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Aims and scope

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The Journal of Environmental Health Research is a peer reviewed journal published in three formats; Printed Full Journal, Printed Abstracts and On-Line Journal.

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

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Editorial team

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Editorial

Dr Ken Stewart
Associate editor

I well remember the fascinating discussions I had with Harold Harvey in the late 1990s into the early 2000s about the need for a peer-reviewed journal on environmental health research and practice. These discussions came to fruition in 2002 with the launch of this Journal under the auspices of the CIEH with support from the Environmental Health Officers Association of Ireland and my own institution, the Royal Environmental Health Institute of Scotland. JEHR is now well established as a leading research journal in environmental health and this issue again reflects some of the many and varied challenges on today's environmental health agenda. A glance at the Contents page confirms this.

I sometimes reflect on the major contribution environmental health professionals have made to improvements in human health, and the challenges that have been successfully tackled during the past 100 or so years. In the UK, infant mortality today per 1000 live births is in the mid teens. Prior to 1915, the figure was never below 100. Mortality today in every age group up to 35 years is one tenth or less than the rate of 100 years ago. Among children aged 1-9, mortality is now one twentieth of what it was then. Since the period 1861-1870, expectation of life at birth has increased by 28 years for males and just over 30 years for females with the greatest improvements in the first half of the 20th century.

A consultation document *Prevention and Health: Everybody's Business* published in the UK in the late 1970s painted a graphic picture of life in Victorian Britain:

"It is difficult to appreciate just how vulnerable life was 100 years ago. The dangers which assailed men and women from the moment of birth were many and varied. Child-birth itself was a hazard for both mother and infant and having survived that, the child had to run the gauntlet of scarlet fever, measles, whooping cough, and diphtheria, and to survive those other scourges which struck at any age: enteric fever (typhoid and para-typhoid), tuberculosis and smallpox. Nutrition was often poor so that children had less resistance than today, and the deformities of rickets were common.

"Perhaps television has painted too cosy a picture of Victorian Britain based on middle-class families, though a visit to your local churchyard will soon remind you how many died young in those days. There were in fact gigantic slums in every great city, the legacy of the industrial revolution. A grim picture of the times was painted by, among others, General Booth (founder of the Salvation Army) in his book 'In Darkest England'. Houses were insanitary and overcrowded. Piped water was unknown in most houses until the early 1900s and was in any event often unsafe. Most water for domestic use was drawn from wells. The water pump was as familiar a feature of town and village life as the petrol pump is today. Unhappily in cities in particular, many of the wells were contaminated by sewage. This contamination was responsible for the great outbreaks of cholera which ravaged the population in several of our urban areas, in 1831 (21,800 deaths), 1848-49 (53,000 deaths) and 1854 (20,000 deaths). It was not until the 1850s that Londoners ceased to drink their own sewage when extraction of water from the Thames below Teddington Lock was forbidden by law "

Clearly there is no single answer to the drastically improved situation in the UK today. There are many contributory factors including improved medical care, skills and knowledge, the development of immunisation and new effective drugs. But the contribution that environmental improvements have made in the form of clean water supplies, efficient drainage and sewerage systems, removal and disposal of household and other waste, hygiene in food preparation, clean air, occupational health, and provision of good housing is without doubt considerable.

Sadly, the graphic picture of life in Victorian Britain is still the picture too often seen in much of the developing world. Environmental health professionals have a continuing major contribution to make to improve the quality of life for people around the world, both in developed and developing countries.

Guest editorial

Alan Higgins
Chair of Council, Chartered Institute of Environmental Health

Environmental Health Practitioners (EHPs) are very good at getting things done, whether it be delivering food safety to customers of a major supermarket chain or ensuring safe water supplies in an emergency situation. As a profession we have, however, not been very good at writing up our experiences and reaction to differing problems or developing the evidence base to inform professional practice at all levels.

What is apparent is that there are very few problems in environmental health of which someone, somewhere has not had experience and may have the answers you are seeking. How we share those experiences and approach the resolution of environmental health problems must involve the gathering and dissemination of research.

I am therefore particularly pleased to be invited to write this guest editorial for a journal that is seeking and succeeding in addressing this need across our profession and providing the opportunity for practitioners to share their knowledge and effective practice with their professional colleagues in a peer reviewed context.

This edition of the journal has articles from the United States, India, Africa, Jamaica and Wales demonstrating that environmental health issues are no respecters of international boundaries but also that many of the problems discussed have common threads that all EHPs can learn from in their practice, wherever they work.

This is true in respect of the work on blood lead in Botswana, lead exposure in small factories in India, the relationship between contraceptive use and sexually transmitted disease in the US, and exposure to asbestos in Jamaican hospitals. Each of these will have some resonance for practitioners in other countries and provide learning opportunities and all are contained within this journal.

The work on sun beds in Wales, supported by CIEH Wales, provides a practical example of how research can directly influence policy and practice. The research has demonstrated the need for tighter regulation of businesses offering the use of sun beds both in terms of the equipment standards and also the training and supervision of staff. Partly as a result of this research new regulatory controls on sunbeds and their use have now received parliamentary approval. Further work has also been established by the HPA, related to the monitoring problems identified in this research, to determine a simpler methodology for measuring emissions which, if successful, should lead to greater ease of monitoring and enforcement. Follow up research on the level of the 'exceedance' is also being planned, which will require the cooperation of EHPs.

Evidence-based policy and practice increasingly demands the use of research as a key tool to improve practice. However, research is often not directly applied to practice, as many practitioners aren't adequately equipped to digest research and appropriate support systems are lacking. What is needed is a better understanding of the relationship between environmental health research and the work of EHPs including what organisational structures are needed to better enable the practical use of research. This will require much more involvement from policy makers and service managers in determining and disseminating what works through an evidence-based approach and ensuring practitioners are encouraged to adopt these approaches through performance management processes.

Research can sometimes be seen as a luxury, particularly with the ever increasing demands on environmental health practitioners. However, it should be viewed as a central and essential element in delivering efficient and effective environmental health services.

Knowledge, attitudes and practices of hospital employees/workers with respect to asbestos, its potential health hazards, and management

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Abstract

Asbestos is an established human carcinogen. In the occupational exposure setting, many workers who handle or come in contact with asbestos may not be able to identify it as such. In two companion papers, we identified asbestos in a poor condition indicative of fibre release in several Jamaican hospitals, suggesting the possibility of worker exposure.

Subsequent collection and analysis of personal air samples at two major hospitals indicated that asbestos fibres were not present in the samples. The purpose of the study reported in this paper was to assess the knowledge, attitudes and practices of hospital employees with respect to asbestos, its potential health hazards, and management.

From two major hospitals with asbestos containing material, 277 employees selected by stratified random sampling responded to an interviewer-administered questionnaire. The proportion of respondents who had never heard of asbestos was about 22% overall, 13% for maintenance workers, 69.5% for other non-professionals and 9% for professionals. Among those who had heard about asbestos, only about 36% were aware that asbestos was present at the hospitals. Maintenance workers were more likely to be aware of asbestos at the hospitals and to know about the uses of asbestos in buildings than other workers. About half of the maintenance workers reported that they had disturbed suspected asbestos containing building material (ACBM) during routine work and 41.5% reported not being provided with appropriate personal protective equipment. Only 9.7% of maintenance workers received training on asbestos.

