must have regard to Codes of Practice (CoP) when implementing their inspection programs.

Background to the Norwich SOTD Scheme

In 1997 Jaan Stanton and Duncan Smith of Norwich City Council discussed replacing the City's Heartbeat Award (a national award scheme) with a local, paper-based SOTD scheme. The Heartbeat Award had not won general recognition in Norwich and was problematic to administer since additional inspections were required and different inspection criteria applied to them.

A new award scheme was devised that took advantage of the hazard scoring system contained in the Food Standard Agency's CoP – information already gathered as part of a routine inspection (Ministry of Agriculture Fisheries and Food, 1991). A pilot study was launched that involved issuing the food business with a breakdown of its CoP hazard score after the inspection. Coventry City Council was among a few LAs already providing these figures but the Norwich pilot presented the information in the form of a certificate intended for public display. It also incorporated the same descriptors used in the CoP to guide inspectors in their scoring (either 'very good' 'good' 'fair' 'poor' 'bad' or 'very bad'). This Norwich initiative was the first occasion that the CoP had been linked to a SOTD scheme in this way (Stanton and Smith, 1997).

'The Norwich pilot was cautiously welcomed by those food proprietors able to attract 'very good' and 'good' scores but was later shelved after concerns were raised by the council's legal department. It was felt that the way the information was presented could be misconstrued by consumers as being evidence of continuing compliance thereby laying the authority open to legal action should a business's standards ever drop before its next routine inspection. The question as to why the new scheme was so different to the Heartbeat Award it was designed to replace was put to the council's legal advisers but was never answered. It was clear that the objection was more indicative of a widely held suspicion afforded to award schemes at the time and in particular the voluntary disclosure of previously hidden council information in the express hope of changing attitudes.'

Despite this initial setback, work continued on a more sophisticated scheme which used an Excel spreadsheet to produce an inspection summary and an award. Instead of words describing the level of compliance, a number of stars were awarded (0 to 5) representing the business's CoP hazard score. A desktop study showed the new SOTD initiative was workable (Stanton, 2002) but it was not until January 2005 (when the Freedom of Information Act (2000) allowed access to information held by over 100,000 public bodies) that the necessary local political support for the idea was gained and the scheme launched that April (Stanton, 2005).

The Norwich Safer Food Award

The Norwich Safer Food Award was the first in the UK to be based on the accepted risk-scoring protocols contained in the Food Hygiene Inspection Rating Scheme (Food Standards Agency, 2006b) and the first scheme in England to publish the inspection report in full on the Internet (Norwich City Council, 2007). The Norwich SOTD works by converting the previously undisclosed CoP hazard score into a number of 'stars'. The Norwich food team felt that consumers would more easily accept stars as being a measure of a food business's compliance with food hygiene laws and this has been ratified by a recent study showing that consumers preferred the use of stars to inform them on hygiene ratings (Worsfield, 2006). A zero to five star scheme (as opposed to a 0–3 star scheme) was also thought to be more sensitive to changes in compliance (but not overly so) and to afford the proprietor with a greater incentive to maintain and improve upon existing standards.

The sum of three CoP compliance scores (Table 1.0) is used to allocate a specific number of stars according to the ranking in Table 2.0. The scheme utilises a traffic light system to further indicate good, fair and bad levels of compliance. Food businesses must stay out of the red zone to be awarded stars. The use of the traffic light system also helps people, including FBOs and the public, to appreciate that a low score indicates a low food safety risk and thus a safer business.

Compliance with the law	Stars				No Stars		Score
	Green Zone		Yellow Zone		Red Zone		
Food hygiene and safety	0	5	10	15	20	25	5
Structure and cleaning	0	5	10	15	20	25	10
Confidence in management	0	5	10	-	20	30	5
Total							20

Table 1.0
Hazard Scoring
Matrix

Between 0 and 5	★★★★	= 5 Stars
Between 6 and 15	★★★★	= 4 Stars
Between 16 and 25	★★★	= 3 Stars ✓
Between 26 and 35	★★	= 2 Stars
Between 36 and 40	★	= 1 Star
41 or over (or Red Zone Forfeit)		= Zero Stars

Table 2.0
Star Rating
Scorecard

Prior to the launch, every food businesses likely to be included in the scheme was written to and given the opportunity of establishing their current star rating ahead of their next programmed inspection. Apart from the study itself, this was the only occasion historical data was used in Norwich to calculate star ratings retrospectively.

The scheme was allowed to run for some months so that a body of star rating data could accrue before a press statement was issued. It received a great deal of very positive attention from the press who were nevertheless rather too keen to publish the details of miscreant proprietors (so called 'naming and shaming'). To help counter any negative connotation associated with the publishing star ratings, the authors coined the term 'show and glow'. The phrase quickly caught on and its effect was to reinforce the message that most food businesses were, in fact, broadly compliant and that Norwich had much to be proud of.

The key components of the Norwich SOTD 'show and glow' scheme are:

- It is a zero to five star award based on nationally recognised risk-rating criteria (an example of which is shown in Table 2.0). Zero stars means the premises has generally failed to satisfy the law in respect of one or more of the compliance categories. In line with CoP guidance, such premises would also attract additional visits or formal action in order to secure compliance. Food businesses with one or two stars demonstrate a very basic compliance with the law and may have many, minor problems. Premises with three stars are broadly compliant whereas those with four or five stars are meeting or exceeding the industry standard (Norwich City Council, 2007).
- Consistency of scoring is central to the confidence consumers and food business operators (FBOs) have in the scheme. Officers are helped to score consistently by using an electronic scorecard which calculates the Star Rating from the scores entered and generates a three-line inspection summary based on the CoP (a line for each of the compliance categories in Table 1.0). If an inspector's score generates a phrase that accurately summarises compliance in a particular category, then the score must be correct.
- Caterers, food manufacturers and retailers that prepare open food are included in the scheme. Food retailers that do not handle open food are excluded since they find it easier to 'earn' stars by virtue of their being low risk premises and from the public's perspective any star rating would be less relevant. Every food business that is part of the scheme is given a certificate (even in the case of zero-rated premises). In general, food premises that are part of the scheme can expect to be given a new star rating every 6 to 18 months.
- Following a primary inspection, the proprietor is issued with an inspection report; a Safer Food Award certificate (showing the star rating); and an inspection summary sheet. The latter contains the system generated, three-line summary of the inspection and the scorecard (incorporating the traffic light system (see Table 1.0)). A single score in the 'red zone' (i.e. 20

or above) entails a forfeit ensuring no stars are awarded regardless of scores in the other categories.

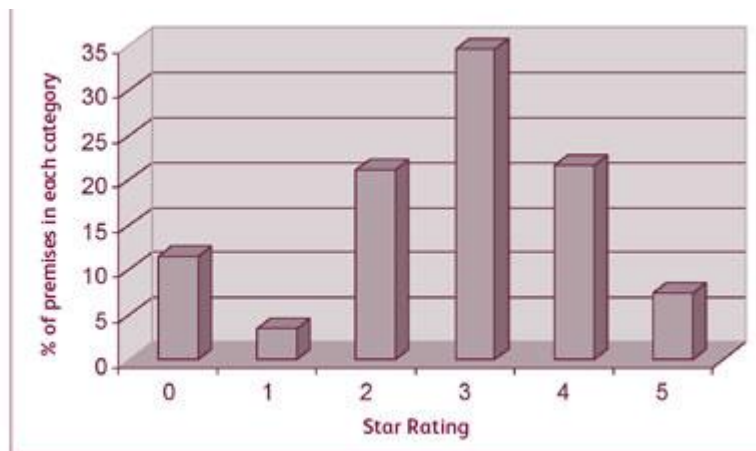
- Food premises are only awarded a star rating at their primary inspection and are not afforded the opportunity of improving upon their score at any subsequent reinspection. For consumers to have confidence in the scheme it was considered important that the star rating be a true reflection of the standards present and not simply the result of a recent intervention by the local authority. This also has the benefit of reducing the impact on inspection resources and is in line with the practices of other authorities running similar schemes (Hibbert and Bulloch, 2007).
- Since October 2005, people viewing the list of star-rated premises on the website can link to a copy of the inspection summary and from there to the inspection report itself. Publication of the star rating and report is seen as fundamental to the success of the Norwich SOTD scheme since the proprietor is not compelled to display their certificate on the premises. Of interest here is that in many cases internet search engines place the city council star rating and inspection report higher than the business's own website, making the star rating the first thing the consumer sees.

The mechanism of the Norwich SOTD system together with the electronic scorecard was made available to many other LAs who have adapted the scheme to fit local circumstances.

Background to the Norwich SOTD Study

To establish the effectiveness of the Norwich SOTD scheme, changes to the star rating profile for the city were tracked over time. An initial examination of the star ratings during the latter half of the second year of the scheme showed that the number of premises getting a 'no star' rating decreased (from 17.5% to 11.5%) while the number of premises getting a 4 or 5 star rating increased (from 25% to 28%). Similarly, for those premises that had been star-rated for a second time, it was found that 53% increased their star rating at their second star-rated inspection and that only 6% showed a drop in standards. The total number of stars awarded to these premises rose from 185 to 265 on their subsequent inspection; an increase of 43%. The star rating profile for the Norwich food premises rated by March 2007 is shown in Figure 1.0 (Stanton, 2007).

Figure 1.0
Norwich Food
Premises Star
Rating Profile
(March 2007)



The increase in the number stars awarded to food premises was very encouraging since it equated directly to an improvement in food hygiene compliance. Moreover, it appeared to have been sustained over the entire life of the project. Nevertheless there were limitations as to the conclusions that could be drawn from these results. No analysis of the standard of the 100 food premises had been undertaken before the introduction of the Safer Food Award and so it was not certain that the improvements noted could be solely attributed to the award itself. A concern was also raised as to the improving star rating profile for the city as the comparisons between the early and the later profiles were potentially misleading. Early star rating profiles were based on a relatively small number of inspections whereas the later profiles were based on many more premises inspections and thus would have a higher statistical accuracy.

Methods used in the Norwich SOTD Study

A further study was proposed of those premises that had been star rated twice within the life of the scheme. By the end of March 2007 the number of these premises had grown substantially and it was decided to analyse these in more detail. A sample group of premises was chosen by applying the following criteria:

- The food premises must have received three consecutive, primary food hygiene inspections.
- The first inspection must have been done before the Norwich Safer Food Award was launched and the premises hazard rated in accordance with the FSA's CoP.
- The next two consecutive inspections had both to be star-rated and been done between 1st April 05 and 31st March 07.

A total of 121 food premises meeting these criteria were identified and used in the study. Each had received three consecutive inspections, one made before the Norwich SOTD scheme was launched and two after. The premises type profile for the sample group is shown in Table 3.0.

Premises Type	Number of Premises Studied
Takeaways/mobile	28
Restaurant	18
Public house	14
School	12
Residential Care Home	10
Café	8
Bakery	7
Club	7
Caterer	4
Nursery	4
Butcher	2
Hospital	2
Hotel/hostel	2
Manufacturer	2
Canteen	1
Total	121

Table 3.0
The types of premises used in the study

For the purposes of the study the council's database was interrogated for each premises meeting the above criteria. The hazard score in place prior to the launch of the scheme was then converted, retrospectively, into a star rating using the same method as detailed in Tables 1.0 and 2.0. This allowed direct comparisons to be made with the following two, star-rated inspections.