Key words: *Asbestos; attitudes; awareness; environmental health; exposure; hospital employees; Jamaica; knowledge; occupational health.*

Introduction

Asbestos is an established human carcinogen (ACGIH, 2005; IARC, 2008). Although the production and use of asbestos has declined steadily in the past 30 years, significant amounts remain in buildings including schools and hospitals. Historically, most asbestos-related diseases are associated with working with asbestos-containing building material (ACBM). However, there have been many documented cases where asbestos exposure and subsequent development of health effects were not due to working actively with asbestos but due to the presence of ACBM in the building where the work was performed (Anderson *et al*., 1991; Oliver *et al*., 1991; Markowitz *et al*., 1991; Selikoff *et al*., 1991). Asbestos is one of, if not the most important single factor causing work-related fatalities (Takala, 2003).

According to the ILO (2005), Jamaica is included among a group of countries that need to "adopt a national policy for a world ban of asbestos". Countries in this group "have not banned asbestos and have not ratified ILO 162 and do not produce, or engage in the trade of asbestos".

Despite the abundance of information on its hazards, asbestos continues to be used and many doctors are not fully aware of its potential for causing disease (WHO, 2000). Many factors shape the messages workers have been exposed to about asbestos (O'Regan *et al*., 2007) and these messages help to inform workers' knowledge, attitude and practices relative to asbestos. Many workers who handle or come in contact with asbestos may not be able to identify it as such. The only way to positively identify ACBM is to have it tested by laboratory professionals. It is imperative that workers be aware of asbestos in their work environment. In two companion papers we a) described a recent survey, which identified asbestos (mainly used as thermal system insulation on boilers and steam pipes) in a poor condition indicative of fibre release in 16 (61.5%) of 26 Jamaican hospitals (Scarlett *et al*., 2009a,), and b) presented data from personal and area sampling conducted at the two largest hospitals with asbestos. The data showed that asbestos fibres were not present in air samples analysed by phase contrast microscopy (PCM) and transmission electron microscopy (TEM) (Scarlett *et al*., 2009b).

The purpose of this study was to assess the knowledge, attitudes and practices of hospital employees with respect to asbestos, its potential health hazards, and management. We hypothesized that professional health workers are more knowledgeable about asbestos than hospital maintenance and other non-professional hospital workers.

Methods

Selection of hospital employees

Subjects were selected from two of Jamaica's largest hospitals, which had the highest proportion of bulk samples collected that contained asbestos and where 10 or more maintenance workers were employed (Scarlett *et al*., 2009). The general approach to subject selection was random sampling at each hospital, with stratification

according to three employee groups: 1) maintenance (boiler operators, pipe fitters, electricians, plumbers and carpenters); 2) other non-professional (male porters, sanitation workers, and security guards); and 3) professional (doctors, nurses, medical technologists, pharmacists, physiotherapists, and radiographers). The sampling fraction was 100% for maintenance workers and for other groups was specified to achieve a total study size of approximately 300 in the ratio 1 (maintenance): 1 (other non-professional): 3 (professional). Professional employees were the largest group of employees at each hospital. In all, we selected 308 workers for the study, including 60 maintenance, 70 other non-professionals and 178 professional employees.

Questionnaire administration

A structured, pilot-tested interviewer-administered questionnaire was utilised to collect data. Topics covered by the questionnaire included socio-demographic characteristics, asbestos knowledge and attitude questions and a section on practices for maintenance workers. All questionnaires were administered by one of us (HS) in private at each hospital. Hospital management and heads of departments (HODs) gave permission for employees to be interviewed during their work shift. Each respondent signed a consent form. The questionnaires were administered over the period 12th June 2006 to 12th February 2007. The protocol for this study was approved by the IRB at the University of Alabama at Birmingham (UAB), the Jamaica Ministry of Health (JMOH), and the University of the West Indies, Mona (UWI).

Analysis

The data were checked to ensure face validity. Chi square and logistic regression analyses were done to determine if knowledge and attitudes about asbestos varied by job group. Odds ratios were computed as the measure of association, using professional workers as the referent category for the job group variable. Analysis was performed using SAS Version 9.1.

Results

A total of 277 questionnaires were administered giving an overall 90% response rate. The response rate was 78% for maintenance workers; 84% for other non-professionals; and 96% for professional employees. Professional employees comprised the largest proportion of the 277 employees interviewed (62%). This was followed by other non-professional employees and maintenance workers, comprising 21% and 17% of respondents respectively. Almost equal numbers of males and females participated (Table 1.0). Most respondents (69%) were less than 40 years old and had a mean age of 34.8 years (SD = 11.58) (Table 1.0). All maintenance and other non-professional workers were males. Maintenance workers were older and more likely to be married than the other two groups. Maintenance workers and other non-professionals were more likely to have finished their formal education at the primary/secondary level while professionals were more likely to have expanded their education to the college/university level (p=0.0001). Over 70% of the respondents had worked at the two hospitals for less than 10 years, and overall the median number of years for which respondents were employed was 3.3.

Of the 277 participants, 215 (77.6%) reported having heard about asbestos while 62 respondents (22.4%) had never heard of asbestos. Maintenance workers were less likely to have heard about asbestos than professionals but the association was not significant (OR=0.67; 95% CI=0.24-1.80). Other non-professionals were also less likely than professionals to have heard about asbestos and this association was significant (OR=0.04; 95% CI=0.02-0.09).

Further analysis focused on the 215 subjects who had heard about asbestos. Seventy seven employees (35.8%) were aware of asbestos at their workplace. This contrasted with 138 or 64.2% who were not aware of asbestos at their hospital. Maintenance workers were thirteen times more likely than health professionals to be aware of asbestos at the hospitals and this association was significant (OR=13.3; 95% CI=5.64-31.23). Other non-professionals were also two times more likely than professionals to be aware of asbestos at the hospitals but this association was not significant (OR=2.05; 95% CI=0.74-5.66). There was no association between hospital and employees' awareness of asbestos.

Just fewer than 50% of respondents identified insulation as a major use of asbestos in buildings, while almost a third was unaware of the use of asbestos (Table 2.0). Approximately 21% identified other uses of asbestos inclusive of fire protection and decoration. Almost 91% of respondents reported that asbestos was harmful to humans. There was no association between job group and the perceived hazard of asbestos. Maintenance workers and non-professionals were less likely than health professionals to report that they could name a disease(s) caused by asbestos and in the case of the latter group the association was significant (OR=0.21; 95% CI=0.07-0.62). However, not everyone who said they could name

Socio-demographic/ employment characteristics		Maintenance workers		Non-professionals		Professionals		p-value	Total	
		No.	%	No.	%	No.	%		No.	%
Total		**47**	**100.0**	**59**	**100.0**	**171**	**100.0**		**277**	**100.0**
Gender	Male	47	100.0	59	100.0	36	21.0	<0.0001	142	51.3
	Female	0	0.0	0	0.0	135	79.0		135	48.7
Age (yrs)	18-29	10	21.3	22	37.3	74	42.9	0.0030	106	38.3
	30-39	15	31.9	17	28.8	53	31.2		85	30.7
	40-49	4	8.5	11	18.6	27	15.9		42	15.2
	50-59	13	27.7	7	11.9	11	6.5		31	11.2
	⩾60	4	8.5	2	3.4	1	0.6		7	2.5
	Not given	1	2.1	–	0.0	5	2.9		6	2.2
	Mean (SD)	40.8 (13.8)		36.3 (12.9)		32.5 (9.6)				
	Median	37.5		33.0		30.0				
	Interquartile range	24.0		19.0		13.0				
Education	Primary/All-Age	18	38.3	16	27.1	1	0.5	<0.0001	35	12.6
	Secondary/High	19	40.4	36	61.0	1	0.5		56	20.2
	College/University	9	19.2	1	1.7	166	97.2		176	63.5
	Other	1	2.1	6	10.2	3	1.8		10	3.7
Marital status	Single	16	34.0	35	59.3	107	62.6	0.0002	158	57.0
	Married	21	44.7	19	32.2	52	30.4		92	33.2
	Common Law	9	19.1	3	5.1	4	2.3		16	5.8
	Separated/Divorced	1	2.1	2	3.4	8	4.7		11	4.0
Duration of employment (yrs)	<1	5	10.6	21	35.6	39	22.8	0.0010	65	23.5
	1-4	16	34.0	19	32.2	59	34.5		94	33.9
	5-9	4	8.5	14	23.7	34	19.9		52	18.8
	10-14	7	14.9	2	3.4	19	11.1		28	10.1
	15-19	5	10.6	1	1.7	7	4.1		13	4.7
	⩾20	10	21.3	2	3.4	13	7.6		25	9.0
	Mean (SD)	11.3 (11.4)		4.2 (6.0)		6.1 (6.8)				
	Median	7.0		1.5		4.0				
	Interquartile range	16.0		5.5		7.75				
Ever heard of of asbestos?	Yes	41	87.2	18	30.5	156	91.2	<0.0001	215	77.6
	No	6	12.8	41	69.5	15	8.8		62	22.4

Table 1.0
Distribution of three groups of respondents: maintenance workers; non-professional health workers; professional health workers by selected socio-demographic and employment characteristics

Table 2.0
Distribution of responses to selected parameters relating to awareness, use, and health effects of asbestos by maintenance workers, other non-professionals and professionals

		Maintenance workers		Other non-professionals		Professionals		p-value	Total	
		No.	%	No.	%	No.	%		No.	%
Awareness of asbestos in hospitals	Yes	33	80.5	7	38.9	37	23.7	<0.0001	77	35.8
	No	8	19.5	11	61.1	119	63.3		138	64.2
	Total	41	100.0	18	100.0	156	100.0		215	100.0
Use of asbestos in buildings	Insulation	26	63.4	5	27.8	73	47.4	0.0077	104	48.8
	Other	6	14.6	9	50.0	29	18.8		44	20.7
	Don't know	9	22.0	4	22.2	52	33.8		65	30.5
	Total	41	100.0	18	100.0	154	100.0		213	100.0
Asbestos is harmful to human health	Yes	34	82.9	15	83.3	145	93.5	0.0620	194	90.6
	No	7	17.1	3	16.7	10	6.5		20	9.4
	Total	41	100.0	18	100.0	155	100.0		214	100.0
Can you name a disease caused by asbestos?	Yes	25	62.5	5	27.8	101	65.6	0.0076	131	61.8
	No	15	37.5	13	62.2	53	34.4		81	38.2
	Total	40	100.0	18	100.0	154	100.0		212	100.0
Health effects of asbestos	Affect respiratory system/lungs	6	14.6	2	11.1	44	28.2	0.0008	52	24.1
	Lung cancer	10	24.4	2	11.1	54	34.6		66	30.6
	Mesothelioma/ asbestosis	6	14.6	2	11.1	15	9.6		23	10.7
	Harm but no specific disease	1	2.4	0	0.0	10	6.4		11	5.1
	Other	3	7.3	5	27.8	6	3.8	0.0002	14	6.5
Route of exposure	Inhalation	30	73.2	11	61.1	138	90.1		179	84.4
	Ingestion/ skin absorption	1	2.4	0	0.0	1	0.6		2	0.9
	Other	1	2.4	4	22.2	5	3.3		10	4.7
	Don't know	9	22.0	3	16.7	9	5.9		21	9.0
	Total	41	100.0	18	100.0	153	100.0		212	100.0

Statements (True/False)	Maintenance workers % correct responses	Other non-professionals % correct response	Professionals % correct responses (%)	Total correct response (%)	p-value
(A). Asbestos is a mineral made up of tiny fibres (N=191) (True)	94.7	72.2	80.7	82.7	0.0609
(B). White asbestos is the most commonly used form of the mineral (N=147) (True)	84.9	50.0	74.5	74.2	0.0326†
(C). A smoker who is exposed to asbestos is at increased risk of developing lung cancer (N=205) (True)	94.6	94.4	96.0	95.6	0.9033
(D). The use of asbestos is banned in Jamaica (N=205) (False)	45.9	75.0	61.7	59.5	0.0977
(E). Trying to remove asbestos from a building can sometimes create a bigger problem than existed before (N=199) (True)	89.5	76.5	84.0	84.4	0.4557
(F). Human risk of asbestos-related disease depends on exposure (N=206) (True)	97.4	100.0	98.7	98.5	0.7234
(G). Asbestos-related diseases show several warning signs before they become dangerous (N=187) (False)	41.2	50.0	67.9	61.5	0.0101†
(H). You have to work directly with asbestos to be at risk from exposure to airborne fibres (N=204) (False)	61.5	76.5	87.2	81.4	0.0011†
(I). Warning signs are placed at all entrances to asbestos work areas to prevent accidental or unauthorised entry (N=198) (True)	52.5	31.3	39.4	41.4	0.2304
(J). If you find any material that you suspect may contain asbestos, it is not necessary to inform your supervisor (N=204) (False)	76.3	83.3	94.7	86.7	0.0806
(K). Asbestos waste can be thrown away with regular garbage (N=207) (False)	74.4	83.3	94.7	89.9	0.0006†

Table 3.0
Distribution of percent correct responses by maintenance workers, other non-professionals, and professional health workers to knowledge questions on asbestos

a disease was able to do so. Of the 131 respondents who indicated that they could name a disease, 99 were able to do so correctly. The three most important asbestos-related diseases were named (asbestosis, lung cancer, and mesothelioma). Professionals were more likely to name correctly an asbestos-related disease than the other two groups.

Approximately 84% of respondents correctly identified inhalation as the major route of human exposure to asbestos. Approximately 9% did not know the major route of exposure while 2 (0.94%) said the major route was ingestion or absorption through the skin (Table 2.0). Professionals were more likely than other groups to name the major route of exposure (p=0.0002). Respirators (29.11%) and protective clothing (31.92%) were the major RPE for asbestos named by respondents; 10% did not know of any PPE.