The period ending 31st March 2007 was chosen to, as far as possible, exclude the influence of the Food Standard Agency's 'Safer Food Better Business' (SFBB) initiative designed to help businesses comply with new food hygiene legislation. Norwich City Council worked with three neighbouring local authorities to secure FSA funding to implement SFBB in the region and has, since April 2007, when business implementation of the pack started to be assessed with a risk rated inspection, noted an apparent improvement in compliance scores.

Results

Figure 2.0 shows a frequency distribution of premises across each star rating and for each of the three consecutive inspections. Table 4.0 compares the total number of stars awarded at each of the three inspections together with mean and median values. The mean values for the pre-award and the first star rating were calculated and compared using a one-sample T-test. No significance difference was found between the two mean scores ($t = 0.29$, $p = 0.05$). The mean values for the first star rating and second star rating were similarly compared.

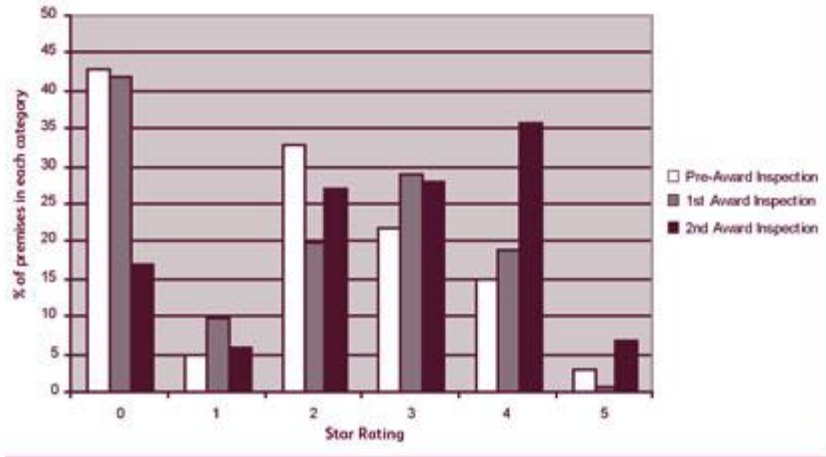


Figure 2.0
The star rating profile for a group of 121 Norwich food premises studied over three consecutive inspections

Table 4.0
Analysis of the results of the total numbers of stars awarded at each inspection

	Pre-Award	1st Star Rating	2nd Star Rating
Total number of premises	121	121	121
Total number of stars awarded	212	218	323
Mean number of stars awarded	1.75	1.80	2.67
Median number of stars awarded	2	2	3
Standard Deviation	1.5173	1.5407	1.4511

A significant difference was found between these two mean scores ($t = 4.81, p = 0.001$). The median number of stars was the same for the pre-award and the 1st star rating but increased to 3 stars on the subsequent inspection. The results show that of the 121 food premises included in the study, there is a significant increase in the Star Rating given to premises at their second, star rated inspection and suggests that the SOTD scheme has improved compliance with the food safety legislation. This result supports the anecdotal evidence of inspecting officers that since the launch of the Safer Food Award, premises in Norwich have improved.

The result is consistent with the results reported from Los Angeles, namely that following the introduction of a SOTD scheme hygiene levels improved in food businesses (Clapham, 2004). Despite this improvement, the difference in the average star rating between the pre-award inspection and the 1st inspection under the SOTD scheme was not found to be significant, indicating that any improvements were deferred until after receipt of the first Award. This was further supported by the observation that the median star rating between the pre-award and 1st inspection remained at 2 stars.

Discussion

The fact that there is no significant difference between the average pre-award star rating and the average 1st star rating was in many ways reassuring as it pointed to hazard scores having been applied consistently on both occasions. That this consistency was achieved by officers inspecting under a new regime is also of note. Fears over whether the accuracy of historical hazard scores could be relied upon were probably unfounded in the Norwich case. LAs wishing to launch their SOTD schemes with maximum impact rather than by phasing them in, as in the Norwich case, may find that star ratings can be applied retrospectively; although some assessment of whether the data is accurate, consistent and comparable would be advisable.

The authors were surprised that improvements in compliance were delayed until after the first star rating was issued since this had not been reflected in the tracked star rating profile for the city. It became apparent that the addition of a large number of newly-rated premises to a growing pool of inspections made under the scheme, was masking what was happening to the relatively small number of businesses that had been star-rated for a second time. It was only by looking at this group of food premises in isolation that the true effect of the SOTD initiative could be gauged. LAs who choose to ‘phase in’ their SOTD schemes must take this masking into account before evaluating the effectiveness of any SOTD initiative on underlying

food hygiene compliance. Each food premises was written to prior to the launch and invited to learn what their star rating would be using hazard scoring data that was current at the time.

Only three premises requested this information. Despite the SOTD scheme being widely publicised, FBOs showed an initial indifference to the initiative. Since improvements in compliance were deferred, one might reason that had each premises been given a 'provisional' star rating (say with the pre-launch letter) standards would have improved in time for their first inspection under the scheme. That historical data can be used in this way may prove of benefit to local authorities keen to see early improvements in compliance scores. The Norwich experience provides circumstantial evidence as to the value of disclosing provisional star ratings to the proprietor. However, further study is needed in this area since without the consumer being privy to the provisional rating (by way of its publication) the effect on compliance may not be as marked.

The extent to which information that accompanied the first Safer Food Award might have influenced compliance is also worth noting. With the introduction of the Norwich SOTD scheme came a new reporting style, which was thought to be far more effective at conveying the sort of information FBOs needed to improve upon their star rating. It must be accepted that FBOs are probably more receptive to the idea of gaining more stars than they are to the need for improved food hygiene compliance per se. The recognition of effort that comes with the allocation of a star rating is an incentive for the FBO and any information that provides the means whereby they can improve upon their score was well received (Burton, 2007).

Making the display of SOTD material mandatory through legislative changes might ensure proprietors engage with the scheme more quickly but the Norwich experience has shown that a voluntary scheme may still be just as successful in the longer term. In a cross-section of starrated premises in Norwich, six out of the 12 food businesses visited were displaying their SOTD certificate (Burton, 2007). Food Safety Officers have observed that as the scheme becomes more widely known and trusted, so FBOs are more willing to display their Safer Food Award of their own volition.

It was felt that the Norwich 'broad brush' approach to issuing Safer Food Awards and publishing reports on the internet to a large extent compensated for the fact that FBOs were not compelled to display an award on the premises. Publication of star ratings and inspection reports ensures that the public's awareness of Norwich SOTD builds year on year and with it, the public's expectation of the standards in the places they eat.

A recent survey of consumer awareness of the Norwich Safer Food Award concluded that currently 22% of those questioned had heard of the scheme and that 98% said such information should be available to the public. 92% of people said they would welcome a national scheme (Burton, 2007), a sentiment also expressed by many LAs (Hibbert and Bulloch, 2007). Many changes to working practices were required to implement the Norwich SOTD initiative. Enforcement officers had to get used to new procedures and adopt a new reporting style. An inspection summary at the head of the report qualified what was to follow in the main body of the text. Inspectors were encouraged to comment on the good aspects of a business as well as the bad so as to give a more balanced account which better justified a particular star rating and reinforced the new 'show and glow' approach. Officers also lost no opportunity in explaining to the FBO how the scoring system worked.

Despite the time spent on additional administrative functions, the number of inspections undertaken improved marginally over the previous year. Similarly, the time spent by senior officers in developing and endorsing the SOTD initiative generated good publicity for the authority and was instrumental in putting food safety high on the council's political agenda. Enforcement officers reported satisfaction in implementing the Norwich SOTD initiative and were delighted to see their efforts result in substantial improvements. This was also found to be the case with other LAs (Hibbert and Bulloch, 2007).

Although a subjective assessment, the quality of Norwich inspection reports also seemed to improve; evidence perhaps that the public disclosure of such information works to the benefit of the food business operator and the enforcing authority. Transparency should (and does) work both ways, it would seem. That improved compliance can be achieved without the need for greater resources is of major significance and serves to show how, through the application of recognition schemes such as SOTD, the general public can have a huge influence on the behaviour and attitudes of the FBO. Moreover, it would appear to be the mere prospect of adverse public reaction that is the driver since in the Norwich case only 1 in 5 people questioned said they had heard about the scheme (Burton, 2007).

The need for enforcement strategies based on outcomes rather than outputs is reflected in proposed changes to the FSA's method for monitoring LA enforcement activity to be introduced 2008/09 (FSA, 2006c). This will be based largely on the number of premises that are 'broadly compliant' and we believe fits well with our SOTD model and SOTD schemes generally. Conclusions Food premises showed a significant increase in the average star rating after their second SOTD inspection, suggesting that the

Norwich SOTD scheme had markedly improved compliance with food hygiene legislation. Improvements were noted without the need for more resources and with the number of inspections of food premises remaining the same.

It is the food businesses operator's own perception of the possible effects on their business that is the more influential in altering behaviour than the proportion of the general public that are aware of the scheme. Improvements in compliance were also achieved without the need to compel food business operators to display their certificate and a relatively large proportion of those businesses visited are choosing to do so. The initial reluctance of food businesses operators to engage with the scheme demonstrates that the launch letter and attendant publicity were both, in themselves, ineffective at changing attitudes. Local authorities wishing to assess the effectiveness of their SOTD schemes should have regard to the fact that improvements may not be evident straight away.

LAs that choose to phase in their SOTD scheme will need to take account of the volume of newly-rated premises when evaluating underlying trends in food hygiene compliance. For LAs yet to introduce SOTD schemes there is a persuasive argument for issuing provisional ratings based on historic data in order to possibly expedite improvements in food hygiene compliance. Any decision as to the suitability of using historical data for this purpose should be carefully considered. Local authorities hoping to launch a SOTD scheme should consider how the food business operator may usefully use the information contained in their inspection report to improve upon their rating at their next inspection. LAs may need to modify inspection reports and supporting material in order to assist the food business operator in this regard.

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References

- Burton Y (2007). An Assessment of Norwich City Council's 'Safer Food Award' Dissertation for the Diploma in Food Safety and Food Legislation. University of Birmingham
- Clapham D (2004). 'Opinion – scores on doors'. *Environmental Health Journal*, Vol. 112/11, 346-8.
- Food Standards Agency (2006a). Development of FSA sponsored "Scores on Doors" pilot schemes PRO 06/09/01 Agenda item 4.1.21 September 2006.
- Food Standards Agency (2006b). Food Law Code of Practice ANNEX 5: Food Hygiene Inspection Rating Scheme, pp 130 - 137. London, Food Standards Agency.
- Food Standards Agency (2006c). "Food Law Enforcement by Local Authorities: the New Vision" PRO 06/10/02 Agenda item 4.2, 12 October 2006, London, FSA.
- UK Government (2000). Freedom of Information Act (2000) Chapter 36. The Stationery Office.
- Hampton P (2005). Reducing administrative burdens: inspections and enforcement. HM Treasury. HMSO Norwich.
- Hibbert T and Bulloch A (2007). Interim Findings of an Evaluation of the Impact and Effectiveness of "Scores on the Doors" for the "Scores on the Doors" User Group, School of Applied Sciences, Northumbria University.
- Ministry of Agriculture Fisheries and Food (1991). Food Safety Act 1990 Code of Practice No. 9: Food Hygiene Inspections. London, HMSO.
- Norwich City Council (2007). Safer Food Award: Food Safety Award Ratings. Available on-line at: www.norwich.gov.uk [accessed 02/02/08].
- Stanton J and Smith D (1997). A Pilot Study of the Food Hygiene Inspection Rating Sheet, Internal publication, Norwich City Council.
- Stanton J (2002). A Desktop Study of a 0-5 Star Award, Unpublished results, Norwich City Council.
- Stanton J (2005). "The Safer Food Award – Implementation of the Scheme": Report to Executive for Resolution, Norwich City Council.