Respondents were asked to indicate whether each statement in Table 3.0 was "true" or "false". Overall, correct responses to the statements were given by 41.4% to 98.5 % of respondents with the mean being 77.8% and the median, 82.7%. In all but one case,

Table 4.0
Distribution of respondents by responses to statements reflecting possible attitudes towards asbestos

Statements	SA (%)	A (%)	U (%)	D (%)	SD (%)	p-value
1. Since asbestos-related diseases take many years to develop, workers should not be concerned about these diseases (N=208)	2.88	2.88	1.44	33.17	59.62	<.0001
2. The presence of asbestos in a building does not automatically result in worker exposure if the asbestos is managed properly (N=207)	6.28	56.52	14.49	18.36	4.35	0.0080
3. Asbestos in any form or condition found in a building should be removed immediately (N=207)	23.19	46.38	14.98	12.56	2.42	Not significant (NS)
4. Workers without adequate PPE can work with asbestos without risk of being harmed (N=207)	0.97	5.80	4.35	46.86	42.03	NS
5. Appropriate warning signs should be put up in areas of the hospital where asbestos is located (N=206)	49.03	45.15	3.88	1.46	0.49	NS
6. Every hospital where asbestos is present should have an asbestos policy and control programme in place (N=206)	47.09	50.00	1.94	0.49	0.49	NS
7. There should be periodic medical examination of workers who may be exposed to asbestos fibers (N=207)	52.66	44.93	1.93	–	0.48	NS
8. Workers should not be punished if they refuse to wear PPE when working with asbestos (N=207)	3.86	19.81	13.53	44.44	18.36	NS
9. I would not work at a hospital if I knew that asbestos was present in the building (N=206)	4.85	11.17	28.64	51.46	3.88	0.0001
10. Hospital workers in Jamaica should be educated about asbestos (N=206)	57.28	41.75	0.49	–	0.49	NS
11. I want to know more about asbestos (N=207)	49.28	49.76	–	0.48	0.48	NS
12. I would not wear PPE for asbestos if required to (N=207)	0.97	2.90	1.45	54.59	40.10	NS

Parameters relating to asbestos		Frequency	Percent
Heard about asbestos	Yes	41	87.2
	No	6	12.8
Disturb suspected ACBM on the job	Yes	23	56.1
	No	18	43.9
Provided with PPE	Yes	24	58.5
	No	17	41.5
PPE provided	Coverall/Gowns/Protective clothing	14	58.3
	Respirator	8	33.3
	Dust mask	5	20.8
	Boots	4	16.7
	Hard hat	3	12.5
PPE usually worn on the job	Yes	24	58.5
	No	17	41.5
"Street clothing" worn on job sometimes	Yes	12	29.3
	No	29	70.7
Ever participated in removal of suspected ACBM	Yes	7	17.1
	No	34	82.9
Received training on asbestos	Yes	4	9.8
	No	37	90.2

Table 5.0
Frequency distribution of PPE provided, practices, and training of maintenance workers in relation to asbestos

approximately 60% or more of the participants answered correctly to each statement. For most of the statements there was no association between knowledge of asbestos and group of hospital employees (Table 3.0). Respondents at hospital X were more likely not to report suspected ACBM to their supervisors than their counterparts at hospital Y (p=0.0375).

Over 94% of respondents felt that appropriate warning signs should posted in hospitals with asbestos; that hospitals with asbestos should have a policy on asbestos and a control programme in place; that workers exposed to asbestos should undergo periodic medical examination; that hospital employees should be educated about asbestos; and almost everyone wanted to learn more about asbestos. For most respondents (54.3%) the presence of asbestos in hospital buildings would not deter them from working at the hospital. Almost 70% of respondents felt that asbestos in any form or condition found in a hospital should be immediately removed (Table 4.0).

Practices of maintenance workers

Seven of 41(17.0%) maintenance workers had participated in the removal of suspected ACBM from different sections of the hospitals. The suspected ACBM removed was reportedly collected for disposal by municipal waste collectors. The seven maintenance workers reported wearing PPE during the removal of the ACBM and the PPE worn included protective clothing and respirator.

Four maintenance workers (9.8%) reported participating in asbestos training programmes rated as "good to excellent" (Table 5.0).

Discussion

This is the first study of its kind in Jamaica to interview hospital employees to elicit data on knowledge, attitudes and practices with respect to asbestos and its management. Although adverse health effects due to asbestos exposure have been well documented in the

literature for several decades, in this study nearly a quarter of the hospital employees interviewed had never heard of asbestos and approximately two-thirds of those who had heard of asbestos were not aware of its presence at their hospital. This is not surprising as asbestos is rarely mentioned in the national media.

Most maintenance workers at both hospitals were aware of asbestos being present in certain areas of the hospitals and a few openly voiced their displeasure about the matter as they felt the hospital management could do more to address the matter. One worker explained that

> *"if it were doctors and nurses having to work where asbestos was located, then the matter would have been addressed".*

Since most of the asbestos found in the hospitals was used as thermal system insulation, then workers in boiler rooms and some laundries would be most at risk owing to natural degradation of asbestos or when asbestos lagging is removed. The provision and wearing of PPE was not universal among maintenance workers. In some cases dust masks were worn and these do not protect workers against asbestos fibres. Appropriate respirators that afford protection against asbestos fibres should be provided for maintenance workers. These workers could easily be exposed if asbestos fibres were to become airborne in their work setting. The reported collection and disposal of asbestos by municipal waste collectors need urgent attention as asbestos should never be disposed of with municipal or domestic solid waste. Very few maintenance workers reported obtaining training on asbestos and this situation should be urgently addressed. All workers working with hazardous materials should receive appropriate training so that adverse health impacts may be averted.

Workers have a right to know about hazardous materials present in their work environment and the risks they face from exposure to these materials (Bayer, 1986). Information on the hazards posed by asbestos has either been suppressed or made difficult to come by in several countries across the globe (Walker and Montagne, 2004). Despite the paucity of public information on asbestos in the Jamaican situation, hospital employees exhibited good knowledge on asbestos, its health effects and management. Professional health workers were the most knowledgeable about asbestos followed by maintenance workers and non-professionals, respectively. Concomitantly, several gaps in knowledge pertinent to asbestos were identified. None of the respondents knew the permissive exposure limit (PEL) for asbestos and many failed to name appropriate PPE for asbestos. There seems to be some confusion in the minds of respondents as to the difference between a respirator and a dust mask and very few were able to describe the appropriate respirator for asbestos. Gaps in knowledge should be addressed by educational interventions.

Respondents displayed an overall positive attitude towards asbestos and the need for proper management within the hospital environment. This type of attitude will guarantee the co-operation of hospital employees with management's effort to address the asbestos pollution in the hospitals. Some employees appear to be fearful of asbestos. This was evidenced by the expression of most respondents that asbestos in any form or condition found in the hospitals should be immediately removed. The mere presence of asbestos in a building does not warrant its immediate removal. Of far greater importance is the condition of the asbestos. Certainly if the ACBM is friable with signs of degradation indicative of fibre release, then the best management option may be to remove it by trained personnel. In some cases encapsulation of the asbestos may be an option where the asbestos is serving a useful purpose. There seems to be some disparity between responses to knowledge questions and attitude questions. For example, most respondents (84%) stated correctly that "trying to remove asbestos from a building can sometimes create a bigger problem than existed before", while 69% strongly agreed/agreed that "asbestos in any form or condition found in a building should be removed immediately". This could suggest confusion over the relative risks associated with the presence of asbestos and the process of removing it. It could also confirm that correct knowledge does not necessarily lead to the correct attitude.

Despite the presence of asbestos in sections of Jamaican hospitals, there is no national asbestos policy or hospital asbestos policy. The National Environment and Planning Agency (NEPA), the lead government agency with responsibilities for the environment published a "Proposed Asbestos Management Policy for Jamaica" in April 2002. NEPA disclosed that the proposed policy was established

> *"out of the concern for the extent of the asbestos contamination in Jamaica based on the increase in the number of Environmental Permit applications received for asbestos abatement programmess."* (National Environment and Planning Agency, 2002).

The time is now opportune for the Jamaican authorities to approve and promulgate this important policy document and move to have asbestos regulations in place. In the US a hospital asbestos policy must outline specific OSHA requirements relating to the safety and protection of employees (National Institute of Occupational Safety and Health, 1988) and the authorities in Jamaica should consider adopting and modifying this policy to fit the Jamaican situation. A national policy would provide guidance to hospitals developing their own policy.

Jamaica has not banned asbestos and this appears to be indefensible given the fact that Jamaica does not produce or trade in asbestos. What Jamaica has done is to include asbestos on a list of hazardous chemicals for which importation is restricted. Jamaica should therefore ratify ILO 162 and join the rest of the world which has banned asbestos.

Current levels of asbestosis, mesothelioma and other asbestos-related diseases in Jamaica are unknown but thought to be extremely low, while the levels of these diseases in countries, including the EU, which have banned asbestos continue to soar. Two cases of asbestosis and five cases of mesothelioma were diagnosed at two hospitals in Jamaica between 1971 and 1995 (Kahwa and Reid, 1994; UHWI Department of Pathology, 2007). None of these cases were ex-hospital workers. Mesothelioma has shown an increasing trend in the EU and this disease is estimated to peak in 2020 (Sigsgaard *et al*., 2010). The incidence of asbestosis and mesothelioma in ex-hospital workers in Jamaica is not known but there have been reports of asbestos-related diseases in ex-hospital workers in the UK.

Participation in the study was limited to employees in two of sixteen hospitals in which ACBM was found and this could affect the extent to which the results can be generalised to other hospitals. Although participation varied by job group, response bias was minimised via the objective manner of approaching potential participants.

Conclusions

- We have noted that despite not finding asbestos fibres in personal air samples taken from the two hospitals in this study, almost all the ACBM found in these hospitals was friable and in a poor condition indicative of fibre release, thus posing a potential exposure risk for employees.
- Nearly a quarter of hospital workers surveyed had never heard about asbestos despite its presence at their workplace.
- Among those who knew about asbestos, only 36% were aware that asbestos was present at the hospitals.
- Maintenance workers were more likely to be aware of asbestos at hospitals than health professionals and non-professionals.
- Health professionals were more likely to name an asbestos-related disease than non-professionals and maintenance workers.
- Overall respondents exhibited good knowledge and attitudes about asbestos.
- Maintenance workers had the greatest potential risk for exposure to asbestos and some reported participating in the removal of suspected ACBM from the hospitals.
- Over 90% of respondents felt that appropriate warning signs should be posted in hospitals with asbestos and that a policy on asbestos should be instituted.
- An awareness-raising and educational programmes on asbestos for hospital employees and visitors is needed.
- The hospital authorities should implement a management programme for asbestos in the facilities affected. This programme should focus primarily on abatement as appropriate alternatives to asbestos exist.
- The authorities should be proactive as one reported case of an asbestos-related disease in a hospital worker could lead to widespread fear, panic, legal action and possibly, resignations.

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Exposure to lead among children aged 1-6 years in the City of Gaborone, Botswana

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Abstract

This study evaluated blood lead-levels and potential risk factors for lead exposure among children aged 1-6 years in Gaborone, Botswana. Children were recruited from 10 pre-schools and five health clinics. Schools and clinics were selected to represent geographic and socioeconomic strata. Blood-lead levels (PbB) measured in 213 children ranged from 1.6 to 28.6 micrograms per deciliter (µg/dL) of blood with a mean of 8.8, median of 7.45 and standard deviation of 5.6. 31% of the children had PbB ⩾10µg/dL. 5% of all study children had PbB ⩾20µg/dL. No significant differences were observed between girls (mean=8.4) and boys (mean=9.3) (Kruskal Wallis test p=0.3); and age 24 months (mean=8.4) versus >25months (mean =8.9) (Kruskal-Wallis test p=0.5).

Significant risk factors for elevated PbB were maternal unemployment (OR=2.6), parent job involving lead (OR=2.4) and hobbies involving lead (OR=3.4). Compared to children who were recruited at schools, children recruited from clinics were 3.9 times more likely to have elevated PbB. Children whose dwellings were closer to a busy road were 1.7 times more likely to have elevated PbB than those who resided close to roads with less traffic.

Key words: Blood-lead levels; Botswana; Children; Environmental Health; Exposure; Lead; Gaborone.

Introduction

Lead is a ubiquitous toxic heavy metal resulting with negative public health consequences. While there is no specific data available in Botswana with regard to lead toxicity, information has been reported by several studies elsewhere (Bellinger, 2008a,b; Levin *et al*., 2008; Chiodo *et al*., 2004; Rossi, 2008; Lanphear *et al*., 2005; Needleman, 2004; Needleman *et al*., 2004). Lead has been associated with a range of adverse health effects, some of which have been shown to occur even at very low concentrations (Canfield. *et al*., 2003). Fewtrell and others (2003) estimated that mild mental retardation and cardiovascular outcomes resulting from exposure to lead amount to almost 1% of the global burden of disease, with the highest burden in developing regions (Fewtrell, *et al*., 2003). There is evidence that lead contributes to mental retardation and neurotoxicity (Ronchetti *et al*., 2006; Norman *et al*., 2007; Needleman *et al*., 1996; Rothenberg *et al*., 1989). Some of the earliest toxic effects of lead to be recognised are gastrointestinal effects and anaemia. Over the years, it has become increasingly evident that the nervous system is the principal target for lead among others (Bellinger, 2008a; Bellinger, 2004; Goyer, 1996; Todd *et al*., 1996; Goyer, 1993). Lower levels of lead are known to decrease reaction time (Chiodo *et al*., 2007; Min *et al*., 2007; Lilienthal *et al*., 1990), brings about deficits in hand-eye co-ordination (Stokes *et al*, 1998) and decreased nerve conduction velocities (Patocka *et al*, 2003; Landrigan *et al*. 1976; Needleman and Bellinger, 1991). Severe lead poisoning is known to result in encephalopathy with symptoms such as seizures and convulsions which can be followed by coma and death (Fleece and Robinson, 2007; Goyer, 1990). Lead is also known to cause reproductive toxicity and developmental effects (Wang and Jia, 2009; Telisman *et al*., 2007; Silberstein *et al*., 2006; Bellinger, 2005).