Stanton J (2007). The Norwich Safer Food Award 2nd Anniversary – Improving Trends in Food Hygiene Compliance, Internal Report, Norwich City Council.

Worsfold D (2006). Consumer information on hygiene inspections of food premises. *Journal of Food Service*, 17 pp 23-33.

The investigation of statutory nuisance mineshafts: A project to establish awareness and actions amongst local authority environmental health departments - David Holmes BSc MSc DIC MCIEH MIEEnvSci

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Abstract

The hazards of abandoned mineshafts and the risks to walkers and others may be overlooked or ignored by both landowners and regulators. The risks to the public may be significant as the mineshafts are often in areas frequented by tourists. With the new 'right to roam' legislation – the Countryside and Rights of Way Act 2000 (CROW) – and an increasing interest in industrial archaeology, it is likely that more people will be visiting areas that have been subject to past mining activities thus increasing the potential for accidents to occur.

Local authorities have had duties in respect of abandoned mine workings for some 50 years. This paper identifies the hazards of abandoned mines and the concomitant risks. The applicable legislation is reviewed, and – based on the results of initial and follow up surveys – the level of awareness of, and the actions by, local authority environmental health departments is estimated.

The initial surveys found that while awareness of the issue is quite high (70%) and some local authorities have been proactive, many with a history of mining have taken no action, or only limited action, to inspect their districts and secure abandoned mine entrances. Awareness of CROW was high, but only in a minority of cases (23%) had additional action been taken in respect of the new access land created by this legislation.

The follow-up surveys investigated in more detail what actions were being taken and the reasons for not taking action. Lack of resources, the complexity of the legislation and uncertainty of what actions are practical in securing mine entrances, were all identified as barriers to action. Where mine entrances had been investigated and secured, very little follow-up work was taking place to maintain or monitor the works.

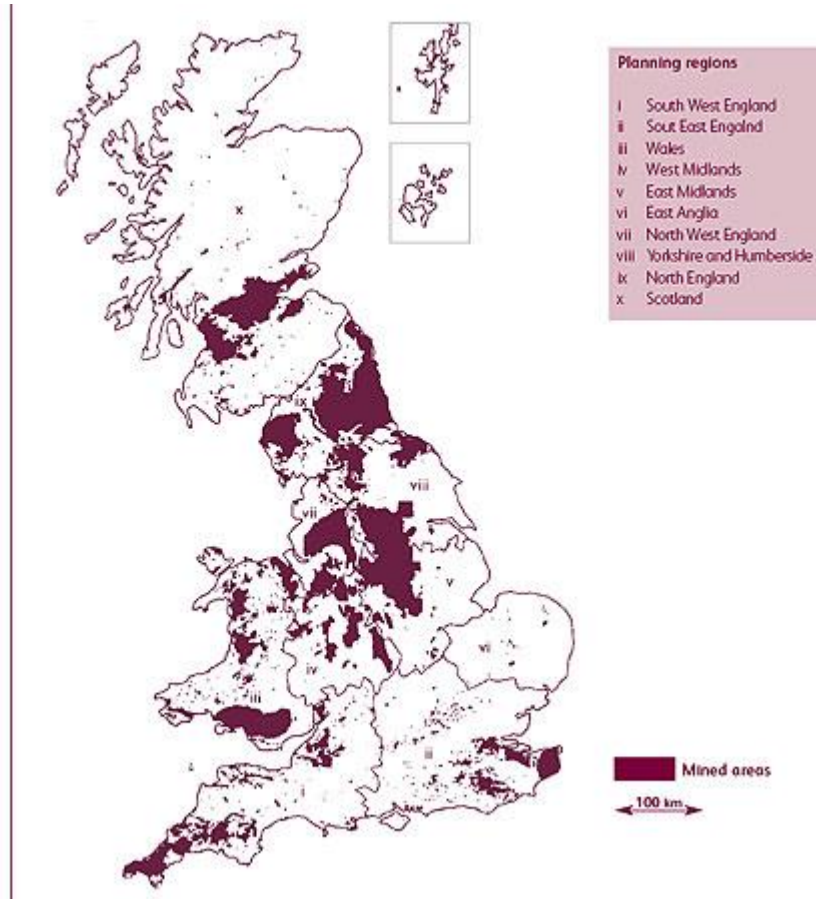
Key words: Environmental health; countryside; mineshafts; safety; statutory nuisance; walking.

Introduction

Abandoned mineshafts and the risks of accidentally entering or falling into them are a hazard that may be being overlooked or ignored by both landowners and regulators. However, the risk to the public may be significant as they are often in areas frequented by tourists. With the new 'right to roam' legislation (Countryside and Rights of Way Act 2000) and an increasing interest in industrial archaeology, it is likely that more people will be visiting areas that have been subject to past mining activities. The likelihood of a serious incident occurring is therefore growing. Aims of this research

The aims of this research project were to establish the level of awareness of the issue of abandoned mine workings among local authority environmental health practitioners to see what actions are being carried out in areas where mining occurred in terms of identifying and dealing with potential statutory nuisances. The scale of abandoned mines Large areas of the UK have a significant mining legacy. A review published in 1991 revealed that mining had occurred in every county of England and Wales, and that in some areas around 20% of the land area had been subject to mining (Figure 1.0) (Ove Arup/DOE 1992).

Figure 1.0
Areas Subject to
Mining (from Ove
Arup & Partners,
1991)



Based on estimates from the literature and other sources, the number of mine entrances could be in the order of 300,000. Areas of the country particularly affected by mining include Cornwall, Devon, The Peak District, Shropshire, Cumbria, the Mendips, Wales, and parts of the Scottish Lowlands. The mines may take the form of drift mines, adits, surface workings or deep mine shafts. The mines may have been worked for long periods, or have been short-term trial workings. Old mines may have numerous exits and shafts, (for drainage, transporting ore, for access). Often mines were started speculatively and shortly afterwards abandoned.

Other mines limped along with a succession of owners, mining a variety of minerals, and all the while making changes to the surface features and mine workings. Many mines ended up with a variety of entrances and exits, varying between large shafts some metres in diameter to small one-metre-square ladder or ventilation shafts. A working paper for the International Institute for Environment and Development attempted to put into perspective the scale of abandoned mine workings. It found that the problems in respect of abandoned mines were similar in many countries. It found that no country has a definitive abandoned mine list and that globally the number of abandoned mines runs into millions. Some countries had identified inventories of abandoned mines, but none appeared to have a dedicated and detailed database of all abandoned mines (IIED 2002).

The hazards created by old mine workings The International Institute for Environment and Development identified that globally, the most important issues of abandoned mines are the physical hazards (safety of excavations and structures) and environmental contamination; however, the focus of public opinion has usually been on visual impacts of mining (IIED 2002). The IIED also identified that accidents related to vertical openings or deteriorating structures are the most common cause of death and injury in abandoned mines. Having identified this potential for accidents, it appears that with the exception of the US Mine Safety and Health Administration (www.msha.gov), few statistics are kept relating to accidents involving abandoned mines. There appears to be no UK database of such incidents.

For this project, the main problem with old mine workings is the risk of accidental entry. Mine entrances invite exploration, varying from organised fully trained and equipped mining and caving club members, to the curious rambler. Mineshafts are obvious hazards and in addition to their depth, may be full of water (Plates 1.0 and 2.0).



Plate 1.0
Exposed entrance
to deep mine shaft

Some mineshafts can take the form of ponds at the surface (Plate 2.0).



Plate 2.0
Mineshaft of
unknown depth
filled with water

Mine adits (horizontal tunnels from the surface, or side of a hill for access or drainage), while less obviously a source of danger, have hazards such as collapses, becoming lost, sudden drops, internal shafts and 'bad air'. Flooded mine tunnels can conceal hazards such as internal shafts, false floors and sharp objects. Many of the areas with a history of mining may now be scenic and seemingly unspoiled. Some are World Heritage sites, such as the Ironbridge Gorge or Blaenavon Industrial Landscape. Old mining areas may have an extensive public footpath network, with areas opened up by landowners and National Parks Authorities as recreation and historical sites. Such areas may attract many visitors, and guidebooks exist to satisfy the demand for walks and information.

The new 'right to roam' legislation – the Countryside and Rights of Way Act 2000 – may mean that even more people will visit and instead of staying on the footpaths, they may choose to explore off the paths. Paths may run close to old mine openings, or even across the top of old shafts. Capped or infilled mineshafts, while not appearing to pose any immediate hazard, may collapse without warning.

The walls or linings of the shaft may fail, the cap or cover fail due to age, rot or corrosion, and backfilled shafts may subside as the fill compacts, or is washed out by underground streams or drainage adits. Some deeper mineshafts may pass through the remains of earlier abandoned shallow mines. These shafts may be particularly unstable, their linings prone to collapse, and the area affected by a shaft collapse much larger than normal. (DOE 1994). Where a shaft lining fails, it may form a cone or crater with steeply angled sides dropping into the shaft.

The cone may have loose unstable slopes, and should a person enter the cone, they may be at risk of sliding into the shaft (Plate 3.0).



Plate 3.0
A coned mineshaft.

Mine openings that have been capped or filled within recent years, may also be at risk of failure. The report "Treatment of Disused Mine Openings" (DOE, 1994) identified that certain widely used types of caps or fills may be unsuitable as long-term methods of sealing mineshafts. There have been recent suggestions that rising mine water levels may be having an impact on the stability of old mineshafts. Once a mine is abandoned, the deeper workings may be flooded to the level drained by any drainage adits, and in time these may collapse or become blocked. Rising mine water may be acidic and have a corrosive effect on shaft linings, leading to shaft collapse or fill or cap failure (SHMRAB 2005).

The legislation

There are three main sets of legislation that are significant in respect of the duties of local authorities in securing against accidental entry to abandoned mineshafts: The Mines and Quarries Act 1954, The Environmental Protection Act 1990 and The Countryside and Rights of Way Act 2000.

The Mines and Quarries Act 1954 (UK Government, 1954) Section 151 places a clear duty on mine owners to secure disused or abandoned mine openings against accidental entry and to maintain such devices. Two circumstances may apply, depending on the date the mine was last worked:

Mines worked since 9th August 1872. The owner of an abandoned mine has a duty to secure the surface entrance to every shaft or outlet to prevent accidental entry by means of an efficient enclosure, barrier, plug or other device and the duty extends to maintenance of these measures. If no device is provided to prevent such entry or it is not maintained, then the mine is likely to constitute a Statutory Nuisance.