Children may be exposed to lead from sources such as house and toy paints (Lin *et al*., 2009; Weidenhamer, 2009; Montgomery and Mathee, 2005; Mathee *et al*., 2007; Mathee *et al*., 2004), dust and soil (Ranft *et al*., 2008; Brown and Jacobs, 2006) petrol (Stromberg *et al*., 2008; Mathee *et al*., 2006; Bacon and Dinev, 2005) and solder in water pipes and canned foods (Cook *et al*., 1993). Pica, the repeated ingestion of non-food substances, is identified by researchers as a major contributing factor to lead poisoning in children (Kumar *et al*., 1998; Yver *et al*., 1991). Children may ingest dust and soil contaminated with lead from aged flaking paint or paint which has been disturbed during home maintenance or renovation. The lead-contaminated house dust, usually ingested through normal repetitive hand-to-mouth activity, is now recognised as a major contributor to the total body burden of lead in children.

Children of parents exposed to lead at their workplaces are known to face an additional risk of elevated blood lead levels (CDC 2001; Chan *et al*., 2000; Friedman *et al*., 2005). Friedman and others (2005), observed a strong association between lead levels in children whose fathers worked manual labour jobs in industries associated with lead exposures.

Use of lead and lead compounds in Botswana

Up until December 2005 Botswana used lead as an additive in petrol and about 95% of petrol used was leaded (Ministry of Health, Environmental Health Unit, 1999). In 1999, lead in fuel was estimated at 106 tons per year (Ministry of Health, Environmental Health Unit, 1999). Lead imported to Botswana is mainly in the form of lead oxides. It is also used as a stabiliser in PVC-manufacturing.

While the main distributors of paint in Botswana report that they do not use lead-based paint pigments currently, it is not clear when these distributors stopped using lead based paint pigments. In South Africa, (where most of the paints used in Botswana originate from), "white lead" in paint was abolished in the 1940s and a voluntary agreement reached among the paint industry to limit the use of leaded pigments in the 1970s (Montgomery and Mathee, 2005). Currently, Botswana has no legislation to restrict the use of lead in paint. There is also no voluntary agreement between the Government and the paint industry to limit the use of leaded pigments. While there are no studies on lead in paint in Botswana, there are a few studies on lead levels in air, water and soil. One such study published by Zhai and others, found that lead levels in soils of Gaborone were moderately high (222mg/kg) compared to rural soils (Zhai *et al*., 2003).

Lead poisoning remains a serious health threat to children in developing countries. Blood lead levels (PbB) above the international guideline of 10µg/dL (CDC, 1991) have been associated with adverse health effects such as lower IQ scores, learning disabilities, hyper-activity and stunted growth among young children. While the developed world has taken aggressive steps to combat lead poisoning, actions in developing countries such as Botswana are slow, in part, owing to the lack of data on the extent of the problem. In response to the paucity of information in this regard, this study represents the first scientific exploration of child lead poisoning in Botswana.

The objective of this study was to determine lead levels in children aged 1-6 years and associated risks.

Methods and materials

Study population, selection and recruitment

This study focused on children aged 1-6 attending selected pre-schools and under-five year-old clinics in the greater Gaborone Area. Approval for ethical and scientific review of the study was obtained from the Ministry of Health (Health Research & Development Committee (HRDC)). Informed consent forms for participation, blood collection protocols and risk assessment questionnaires were reviewed and approved by HRDC. Informed consent contained information on the purpose of the study and contact details of the researchers.

Risk assessment questionnaires

Before sample collection, parents were asked to complete a risk assessment questionnaire with information on socio-demographic parameters, their child's behavior and potential sources of lead exposure in the home environment. Questionnaires were translated from English to Setswana and then re-translated back into English. Where parents were not able to read and write, questionnaires were administered by trained interviewers.

Sample collection and analysis

Blood samples were drawn on site by qualified health professionals using the FDA approved LeadCare II Blood Lead Test System (ESA Biosciences of Chelmsford, Massachusetts) with an analytical range of 1.4-65µg/dL. Before testing, children's hands were washed with soap and water. Each child's finger was then pricked with a single-use lancet and a 50µL capillary tube was filled after the first drop was discarded. The equipment was operated by a medical doctor and nursing assistants over a one week period. Blood samples were analysed within 24 hours at the University of Botswana. Machines were calibrated and control kit samples tested each day. Approximately 20% of samples were re-analysed for test-retest reliability. Data were entered into STATA version 8.

Lead concentrations in soil and paint were analysed using a Finnigan MAT Element 2 high resolution inductively coupled plasma mass spectrometer (ICP-MS). Approximately 100mg of soil sample (silt plus clay) was weighed into a Teflon vial, into which 2ml concentrated HNO_3, 6ml concentrated hydrofluoric acid (HF) and 2ml concentrated $HClO_4$ were added successively. The vial was tightly capped and put in an ultrasonic water bath heated to a temperature of 50°C. After three to eight hours of sonication and digestion, the vials containing the dissolved soil sample were uncapped and heated on a hot plate, at the temperature of 100, 120, 160, and 200°C successively to dry the sample. Then, 3ml concentrated HF and 1ml concentrated $HClO_4$ were added into the vial to dissolve the residue. This solution was dried on a hot plate using the same procedure. In order to remove any remnant traces of HF, 1ml concentrated $HClO_4$ was added into the vial and the vial was heated again on a hot plate to 100, 120, 160, and 200°C successively. When the sample was dried, the residue was dissolved into 100ml 1M HNO_3 and stored. Just before the analysis, this solution was diluted into a 1:1 ratio into deionised water. The method for paint samples digestion depended on the types of paints. For water-based paint, the sample digestion method was similar to that of soils. For oil-based paint, sample digestion was conducted in a CEM Mars 5 Microwave digestion system with 7 HP500

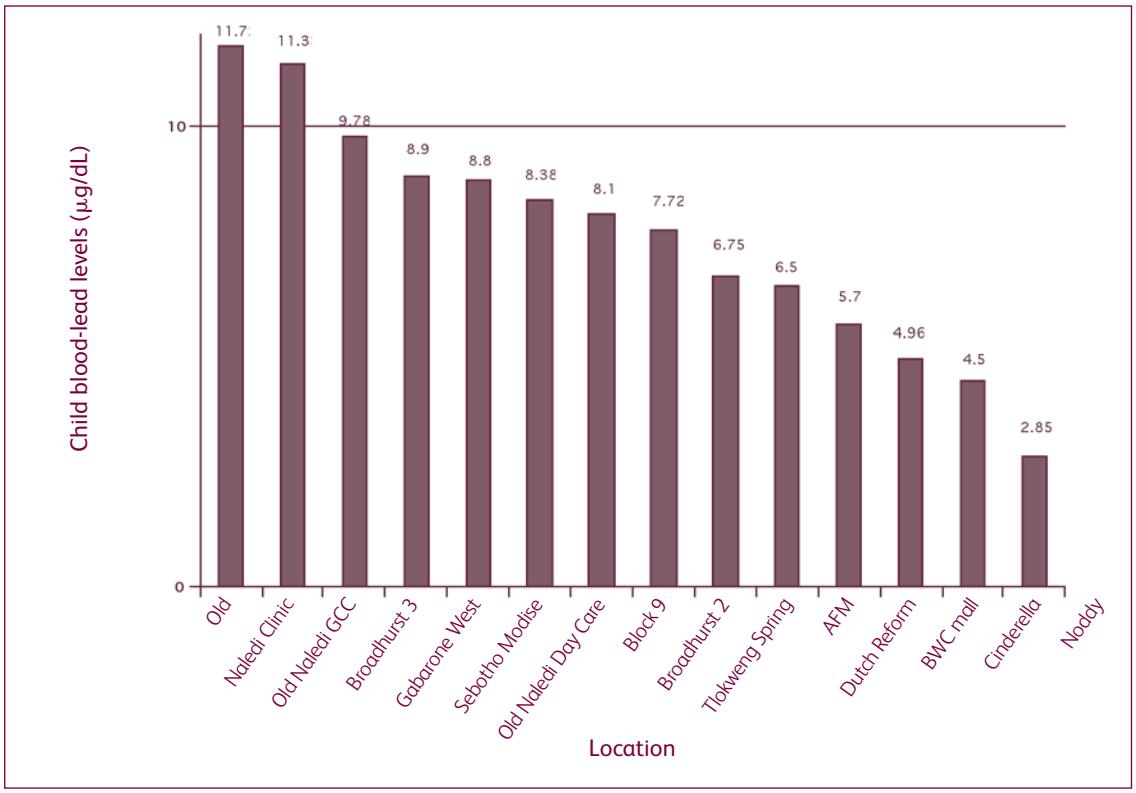

Figure 1.0
Mean blood-lead levels by location (N=213)

vessels. About 0.02g paint samples were weighted into vessels. 2ml of 70% concentrated HNO_3 were added into each vessel. Ramp time was 20 minutes, temperature was controlled to 210°C, and hold time was 20 minutes. After digestion, this sample was diluted to 20ml and stored. Just before the analysis, this solution was diluted in a 1:1 ratio into deionised water. For ICP-MS analysis, low resolution (resolution = 300, 10% valley definition) was used, three isotopes of Pb (Pb^{206}, Pb^{207} and Pb^{208}) were analysed, and the average of three values was the concentration of Pb. Five to nine soil/paint samples were grouped together with one international reference material, digested and analysed at the same time. If the difference between the analytical results of the reference material and the certified values were larger than 10%, the data of the entire group were discarded. The reference materials used in the analysis for paint are NIST 2589 and RTC CRM050-020; for soils are NCS DC73319, NIST 2709, USGS SCo-1, USGS BCR-2, USGS SDO-1 and USGS AGV-2. Repeated analysis for some samples indicated that the relative standard deviations are smaller than 10%.

Results

226 children participated in the study with 57% of them coming from the health clinics and 43% obtained from pre-schools. Blood samples were obtained from 213 children. The other 13 children did not give blood samples for reasons such as refusal to participate, or obtaining inadequate volume of blood samples for analysis. The average age of children who participated was 3 years and 6 months. Girls were 3 months older than boys. The age difference between boys and girls was however not significant ($p<.05$). More girls (51.3%) participated in the study.

Child blood-lead levels ranged from 1.6 to 28.6 µg/dL with a mean of 8.8, median of 7.45 and standard deviation of 5.6. Approximately 69% of child blood-lead levels fell within the Centers for Disease Control (CDC, 1991) action level of 10 µg/dL. 31% of children had blood lead levels equal to or above10 µg/dL while 5% of all study children had levels equal to or above 20 µg/dL. Figure 1.0 shows mean blood-lead level by school or clinic.

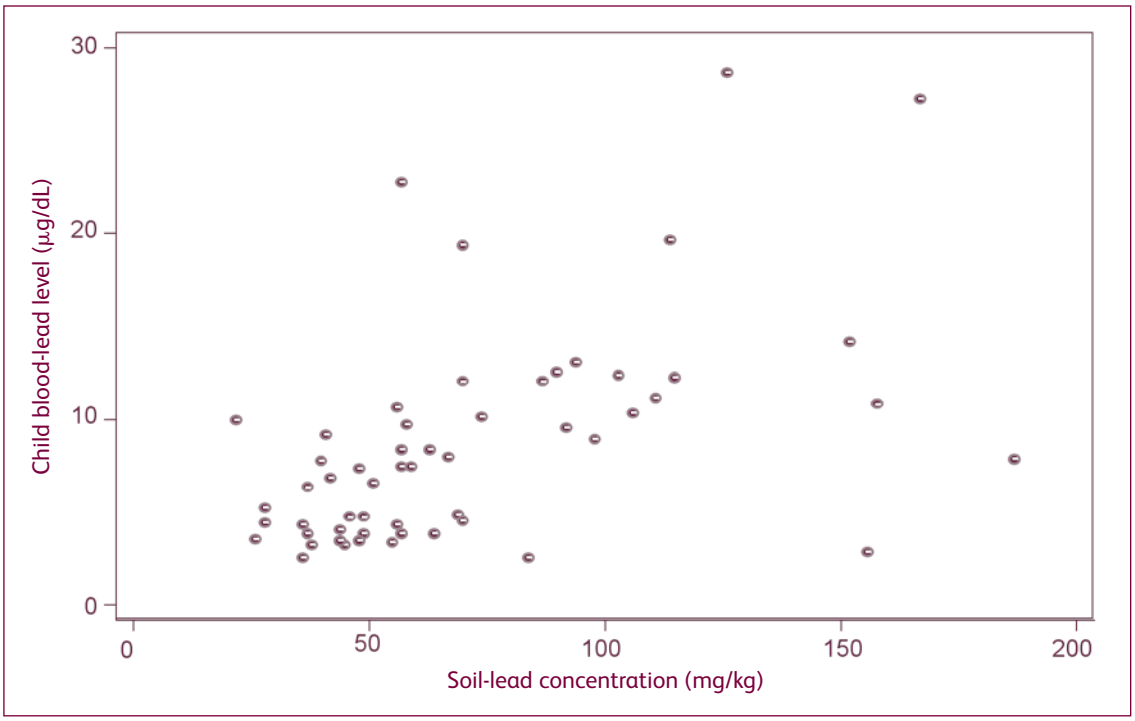

Figure 2.0
Relationship between child blood-lead level and soil-lead concentration