Mines that closed before 9th August 1872. A mine that closed prior to this date, with a shaft or outlet not properly maintained or without a device to prevent accidental entry, and by reason of its accessibility from a highway or place of public resort constitutes a danger to the public, is also likely to constitute a Statutory Nuisance. The legislation and duty placed on mine owners applies to all types of mines as it refers to "every abandoned mine".

There is, however, an exclusion for mines worked only before 9th August 1872. The final part of this exclusion causes confusion over whether Statutory Nuisance applies to coal, stratified ironstone, shale and fireclay mines. My view of this exclusion is that its actual meaning is as follows: The duty on mine owners to secure entrances shall apply to all mines worked after 9th August 1872, and that the duty does not extend to mines worked before the 9th August 1872, other than (i.e. the duty includes) mines of coal, stratified ironstone, shale or fireclay. This implies that the shaft or outlet of any abandoned coal, stratified ironstone, shale or fireclay mine, irrespective of date or location, which is not adequately secured against accidental entry, would be a Statutory Nuisance. For other types of mines, the two important issues are the date of last working and whether the mine is in a place of public resort or is accessible from the highway.

The Mines and Quarries Act does not define what it meant by place of public resort in respect of abandoned mine openings, nor what would constitute accessible from a highway. It is clear that immediately adjacent to a footpath or road would usually be considered accessible, but it is not so cut and dried in the case of mine entrances at greater distances away. A place of public resort would include a park or recreation area although case law appears to have established that any areas where the public frequent, even private land where there is no legal right of access, could also be considered a place of public resort.

The Environmental Protection Act 1990 (UK Government, 1990) Local authorities are under a duty to inspect their areas and to investigate complaints of Statutory Nuisance, under the Environmental Protection Act. Where a nuisance is identified or is considered likely to occur, the authority is required to take action. In the case of an abandoned mine, where the openings are unsecured and the mine was last worked after the 9th August 1872, or was last worked prior to 9th August 1872 and is accessible from a highway or

place of public resort, or is an abandoned coal, stratified ironstone, shale or fireclay mine, then paragraph 79h “any other matter declared by any enactment to be a Statutory Nuisance”, applies. The local authority should then require the mine owner to secure the mine. Under the Environmental Protection Act, the owner or occupier of land can be required to take action or the local authority may undertake works in default or by agreement.

The Mines and Quarries Act allows the recovery by the landowner or occupier of any expenses they incur from the mine owners, following service of a notice by a local authority. Should the local authority carry out works in default following service of a notice, the authority may seek recovery of costs from the landowner or occupier who is then able to pursue the mine owners. It is, however, often difficult to trace the mine owner, old mining company or any person responsible for the mine and even when they are found it is not uncommon to discover that they have no assets or income. Countryside and Rights of Way Act 2000 (CROW) (UK Government, 2000) This Act came into effect in November 2000.

The Act gave a new right to walk freely over certain land which has been mapped as ‘Access Land’. This access land comprises registered common land, land dedicated by landowners as allowing public access, and areas of open country, mountain, moorland, heath and down. Some land already had public access: however for other land this is the first time access has been allowed, except for public rights of way. All access land is a place of public resort, and therefore all unsecured mine entrances, irrespective of date of last working, will be a statutory nuisance. Methodology The research has been carried out in two parts; a postal questionnaire to 112 local authorities in England and Wales followed up by further surveys of several local authorities to examine some issues in greater detail. The initial sample was selected by identifying counties where mining was believed to have occurred.

Local authorities within these counties were then selected randomly for inclusion in the questionnaire survey. Some local authorities in the selection passed the questionnaire onto other authorities for them to complete; data from these additional authorities were also included in analysis. A purposive sample of selected respondents was then used to gather more detailed information on selected issues raised in the initial survey. The initial questionnaire survey The questionnaire was designed to establish the following information: Whether local authority environmental health departments believe they have a role in dealing with abandoned mine workings; what legislation they are aware of; whether they have undertaken any action in relation to abandoned mine workings and entrances; whether the CROW Act 2000 has had any influence on the activities of environmental health departments regarding abandoned mines.

The questionnaire was sent primarily to areas where mining was believed to have occurred, but also included a number of authorities where it was suspected that there was no history of mining. The initial survey results The response rate for a survey of this nature was high at 52.6%. 47 of the responding authorities indicated that they had a history of mining in their areas, with 12 stating that they had no such history. It was encouraging to find that 69.5% of the respondents were aware of old mining as a potential issue for local authorities. This included six that identified that they had no history of mining in their area. Table 2.0 shows that of the 41 authorities that were aware that abandoned mine entrances could be the responsibility of the local authority, over 73% were aware of the correct legislation although not all of these were certain of the actual sections that applied. Of those 18 local authorities that were unaware of their potential roles in dealing with abandoned mine entrances, 12 did have a history of mining in their areas. The most common type of mining reported was coal, then sand, clay or stone. Many authorities had more than one type of mining. Of those with coal mining, eight authorities had just coal mining. As abandoned coal mines are the responsibility of the Coal Authority, those authorities with just coal mining have been excluded from the following assessments of the actions being taken, as it was not expected that they would have a particular need to take action.

Of the authorities with mining, there is a small majority 56.4% taking some action over abandoned mines, but with a significant minority taking no action. The actions taken are shown in Table 4.0.

Authorities taking some action	22
Form of action	
Proactively inspecting area	5
Responding to complaint/concerns	2
Securing against entry	15
Using other body/authority to take action	4

Table 4.0
Action being taken over abandoned mine entrances

Note: some authorities take more than one kind of action

The majority of local authorities secured the entrances against entry when they were notified about open mine entrances, with a smaller number using another body to take action. Only five, however, were proactively inspecting their districts to identify areas of old mining and Statutory Nuisance mine entrances. Nine local authorities indicated that they had a specific council policy in respect of abandoned mines. Other local authorities did mention general nuisance or contaminated land policies that might be relevant, but these were not specific to abandoned mines.

It appears that there is a good level of awareness of the CROW Act among environmental health departments with a history of mining in their areas, with 77% knowing that this legislation has come into effect. 70% (27) were aware of land that had been opened up for public access in their areas. Of the 30% that did not know, several commented that as they were not the Countryside or Highways Department they would not be aware of access land. Of those aware of the CROW Act, only 23% identified that this new access land had had any impact on their approach to dealing with areas of old mining. The comments received from these authorities are given in Table 5.0. Only two authorities were actively surveying these new areas of public access. The follow-up surveys Having established the basic level of awareness in the initial survey, further work was undertaken. The earlier responses were broken down into five distinct groups:

- A Those aware of the legislation and taking action
- B Those aware of the legislation and taking no action
- C Authorities with only coal mining
- D Those unaware of the legislation
- E Those with no mining

Specific questionnaires were sent to the first three groups.

Group A: Those aware of the legislation and taking action

For the group aware of the legislation and taking action, this questionnaire was designed to examine the extent of their actions in dealing with Statutory Nuisance mineshafts, including: whether they were proactively inspecting; how they secured or dealt with any open mine entrances; whether they re-inspected any mine entrances that had been secured; how they established mine ownership and date of last working; whether any notices had been served or works in default undertaken; whether they had been involved with any other organisations, such as National Parks Authority, open access officers or forums; whether the legislation included abandoned coal mines.

Group B: Those aware of the legislation and taking limited or no action

Within this group a small sample was sent a further short questionnaire to examine the reasons why no action was being taken. The questionnaire aimed to explore whether resources or other priorities prevented action being taken, and to find out what these authorities would do in the event of being notified of an open mineshaft in an area with public access.

Group C: Local authorities with coal mining only

Although it was thought at the start of the project that the Coal Authority would deal with any abandoned coal mines, correspondence with the Coal Authority indicated that there is in fact little proactive work being carried out nationally to identify abandoned coal mine entrances.

The Coal Authority, while willing to secure entrances to old coal mines, relied on notifications from other parties, including local authorities. The focus of this small area of research was to establish: whether any of the local authorities with only coal mines in their areas were inspecting for abandoned mines entrances; if any open coal mine entrances were found or notified to them, what steps they would take; whether they were in fact aware of the Coal Authority's remit in securing unsecured coal mine entrances; whether these authorities thought that statutory nuisances applied to abandoned coal mines.

Results from Group A – Those aware of the legislation and taking action

Sixteen of the local authorities that appeared to be undertaking action over abandoned mine entrances were sent a short follow up questionnaire. Eight responses were received (50%). The responses are summarised below.

- Awareness of the legislation

All of these authorities were aware of the legislation and its requirements, although one authority was of the opinion that abandoned coal mines are excluded from Statutory Nuisances as these are the responsibility of the Coal Authority.

- Proactive inspection for mine entrances

Four of the authorities were inspecting or had inspected for unsecured mine entrances, one by an arrangement with their county council, and a further two believed they had come to an arrangement with their National Park Authority for Park Rangers to inspect in the National Park areas. (This later proved to be an incorrect understanding of the National Parks Authority position).

Two had no formal inspection programme, but had undertaken some limited survey work. The other two were not undertaking any routine inspections. Where do notifications of old mines originate? Notification of old mines was rare. Where authorities were notified, this was most often from members of the public although other sources included National Parks Rangers, the property/landowner, certain access groups and for one authority, a database of old mines that the Environment Agency holds. Action over unsecured mine entrances

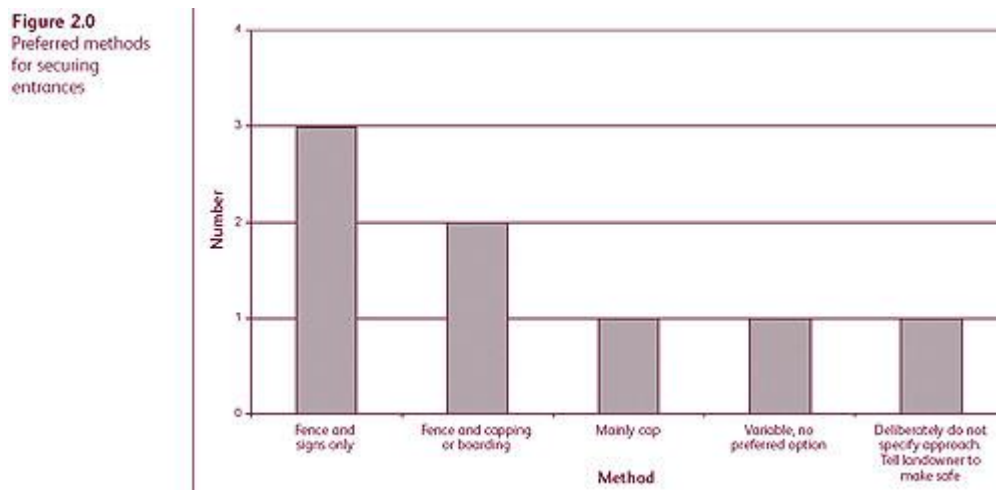
The action taken over unsecured mine entrances in most cases involved a staged process of liaison with landowners, so obtaining works by agreement. Some authorities did have a risk-based approach and prioritisation system to deal with greatest hazards first. The service of legal notices was a last resort and did not normally occur. One authority had an agreement with the Coal Authority whereby any coal mine entrances that were found to be unsafe or unsecured the local authority could take immediate action to make the entrance safe, and then the Coal Authority would take over with a longer-term solution.

- Criteria for securing mine entrances

All eight local authorities had very similar criteria for securing open mine entrances.

This related to the risk of the mine entrance itself, such as depth, size and other factors around the actual entrance; also the actual risk of public access to the site, factors such as accessibility from a highway, proximity to footpaths or place of public resort/access land. It appeared that each authority carried out a specific risk assessment for each site they became aware of. What are the preferred methods for securing entrances?

Figure 2.0 shows the most common methods for securing mine entrances was by fencing with warning signs.



The local authority that preferred capping had an arrangement with their county council that had a budget for such work. The local authority that deliberately did not specify a preferred option required the landowner to make the entrance safe and left it up to them. They pointed out that there were other agencies and considerations such as wildlife, conservation and archaeology that would need to be taken into account, and that it would be up to the landowner to manage this.

See also Plates 4.0 and 5.0.



Plate 5.0
An inadequate
method used to
secure an
abandoned mine
entrance

Who is required to secure mine entrances? The most common answer was the landowner. One authority thought that they could only take action against the mine owner, while two authorities thought that the mineral rights owner could be required to act, with one stating that if the mineral rights owner could not be found then it would require the landowner to act. One authority pointed out that for coal mines it would require the Coal Authority to act. Re-inspection of secured entrances 50% of the local authorities do re-inspect areas where works have been carried out or have been required, and another local authority was intending to. One local authority in a National Park thought its Countryside Rangers carried out the re-inspection, but this later proved to be incorrect.

The other local authorities do not re-inspect. How do the authorities find land/mine owners and dates of last working? There was a range of approaches for identifying land and mine owners. These included: Countryside Rangers already knowing many landowners in a National Park area; using the Land Registry for registered landowners; serving 'Requisition For Information' on potential landowners and occupiers; local knowledge; using the Rural Payments Agency to identify landowners. For establishing details of mines, including minerals worked and date of last working, the approaches included: using county archives; mining reference books; local history and mining experts; local mining museum and library; minerals planning authority records; Environment Agency database for abandoned mines; searching websites. Service of Notices under the Environmental Protection Act 1990 requiring works, and carrying out works in default Five of the local authorities had not served any notices requiring works, two had and one thought they might have done in the past. Only one local authority had needed to carry out works in default.

Almost all the authorities who answered the question found that landowners had been co-operative; only in a couple of cases had there been delays or difficulties. Specific procedures and policies in respect of abandoned mine entrances None of the authorities had a specific procedure or policy concerning abandoned mine entrances, though one said that they were evolving such a policy. Contact with others Seven of the local authorities had been in contact with other agencies outside their councils, such as National Parks Authority, or Countryside Agency/Countryside Council for Wales. In terms of specific contact with Rights of Way, Access and Tourism Departments, only half of the local authorities had made such contact, mostly with Rights of Way Officers.

Three of the authorities thought they owned land on which there may be historical mining, and while two of the environmental health departments had been consulted about this land, one had not. Does the legislation apply to abandoned coal mines? Only three of the authorities had coal mining in their areas, and all were of the opinion that the legislation in terms of the Mines and Quarries Act 1954 and Environmental Protection Act 1990 does apply to coal mines.

Particular problems in dealing with the issue of abandoned mine entrances

The questionnaire asked if there were any particular problems in dealing with abandoned mine entrances. The verbatim responses are shown in Table 6.0.

Identifying partially covered shafts as many resemble collapsed or filled in bell pits and look like depressions
Deciding on suitable measures (for securing entrances)
Fences are cheap but can be climbed over and capping is expensive and not always practicable
Identifying the extent of the mine
Dangers to staff, only investigating when vegetation has died back
Identifying the owner
Finding a contractor who can overcome the practical access problems
Funding the works
Balancing between protecting against the hazard, not destroying the potential for future use and countryside and wildlife responsibilities
It would be useful to have a standard methodology for assessing risks
It is nearly impossible to find mineral rights owners
Finding the date of last working is difficult where there have been many owners
The legislation re the 1872 date regarding determining Statutory Nuisances is very awkward

Table 6.0
Particular problems in dealing with the issue of abandoned mine entrances: verbatim responses by local authority staff

Results from Group B – Those aware of the legislation and taking limited or no action

Eight of the local authorities that appeared to be undertaking only limited action were sent a short follow up questionnaire. Three responses were received which indicated that: all the authorities were aware of the Mines and Quarries Act 1954 and that open mine entrances could constitute Statutory Nuisances (it may, however be the case that only those more aware of this chose to complete and return the survey); in the event of being made aware of unsecured mine entrances, all would take steps to deal with them. Only one had actually received complaints or notifications from the public; two of the environmental health departments would deal with unsecured mine entrances themselves, while one would pass it to its countryside and estates and operations department to address.

At this point it looks as if these authorities, having been identified as taking limited action, are being more active than the initial survey indicated. Two of the authorities stated that their contaminated land strategies had helped to address this issue and it may be that such sites are being addressed, at least partly, through contaminated land functions and officers.

Two of the authorities also stated that as far as they were aware, all known shafts had been secured at this time. When the questionnaire asked about problems, however, one of the authorities indicated that there were insufficient resources to carry out proactive identification and locating of old mine entrances, and one indicated that they were not clear as to the responsibilities in their own authority for inspecting and dealing with old mining areas.

Results from Group C – Local authorities with coal mining only

Responses from seven of the local authorities in this category indicate as follows: Inspecting for abandoned mine entrances None of these authorities were inspecting for abandoned mine entrances. If any coal mine entrances were found or notified to them, what steps they would take? One authority did not know of any action they could take, one stated they would secure the mine entrance, one would refer the matter to a joint body set up with other local authorities, whilst only four would contact the Coal Authority.

Three of the authorities stated that they would contact the landowner, in two cases as well as the Coal Authority, in the other case as they dealt with it themselves. Awareness of the Coal Authority’s remit in securing coal mine entrances Four of these authorities were aware of the Coal Authority’s remit, though one local authority stated this was only in general terms. Two authorities were not aware of their role, while one authority would refer it to their joint body. Whether these authorities thought that the Statutory Nuisance applied to abandoned coal mines While four of the local authorities were aware of the legislation in terms of mine entrances being Statutory Nuisances, three were not. Only one was of the view that the legislation and duties applied to coal mines, one was of the opinion that it does not, while five did not know.

This contrasts with the responses from Group A where all of those with coal mining in their areas were of the opinion that the Mines and Quarries Act 1954 and Environmental Protection Act 1990 duties do apply to coal mines. Discussion There is a clear duty on local authorities to inspect their areas for Statutory Nuisance mineshafts under the Environmental Protection Act. The impact of the CROW Act is to increase the number of unsecured abandoned mine entrances that local authorities should be addressing. It appears from the surveys that awareness of the issue and activity by local authority environmental health departments is patchy, with good examples of proactive work in some areas, and in others little action.

The Countryside and Rights of Way Act has had an impact on how some local authorities deal with the issue, but it appears that there has not been a great deal of contact between access officers and

environmental health departments. Therefore, it is not known in many cases how the issues around mine workings are being addressed as land has been opened up. There are significant issues over the treatment of Statutory Nuisance mine entrances. There is no clear view of what is required, and while some variation is to be expected, the options used vary from filling and capping shafts to simple fences (Plates 4.0 and 5.0).

The degree of treatment possible or desirable is made more difficult by factors such as the impact on the visual amenity by large fences and walls, ecology, wildlife, scheduled monuments and maintaining our national heritage. There is a difficulty in determining what is required in terms of an efficient enclosure, barrier, plug or other device to prevent accidental entry.

This implies more than just safe routes or signs and would appear to require walls, fences, caps, plugs and grilles/gates. There is an issue around the inspection frequency for Statutory Nuisance mine entrances and the re-inspection of previously secured sites. Even where an authority has inspected all its area and has identified all open and Statutory Nuisance mine entrances, there will be an ongoing inspection requirement.

The status of land may change, meaning that mine entrances that are open, but are not Statutory Nuisances due to age and location, may become nuisances following the change, such as a new path being created or the land becoming a place of public resort. Mineshafts that are not open, or not even known about, may open up, particularly in the event of extreme weather conditions, events such as local earthquakes, changes to land use or blasting at a nearby quarry. Having secured a mine entrance, any abatement measures should be checked on a regular basis to ensure that the nuisance has not recurred. Where the local authority has carried out works on 'orphan mines', the authority is virtually duty bound to ensure its abatement works are maintained.

Conclusions The literature and earlier investigations indicate that mining has affected large areas of England and Wales, with potentially up to 300,000 mine entrances existing. There are very real safety risks created by some of these mine entrances. While some local authorities are routinely inspecting for and actively dealing with Statutory Nuisance mine entrances, many are not, either taking no action or purely reacting to notification or complaints. Most are not re-inspecting sites previously secured. The legislation concerning local authorities' duties in respect of abandoned mines does not make easy reading, leading to confusion. Local authorities are under a duty to inspect their districts for all types of mining and have a duty to take action regarding Statutory Nuisance mine entrances. Abandoned coal mines, where they have entrances that are not secured, are Statutory Nuisances in all circumstances.

While there is a body set up to address coal mines, the Coal Authority, it does not currently have an active programme of inspection, relying on notifications from other authorities and bodies. Local authorities still have statutory powers of inspection over these mine entrances. All land opened up as 'access land' under the Countryside and Rights of Way Act 2000 will be a place of public resort. Therefore any open mine entrance on such land will be a Statutory Nuisance, irrespective of date of last working. It is essential that local authorities have an ongoing organised programme of inspection and monitoring of areas subject to historic mining. The inspection regime should record details of the condition of each mine entrance and potential mine entrance found, including photographs, descriptions of features, methods of closure or securing, and grid references. This will be important in identifying any changes in repeat surveys.

Where circumstances change, such as land being opened up for public access or new paths created, it is necessary for local authorities to re-inspect and assess the status of mine entrances. There appears to be little contact between local authorities and the Highways, access officers and National Parks officers on this issue. Within a National Park Authority, their Countryside Rangers or Wardens could, by agreement with the local authorities (or as well as the local authorities), carry out surveys inspections and re-inspections for abandoned mines, Statutory Nuisance mine entrances and methods of securing them.

This may be more effective and efficient than the piecemeal approach adopted by local authorities at present, but the National Parks Authorities may be reluctant to take on this role. And Government may need to provide guidance, encouragement and resources to enable this. Local authorities within National Park Authority areas should not assume that the National Park Authority is dealing with Statutory Nuisance mine entrances. While the National Park Authority may be able assist in a number of ways, the responsibility for dealing with these mine entrances lies with the local authorities.

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References

Coal Authority (2006). Personal communication re: coal mine entries, 21/3/2006. DOE (1994). "The Reclamation and Management of Metaliferous Mining Sites". London, HMSO.

Department of the Environment (DOE) (1994). Minerals Planning Guidance: Treatment of Disused Mine Openings (MPG 12), London, HMSO. IIED (International Institute for Environment and Development) (2002). Mining for the Future – Appendix C: Abandoned Mines Working paper. Report commissioned by the Mining Minerals and Sustainable Development Project of the IIED No. 28 April 2002. NCB (1982). The Treatment of Disused Mine Shafts and Adits. National Coal Board.

Ove Arup/DOE (1992). Mining Instability in Great Britain – Summary Report, London, HMSO.

Rushton R N (1993). "South Shropshire Mines Investigation and Treatment". Report for South Shropshire District Council.

SHMRAB (2005). Annual review 2005 – safety management. Safety and Health in Mines Research Advisory Board, Health & Safety Executive. Available online at www.hse.gov.uk [accessed 09/02/08].

UK Government (1954). Mines and Quarries Act. 1954, Chapter 70. Available online at: www.opsi.gov.uk [accessed 09/02/08].

UK Government (1990). Environment Protection Act. 1990, Chapter 43. Available online at www.opsi.gov.uk [accessed 09/02/08].

UK Government (2000). Countryside and Rights of Way Act. 2000, Chapter 37. Available online at: www.opsi.gov.uk [accessed 09/02/08].

Workshop report: Challenges and opportunities in studying ecologic and population health impacts of endocrine toxicants - Dr James Gomes 1,2 MSc PhD, Paul O'Reilly³ MSc, Jason Gomes⁴ BSc

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Abstract

Endocrine toxicants are a cause for concern because of their potential to tamper with the mammalian endocrine system. Endocrine toxicants are ubiquitous in the environment because of their use in industry, agriculture, commerce, public health and personal care and hygiene products. Ecological impacts of endocrine toxicants have been widely reported and prominent ones include reproductive and developmental health effects in wildlife, fish and birds. Human health impacts include reproductive and developmental effects, certain chronic conditions in adult life from gestational exposure to endocrine toxicants, hormonal carcinogenesis and others.

Conclusive evidence of the relationship between exposure to endocrine toxicants and adverse ecological and human health effects has been elusive. We explore the challenges and opportunities in conducting research on endocrine toxicants, communication of the risk and development of smart regulations and policy.

Key words: Endocrine toxicants; ecological health; environmental health; population health; reproductive health; hormonal carcinogenesis; public policy.

Introduction

Endocrine toxicants are substances that have the potential to interact and interfere with the mammalian endocrine system and disrupt the physiological function of endogenous hormones and their receptors. A number of substances both natural and synthetic, used in commerce, industry, food processing, intensive agriculture and personal hygiene products are reported to have the ability to mimic natural hormones leading to an inappropriate or undesired effect through mechanisms that remain to be characterised. One such example is agricultural chemicals.

Concerns have been raised about the active ingredients used in agricultural chemicals for their adverse effects on human endocrine system. Residues of the herbicide 2,4-dichlorophenoxyacetic acid have been detected in 50% of semen samples of the Ontario farmers (Arbuckle et al., 1999) and the insecticides chlordane, dichlorodiphenyldichloroethylene, heptachlor epoxide, and hexachlorobenzene have been found in the follicular fluid of the exposed residents of Vancouver, Halifax, and Hamilton (Jarrell et al., 1993), and are believed to be associated with adverse reproductive health. However, adverse health effects associated with exposures to a number of other suspected endocrine toxicants remain to be appreciated. The science of endocrine disruption is evolving very rapidly as new advances are made in detecting subtle early effects (Welshons et al., 2006; Weltje et al., 2005).

Although adverse effects in wildlife from exposure to endocrine toxicants are well characterised and well reported, the evidence of the manifestation of similar effects in humans is far from conclusive. To examine the challenges and opportunities in the development of the science and the policy on endocrine toxicants, the McLaughlin Centre for Population Health Risk Assessment and the Faculty of Health Sciences, University of Ottawa assembled an invited audience to a workshop on "Endocrine Toxicants: Ecological and Population Health Impacts".

The purpose of the workshop was to: a) examine the current state of knowledge regarding the scope and magnitude of the impact of endocrine toxicants, b) evaluate current research and barriers to research on the ecological and human health effects of endocrine toxicants and c) identify research gaps and develop vision and strategies for enhanced research, dissemination of information and influence public policy. The

workshop was conducted in five sessions: 1 ecological impacts of endocrine toxicants 2 endocrine toxicants and human reproductive and developmental health 3 endocrine toxicants and hormonal carcinogenesis 4 government and industry perspectives on endocrine toxicants, and 5 endocrine toxicants and communication of risk. Participants included representatives from the government, industry, non-government organisations, community organisations, academia and other professional agencies.

The Endocrine Disruptors Research Program (EDRP) of the National Center for Environmental Research, United States Environmental Protection Agency (USEPA) has been studying the consequences of environmental exposure to ubiquitous endocrine toxicants for the past few years. To examine the sources, nature, mode of action and toxicity of the endocrine toxicants and the uncertainties in our knowledge of the consequences of exposures to endocrine toxicants, the EDRP has defined certain specific goals according to Dr. Elaine Francis, USEPA, who gave the keynote address at the workshop.

The first long term goal of the EDRP is to provide a better understanding of the science by determining the classes of chemicals that act as endocrine toxicants, their potencies, and their mode of action by characterising the chemicals that alter testosterone synthesis, thyroid hormone homeostasis, and androgen receptor function. The EDRP is also studying the major sources of endocrine toxicants in the environment by examining the discharges from wastewater treatment plants, animal feeding operations, and chemical and pulp and paper industries. The second long term goal of the EDRP is to determine the extent of the ecological impact of the endocrine toxicants through identification of hormonal compounds in water bodies and characterization of their consequences including masculinisation of female fish and feminisation of male fish residing in waters receiving effluents from suspect industries.

The validation of protocols for the aforementioned goals is the third long-term priority of the EDRP; therefore, the EDRP is in the process of developing and validating screening and testing protocols to confirm the impact of endocrine toxicants on fish, birds, wildlife and humans. Protocols currently under consideration include pubertal assays in rats, invertebrate reproduction assays, receptor binding and transcriptional assays, aromatase assays, steroidogenesis assays, fathead minnow assays, two generation mammalian reproductive studies, and frog metamorphosis screening and lifecycle studies.

Session 1: Ecological impacts of endocrine toxicants

The 17-ethinylestradiol (EE2), a potent estrogen widely used in birth control pills, has the ability to effect fish reproduction at levels below 1 ng/l. Although, typically EE2 has been detected in sewage effluents at 1-10 ng/l levels, it has also been detected at levels exceeding 150 ng/l near some effluent discharge sources (Fernandez et al., 2007). Under laboratory conditions male goldfish exposed to higher levels of EE2 are reported to be sexually depressed. The aromatase is important during the sexual differentiation of the brain and so is the secretogranin which influences neurotransmitter release and both are affected by estrogens.

Fish exposed to EE2 have elevated expression of aromatase and decreased expression of secretogranin. Another endocrine toxicant, Fluoxetine (Prozac), has been detected in North American streams and lakes, and under laboratory conditions fluoxetine is reported to be able to reduce the expression of isotocin in the hypothalamus and telencephalon (Metcalf et al., 2003). Isotocin has been shown to stimulate spawning behaviour in fish and reduced expression of isotocin coincides with reduced estrogen levels in plasma and reduced expression of estrogen receptors in the hypothalamus and telencephalon. Fish in rivers and streams exposed to effluents from pulp and paper mills have delayed sexual maturity and display reduced gonadal development; male fish residing in sewage treatment effluents have shown signs of feminisation and altered testicular development (Martinovic et al., 2007). 17-trenbolone from feedlot runoff also has had negative impacts on fathead minnow populations. There are numerous examples of endocrine toxicity in the wildlife and birds; therefore, new evidence-supported legislation is required, as newer compounds with hormonal activity are being introduced in commerce ahead of rigorous testing, especially for substances that bioaccumulate in the environment.

Session 2: Endocrine toxicants and human reproductive and developmental health

Endocrine toxicants are reported to adversely affect reproductive health, development of secondary sexual characteristics and neurological development and initiate and promote hormonal carcinogenesis. Scientific literature also indicates increased time to pregnancy and declines in fertility rates in women occupationally exposed to higher levels of endocrine toxicants. Environmental exposures to endocrine toxicants such as the benzo-[a]-pyrene (B[a]P) which is a component of tobacco smoke, bisphenol A (BPA) which is a component of plastics have been well reported. Sidestream and mainstream smokers display reduced rates of in vitro fertilisation, undergo premature menopause, and contain elevated levels of B[a]P in their serum and follicular fluid (Neal et al., 2007).

B[a]P is an anti-fertility agent because it inhibits follicle stimulating hormone and stimulates follicle growth in a dose-dependent manner. Many of the adult diseases have foetal origins, particularly coronary heart

diseases, hypertension and insulin resistant type II diabetes as stated by Barker's hypothesis. Barker's hypothesis also states that there is an inverse relationship between birth weight and incidence of cardiovascular diseases in later life. European studies have described the prevalence of non-insulin dependent diabetes as three times higher in men with low ponderal index at birth (Lithell et al., 1996; Fenster et al., 2006). Exposures to endocrine toxicants (DDT, phthalates and other estrogen and androgen mimics) during gestation have been associated with preterm delivery and intra-uterine growth retardation (Longnecker et al., 2001).

Session 3: Endocrine toxicants and hormonal carcinogenesis

Cancers of the prostate, breast, ovary, testicles and endometrium are believed to have hormonal etiology and are reported to be associated with exposures to endocrine toxicants. There is some epidemiological data for the association between hormonal carcinogenesis of the prostate and breast and exposure to endocrine toxicants, but there is very little information on the etiological relationship between exposure and the hormonal carcinogenesis of the other organs (Cunha et al., 2001; Dunn et al., 2005). The science behind the hormonal carcinogenesis and the mode of action of endocrine toxicants is sound but the quantification of the exposures to endocrine toxicants is still a challenge, and this has hampered progress in this area. The timing of the exposure, the dose and the nature of the endocrine toxicant are important factors that need to be considered in the assessment of the exposure. Collaborative interdisciplinary efforts are needed to understand the toxicology and the etiological relationship between exposure to endocrine toxicants and the process of hormonal carcinogenesis.

Session 4: Government and industry perspectives on endocrine toxicants

A number of Canadian (federal and provincial) government laboratories are engaged in endocrine toxicants research. These laboratories are working to understand the impact of endocrine toxicants on wildlife, fish, birds and humans. Validated tests are needed to help explain inconsistencies in responses to certain chemicals and to understand the long-term impact of these chemicals on the ecosystem.

Many of the industries, too, are individually and collectively working to expand the scientific knowledge of the potential impacts of the endocrine toxicants and other chemicals on the health of the humans, wildlife populations, and the ecosystem. A concerted effort is needed to develop internationally harmonised screening and testing guidelines to validate assays that assess endocrine activity. Validation of these assays will facilitate comparisons and confirm the reliability of the test method over time and across different laboratories, which in turn will provide the knowledge basis to interpret test results.

Session 5: Endocrine toxicants and communication of risk

The risk to ecosystem and human health from exposure to endocrine toxicants needs to be characterised efficiently and communicated effectively, so that informed policy can be developed. The EMCOM project at the McLaughlin Centre was developed to assess the risk of adverse health effects in humans from exposure to endocrine toxicants which include reproductive cancers, fertility, and physiological development from exposure to natural or synthetic hormones including phytoestrogens, pesticides, and industrial chemicals and their by-products.

The EMCOM has developed into a tool for collation, synthesis and dissemination of scientific information to the community and is used as a leading resource on endocrine toxicants. There is uncertainty in the risk of exposure and the development of adverse health effects from exposure to endocrine toxicants as is the uncertainty in the risk from the use of pesticides. Risk associated with the use of endocrine toxicants in industry, commerce, personal care products and agriculture needs to be assessed and communicated effectively. Information on EMCOM can be obtained from www.emcom.ca.

Panel discussion

A panel of experts on endocrine toxicants from government, academia, industry, non-governmental organisation and community association was invited to articulate their perspectives on the impact of endocrine toxicants on the ecology and population health. The panel members underlined the importance of focused research on the impact of endocrine toxicants on the ecosystem and human health using newly developed molecular biology techniques. There is a need to develop validated protocols to identify endocrine toxicants in the environment, understand their mechanism of action and identify precursor events leading to the manifestation of clinically relevant adverse health effects.

It is also important to consider genetic sensitivity to endocrine toxicants and adopt the use of sensitive animal models in screening chemicals for endocrine disrupting effects. The endocrine toxicants issue needs to be addressed in a transdisciplinary manner and there is a need to network among the government, industry, academia and other organisations. This approach will lead to the development of

informed public policy, smart regulations and smart monitoring of the environment. If the message of the research outcome is clear, then the job of disseminating the information and incorporating it in the policy becomes easier.

The panel discussion was followed by a question and answer session with an intense participation by the audience.

Concluding remarks

Although adverse effects of endocrine toxicants in the wildlife are well reported, there is still scepticism and evidence of human exposure and adverse health effects is still inconclusive. However, it appears that endocrine toxicants adversely affect reproductive health (lower fertility, adverse birth outcome), development (physiological and neurological), adult diseases of foetal origin (coronary heart disease, hypertension and diabetes) and hormonal carcinogenesis (cancer of the breast, prostate, ovary, endometrium and testis).

New screening methods are needed to understand the behavior of endocrine toxicants; new protocols are needed to characterise the mechanism of action and determine early changes in biological systems. We need to harness new technology such as the gene and protein microarrays and meticulously study dose dependent effects. There is a need to network to develop the science, disseminate the knowledge and influence the development of evidencebased policy.

The uniqueness of this workshop was the collective participation of the government, industry, academia, non-government organisations, community associations and the media, which is essential for knowledge translation, development of smart regulations and smart monitoring.

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References

- Arbuckle T E, Schrader S M, Cole D, Hall J C, Bancej CM, Turner L A, and Claman P (1999). 2,4-Dichlorophenoxyacetic acid residues in semen of Ontario farmers. *Reprod Toxicol*, 13, 421-9.
- Cunha G R, Wang Y Z, Hayward S W and Risbridger G P (2001). Estrogenic effects on prostatic difference and carcinogenesis. *Reprod Fertil Devlop*, 13(4), 285-295.
- Dunn B K, Wickerham D L, Ford L G (2005). Prevention of hormone related cancers: breast cancer. *J Clin Oncol*, 23(19), 4469-4470.
- Fenster L, Eskenazi B, Anderson M, Bradman A, Harley K, Hernandez H, Hubbard A, Barr D B (2006). Association of in utero organochlorine pesticide exposure and fetal growth and length of gestation in an agricultural population. *Environmental Health Perspectives*, 114, 597-602.
- Fernandez M P, Ikomomou MG, Buchanan I (2007). An assessment of estrogenic organic contaminants in Canadian wastewater. *Sci Total Environ*, 373(1), 250-269.
- Jarrell J F, D Villeneuve, C Franklin, S Bartlett, W Wrixon, J Kohut and C G Zouves (1993). Contamination of human ovarian follicular fluid and serum by chlorinated organic compounds in three Canadian cities. *CMAJ*. 148, 1321-7.
- Lithell H O, McKeigue P M, Berglund L, Mohsen R, Lithell U B, Leon D A (1996). Relation of size at birth to non-insulin dependent diabetes and insulin concentrations in men aged 50-60 years. *BMJ*, 312, 406-10.
- Longnecker M P, Klebanoff M A, Zhou H, Brock J W (2001). Association between maternal serum concentration of the DDT metabolite DDE and preterm and small-for-gestational-age babies at birth. *Lancet*, 358(9276), 110-4.

- Martinovic D, Hofwarth W T, Jones R E, Sorensen P W (2007). Environmental estrogens suppress, hormonal behaviour and reproductive fitness in male fathead minnows. *Environ Toxicol Chem*, 26(2), 271-278.
- Metcalfe C D, Miao X S, Koenig BJ, Stager J (2003). Distribution of acidic and neutral drugs in surface water near sewage treatment plants in the lower Great Lakes, Canada. *Environ Toxicol Chem*, 22(12), 2881-2889.
- Neal M S, Zhu J, Holloway A C, Foster W G (2007). Follicle growth is inhibited by benzo-[a]-pyrene at concentrations representative of human exposure in an isolated rat follicle culture assay. *Human Repro*, 22(4), 961-967.
- Welshons W V, Nagel S C, vomSaal F S (2006). Large effects from small exposures. III. Endocrine mechanisms mediating effects of bisphenol A at levels of human exposure. *Endocrinology*, 147(6 Suppl), S56-69.
- Weltje L, vom Saal F S, Oehlmann J (2005). Reproductive stimulation by low doses of xenoestrogens contrasts with the view of hormesis as an adaptive response. *Human Exp Toxicol*, 24(9), 431-437.

Book Reviews

Books reviewed this issue are:

- [Public Health for the 21st Century – New Perspectives](#)
- [Synthesising Qualitative and Quantitative Health Evidence: A guide to methods](#)
- [Traditional Herbal Medicines – a guide to their safer use](#)

Public Health for the 21st Century – New Perspectives on Policy, Participation and Practice

Judy Orme, Jane Powell, Pat Taylor, Melanie Grey 2007. Open University Press/McGraw-Hill Education.

ISBN 10-0 336 33307 2 (paperback) £24.99

According to its introduction 'Public health for the 21st Century – New perspectives on Policy, Participation and Practice' aims to inspire the development of future public health practice. It seeks to do this by exploring the meaning of public health within in the 21st century context and examining the current debates and policy changes that shape it. The multi-authored book is divided into four parts, being Policy for the 21st Century,

Participation and Partnerships, Major contemporary themes in public health and Evaluation evidence and guidance, each part containing stand-alone chapters, allowing the reader to access specific issues as well as to take a broad overview. Each part is prefaced by an editor's overview setting it in context, and the authors of each chapter usefully summarise their views which in a forward-looking volume such as this is of considerable assistance to the reader.

There are two challenges for the authors of a public health text. The first is that consideration of emerging policy is likely to be out of date very shortly after publication – this second edition follows closely on the first, published in 2003. The second is that the potential span of readership is very wide, encompassing those in mainstream public health to lay readership, all of whom will be looking for different things. This edition manages to address the two challenges well.

It starts in Part 1 by mapping public health, tracing its history and establishing the roles of the main players. It considers how changes in policy have changed delivery mechanisms and have broadened the range of players and critically evaluates the role of public bodies in delivering health improvement.

Part 2 considers capacity and capability of the traditional public health workforce and asks whether it is fit for purpose. It further considers in some depth the newly emerging role of lay people and communities in delivering multidisciplinary public health, and devotes a chapter to community development and networking for health and the informal networks that have sprung up to tackle delivery of local public health issues, and concludes, perhaps predictably, that partnerships and wide participation in both policy design and delivery are the way forward.

In its third part the book looks at national and global themes in public health – tackling health inequalities, neighbourhood renewal and regeneration, sustainable futures in cities and issues around globalisation and health. These are very broad canvases, each of which would probably merit a volume in its own right, but they are tackled well, with the authors not being afraid to raise the big questions even when answers may not be readily forthcoming.

Part 4 considers the evaluation of evidence and evidence-based practice. With health economics being a major driver and resources being finite and increasingly limited, this part of the book is very important, raising as it does issues such as the ethics of public health delivery and the trade offs between efficiency of intervention and equity of delivery. It uses recent UK examples to underline the points made, such as the ban on smoking in public places citing on the one hand the health case and on the other the perceived creep of state control into personal health choices.

Equally uncomfortably for some, the Wanless and Beecham reviews applied hard economic ideas to fuzzy public health concepts and are increasingly seen as the way to cost the effectiveness of justify interventions, which will be a challenge for policy developers and delivers alike in the 21st century. The authors draw no easy or glib conclusions, which, while uncomfortable for the reader, underlines the additional challenge that is on us now and will continue for the foreseeable future. Public Health for the 21st Century is a comprehensive consideration of the emerging challenges for public health policy makers. Its structure makes it accessible to those wishing to dip into specific areas as well as being both coherent and

comprehensible to those who may wish to read the whole volume. It is a valuable addition to any public health library.

Review by Julie Barrat Director, CIEH Wales.

Synthesising Qualitative and Quantitative Health Evidence: A guide to methods

Catherine Pope, Nicholas Mays, Jennie Popay 2007.

Open University Press/McGraw-Hill Education.

ISBN 13: 978 0 335 21956 (paperback). £21.99

If you have a professional interest in pulling together health evidence to inform practice, then "Synthesising Qualitative and Quantitative Health Evidence", published by Open University Press, is for you. There is an underlying paradox that the increasing information mountain of research outputs in various forms makes policy and practice development more difficult than ever. This book goes a considerable way to address this paradox. In three parts, this paperback edition covers the evidence review process, the methods used for synthesis and the output from this process of making 'whole pictures' from multiple research 'snapshots' to inform policy and practice.

The processes of evidence review, described in Part One, clearly acknowledge the different types of review, linked quite closely to and exploiting the wide range of types of primary research. The recent developments from basic literature review, through systematic approaches and decision-support methods, are covered with many helpful examples to illustrate how these may be applied.

Part Two looks at synthesis in three parts: first, mainly quantitative (though statistical methods are not covered) including content analysis and Bayesian approaches are described. Second, the authors cover relatively recent types of synthesis of evidence using mainly qualitative text-based methods having an emphasis on interpretation but again making good use of primary research methods like grounded theory and ethnography, treating published research studies as primary data sources.

Third, other more eclectic methods which by definition do not fit the mould, a.k.a. 'mixed methods'. Thematic analysis is described as a lower order type of content analysis; while realist and narrative synthesis ... are intriguing methods which answer questions such as "What works, for whom, in what circumstances?" In all cases, ample use of exemplar synthesis helps the reader to grasp these fairly complex approaches to secondary analysis of health research. Part Three considers the "so-what?" question: what is the point of synthesis and what can be done with it? Chapters are included to guide researchers on early engagement with end-users to help plan presentation and dissemination of synthesis rationale, methodology and findings. In addition to summary tables, interesting examples of a mind-map, flowchart, graphs and diagrams are included. Software specifically devised to support synthesis is briefly described. Final chapters reemphasise the importance of synthesis in evidencebased health policy-making and re-visit the importance of matching method to purpose (with a helpful table for so matching). The book rightly ends with a neat set of 13 questions to be used in quality assessment of synthesis. This makes me think I need to apply more rigour to book reviews as well: but that is another story.

Review by George Kernohan Professor of Health Research, University of Ulster

Traditional Herbal Medicines – a guide to their safer use

Lakshman Karalliedde and Indika Gawarammana, with Debbie Shaw. 2007

Hammersmith Press, 376pp.

ISBN978-1-905140-04-6 (paperback) £18.99

The world market for herbal medicines is estimated at about US\$70 billion per annum and growing. In the UK, the market is about £275 million and about half of the population will use a herbal product in their lifetime in addition to, or as an alternative to, allopathic (Western) medicines. In the developing world, traditional medicine may be all that is available to most of the population.

In the West, traditional herbal medicinal products are perceived as a 'natural' alternative. They are also more accessible, and may be cheaper. Their use could also reflect discontent with allopathic medicine. Unfortunately, 'natural' does not necessarily mean 'safe'. Many herbals are extremely potent and may produce adverse reactions. Some may interact with allopathic medicines and others may cause complications in surgery.

There have been problems with mis-identified herbs, quality control and contaminants and, often, there is little or no advice about dosage – and, as they say, the difference between a medicine and a poison is the dose. Regulation of herbal medicinal products is generally weak, compared with prescription and over-the-counter medicines, and cannot be relied upon to protect public health, though the USA and UK are currently strengthening their regulatory systems. Consumers might seek advice from their doctor or pharmacist, but the benefits and dangers of traditional herbal medicines are not included in pharmacy and medicine curricula. There has been a long-standing need for an easy-to-use, comprehensive reference text for both the public and for health professionals. Karalliedde and Gawarammana were ideally placed to author such a work.

Their upbringing in Sri Lanka seems to have given them a natural respect for herbal remedies that was later tempered by their training as allopathic medical practitioners and distinguished careers as toxicologists. Editorial advisor Debbie Shaw leads work on herbals at the Chinese Medicine Advisory Service at the Medical Toxicology Unit at Guy's Hospital. About half of the book is an A-Z of commonly used herbs. It sets out their uses, probable modes of action, adverse effects and precautions. Other chapters address: common medical disorders – setting out both allopathic and traditional treatments; potentially harmful constituents; precautions in special circumstances such as pregnancy, breastfeeding, infancy, old age, diabetes and surgery, and drug-herb and herb-herb interactions. There is a very useful glossary.

The book is clearly structured and well indexed for ready reference, and much of the content is set out in tables. In less than a minute I was able to look up Echinacea. This is one of the most commonly taken herbal medicines, and its use is often promoted in popular magazines and newspapers. I found that while it has many benefits, it should not be used except under medical supervision by persons suffering from immune system dysfunction, autoimmune conditions, multiple sclerosis, HIV, tuberculosis and diabetes mellitus, and it has been associated with liver disease and life-threatening allergic reactions. I wondered how many GPs and pharmacists, let alone users of that product, were aware of this.

While I would have preferred more of the content to be academically referenced, the book sits comfortably at an acceptable level for both popular and professional use. For the protection of the public, it should be on the shelf of every GP, herbal practitioner, pharmacist, toxicologist, anaesthetist and public health department.

Review by Norman Parkinson Senior Lecturer in Public Health King's College London, School of Medicine

CIEH supported research

Project descriptions and progress to date from:

- [Noise Induced Hearing Loss in Occupational Motorcyclists](#)
- [Housing Transfer and the Impact on the Strategic role of Local Authorities](#)
- [Noise Complaints: A local Authority Perspective](#)
- [Counterfactual thinking following slipping and tripping accidents](#)
- [Sunbed Salons: An investigation into the knowledge of the risks and precautions taken by proprietors of sunbed salons in the City of Leeds](#)

Noise Induced Hearing Loss in Occupational Motorcyclists

Chris Jordan, University of Ulster

The exposed population of occupational motorcyclists is significant. UK Numbers total over 25,000 with the majority of occupational motorcyclists being couriers, professional racers and police motorcycle officers. World-wide the number of occupational motorcyclists is estimated to be in the region of 2 million.

The measurement of noise levels under motorcycle helmets is by no means an easy task. The methodology used consisted of a miniature microphone placed over the rider's ear canal which fed to a calibrated DAT recorder. Both sound pressure level and frequency analysis of the wind noise was then obtained from the tape. The motorcycles and helmets tested were similar to that used by occupational motorcyclists. These included the modification of a number of helmets, variety of motorcycle styles, helmet types and configurations. This took over 6 months and the results were analysed and useful conclusions have been drawn as follows;

- the noise level the rider is exposed too at over 40 mph is predominantly wind noise, under 40 mph the noise level is predominantly from the tyres, road, engine etc.
- for most motorcycle configurations, the rider is exposed to 90 dB(A) from as little as 35 mph rising to 110 dB(A) at 70 mph.
- the difference between various helmet styles (open or closed face) and motorcycle styles (naked or faired) made little difference to the noise exposure level.
- as a daily dose value, all occupational motorcyclists tested exceeded the second action level of the Noise at Work Regulations.

I am currently studying the noise exposure levels of American police motorcyclists in Mississippi and the surrounding states. Provisional testing has shown that they are exposed to slightly higher levels than their UK counterparts as the helmets they use, 'skull caps', do not cover the ears.

The measurement of noise level contribution from radio communication headsets is the next area of research. A pilot study has already been completed and the full study will commence at the beginning of June.

[top](#)

Housing Transfer and the Impact on the Strategic role of Local Authorities

Robert Cogings, Derbyshire Dales District Council & Sheffield Hallam University

Large Scale Voluntary Transfer (LSVT) is an option local authorities are encouraged to consider when developing plans for sustained improvement of Council Housing. Despite the reported successes achieved by over 150 such transfers of Council stock to new Housing Associations, and various other forms of transfer, there is a lack of reported knowledge of the impact of LSVT.

This research will attempt to show that LSVT has a detrimental affect on the strategic housing functions of local authorities. Reference to private sector housing services is particularly relevant given its prominence in the new role of LSVT local authorities. Councils who have transferred their stock are often faced with the prospect of delivering the continuing housing functions, when many of the original housing staff having transferred to the newly formed housing association. Housing responsibilities are often sidelined within a larger Council department with little or no direct officer representation at a senior level.

A key Government aim in encouraging local authorities to stock transfer is the separation of the management role of social housing, from the strategic role of the local authority. Reported assessments of Council performance have indicated that local authorities have not benefited from this separation.

The Strategic Housing role of a local authority following transfer has a greater emphasis on the work of private sector housing services. The outputs of such services together with other assessments will be used as markers to assess performance before and after transfer.

A case study approach is planned which will focus on a small number of similar rural authorities within the East Midlands Region.

Noise Complaints: A local Authority Perspective

Stephen Grime, Borough of Telford and Wrekin and University of Birmingham

Whilst the numbers of noise complaints made to the UK local authorities is now reported to be levelling off after many years of increase, the current figure is approximately ten times greater than 15 years ago. For the last 60 years researchers have had a keen interest in the quantification of what makes sound develop into noise. The answer remains as elusive today as it did 60 years ago. A plethora of differing noise metrics have been developed to characterise any noise. Unfortunately each of these is only useful in describing the noise characteristics for which the descriptors were developed.

To understand why people complain about noise it is necessary to investigate (i) if there are any links between the social data for the area and the number of complaints from that area and (ii) if there are any common themes as to why persons complain. This is the main aim of this project.

The first strand uses the GIS system. The use of mapping techniques will allow social data to be overlaid with complaint data. The data will then be analysed to look for any statistical associations. There are at least six social indicators in use within the UK, each with a subset of individual parameters that can all have differing weightings within the social indicator.

The second major strand to the research is to use qualitative methods. The use of semi-structured interviews with people who have complained about noise to the local authority; this should allow any common themes to be identified. These themes could then be used in the formation of hypotheses to provide further insight into the nature of the complaints made.

Four years of noise complaint data have been collected so far. These show distinct groupings in areas of high housing density. They are, however, higher than would normally be expected. The best fit of data appears to be with the "Townsend Score" social indicator ($r = 0.4$). There are, however, problems because of incomplete data. Some values of the dependent values are null. If these are included the line of best fit is quadratic. If excluded the fit becomes closer to linear. More data may provide clarification to this.

It becomes apparent when the data is analysed that it is very rare that the complainant lives adjacent to the perpetrator of the noise. Whilst the reasons for the complaints vary, it is common to find that the complainant has suffered other problems in the near past. These are often found to be contributory factors in their decision to complain.

Counterfactual thinking following slipping and tripping accidents

Paul Lehane, London Borough of Bromley and London Metropolitan University

After an unwanted outcome e.g. an accident, people seem to spontaneously engage in counterfactual thinking; that is, they think about how things could have been different, sometimes referred to as "if only....." thoughts. Thus to bring about a different outcome, an antecedent event is identified and then changed. For example, if you miss your flight due to a traffic jam on the motorway, you may think, 'if only I had left earlier I would have caught my flight'. Previous research has looked at various aspects of the antecedent chosen for change. These have included 'counterfactual direction' (is a better or worse outcome chosen), is an action or inaction selected for change, is the outcome achieved by adding or subtracting something from the original sequence of events. Almost all of the previous research has used psychology students in the experiments and few have involved occupational accidents.

This research seeks to validate the existing general research findings against populations of people who have a real but varied psychological involvement with occupational accidents including safety professionals, managers and accident subjects. The first stage of the research will be undertaken by way of a scenario-based questionnaire using a slipping and tripping accident in a supermarket with manipulations of outcome injury severity (minor -v- serious) and amount of information provided to the respondent (minimal -v- maximum). Participants will read the scenario and answer a range of questions including completing a sentence "If onlythings could have been different". The responses to this will be coded and compared.

Data collection is underway and a good response has been obtained from the safety professional population; accident subjects and managers are currently being recruited. It is anticipated that this phase will be completed by late summer 2003. Analysis of the data will follow and a further phase of research will be based on the results. It is likely that this will involve a more qualitative approach. The research hypothesis is that there will be differences in the way the three populations apply counterfactual thinking to slipping and tripping accidents, and that safety professionals will focus on matters that are earlier in the antecedent chain than managers. Managers will focus change on the actions of the accident subject but safety professionals will focus on inactions rather than actions.

The research is currently in its second year (part time). For further details see "[Counterfactual thinking following slipping and tripping accidents](#)".

Sunbed Salons: An investigation into the knowledge of the risks and precautions taken by proprietors of sunbed salons in the City of Leeds

Paul Barnwell, Leeds City Council and Nottingham Trent University

This project will review the literature to indicate the extent of health issues surrounding the sunbed industry, investigate the current extent of knowledge, information and precautions in place in Leeds sunbed salons (including the use of risk assessments) and investigate methods of producing information and educational systems to ensure information and training materials are available in Leeds sunbed salons.

The methods will include;

- Contact with relevant bodies both in UK and abroad including HEA, HSE, CIEH, Sunbed Association, press, manufactures, trade associations, local authorities and other research projects in this study area.
- Developing a questionnaire relevant to the sunbed industry in order to investigate the present state of knowledge, information and precautions already in place in the sun tanning salon businesses in Leeds.
- Personal visits to approximately fifty sunbed salons within the Leeds City Council area to carry out structured interviews with proprietors to assess their awareness, understanding and knowledge of health issues and risks of sunbeds, including the legal requirements under Health and Safety legislation.

Using the information collected from the literature review and structured interviews/questionnaire it is intended to produce a 'Code of Practice' for sunbed salons and a 'Tool Kit' for use by proprietors when carrying out risk assessments.