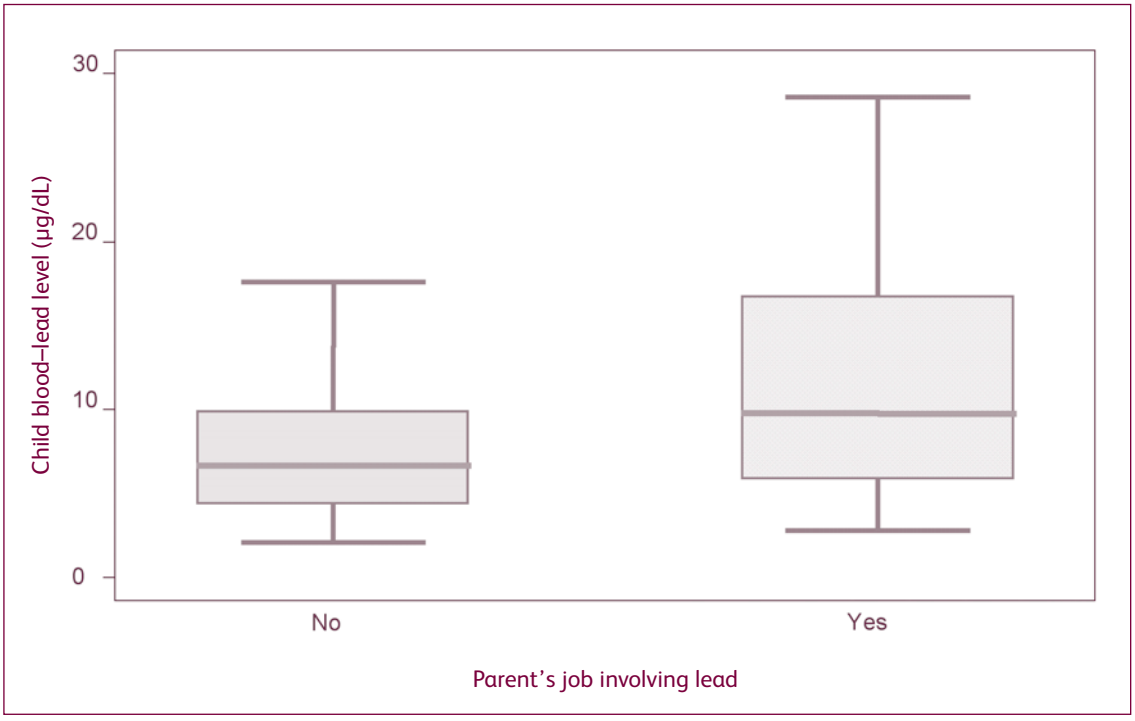

Figure 3.0
Plot of parent's job involving lead and child-blood lead levels

	None	Primary	Secondary	Tertiary
Maternal education (n=137)	9 (6.57%)	16 (11.68)	84 (61.31%)	28 (20.44%)
Paternal education (n=69)	1 (1.45%)	9 (13.04%)	45 (65.22%)	14 (20.29%)

Table 1.0
Maternal & Paternal Education

There were no significant differences between girls (mean=8.4) and boys (mean=9.3) (Kruskal Wallis test p=0.3); and age 24 months (mean=8.4) versus >25months (mean=8.9) (Kruskal-Wallis test p=0.5). Compared to children who were recruited at schools, children recruited at clinics were 3.9 times more likely to have elevated blood lead levels.

Out of the 226 children who participated in the study, soil samples were collected from 72 of the children's homes. There was a positive relationship between elevated blood lead levels and soil lead as represented by the scatter plot (Figure 2.0).

Sixty-four (64%) of respondents did not know when the homes they lived in were built. However, 30% of the homes were newer than 1970 while only 6% were built before 1970. More than 50% of the respondents had occupied the dwelling for a period less than 5 years.

The majority of houses (65%) had not undergone any renovations in the year prior to the study. 59% of the households were within proximity of a busy road. Children whose dwellings were close to a busy road were 1.7 times more likely to have elevated blood lead levels than those who resided close to roads with less traffic.

Peeling paint was observed from the inside of houses in 29% of dwellings while from the outside it was 19%. Peeling paint (indoors and outdoors) and having done renovations in the past year were not risk factors for elevated blood lead-levels in children. Elevated blood-lead levels were not significantly related to either finger sucking (odds ratio 0.64; p=0.28) or playing outside the house (odds ratio 0.62; p =0.32).

Significant risk factors were maternal unemployment (OR=2.6), parent's job involving lead (OR=2.4) and hobbies involving lead (OR=3.4).

A large proportion of the children's mothers (81.75%) and fathers (85.51%) had a secondary education or higher (Table 1.0). There were more fathers employed (83%) than mothers (51%).

Approximately 73% of the households had a monthly income of BWP 5,000 or below, with most households falling in the 1,000-3,000BWP category (27.45%).

Discussion

In this study we examined PbB and possible risk factors for lead poisoning among children 1-6 years of age living in the city of Gaborone, Botswana. Our findings show a significant number of children with blood lead levels above the CDC action level (10 µg/dL). 31% of children had PbB of ⩾10 µg/dL. Of these children, 5% had PbB ⩾20 µg/dL.

The highest mean PbBs among clinics were recorded at Old Naledi Clinic followed by Broadhurst 3 Clinic, both of which are situated in low income locations. Furthermore, even within the schools, the highest mean PbBs were recorded at Old Naledi City Council Day Care Centre followed by Sebotho Modisi Day Care Centre incidentally located adjacent to Broadhurst 3 Clinic. The relationship between low income and elevated blood lead levels is further strengthened by the comparison between data from Old Naledi Day Care Centre (a privately run centre) and the Gaborone City Council Day Care (Old Naledi GCC). Although these centres are both in low-income areas, the privately run Old Naledi Day Care Centre attracts a relatively more affluent clientele than the City Council Day Care Centre. It can therefore be concluded from these findings that elevated PbBs are directly related to the location of the clinic. The risk for elevated blood-lead level may therefore not necessarily be a function of whether the child is recruited at a clinic or a school but rather, a reflection of the location of the clinic or school and socioeconomic status.

A related observation made from this study is that a majority of children recruited at clinics (average age 3 years), were under the age of five years and were more likely not attending pre-school. The non-preschool attendance by a child above the age of two years is related to the parents' inability to pay for the child to attend a private pre-school which is directly linked to socio-economic status, education and unemployment.

It will be noted also that maternal unemployment was a significant risk factor for elevated PbBs. This finding is supported by other studies which have found positive relationships between populations of poorer socio-economic status and elevated lead levels (Arruda-Neto *et al*., 2009; Morley, 2006; Davis *et al*., 2004).

Our results showed that soil lead levels and distance from a busy road were associated with child PbBs. Children who lived in areas with high levels of traffic congestion (living near a busy road) had higher PbBs than those who lived in areas with less traffic. This is consistent with studies carried out elsewhere (Rahbar *et al*., 2002) and thus suggests that the previous use of leaded petrol in Gaborone is still a potential risk factor for exposure to environmental lead in children. Our results agree with those published by Zhai who found that lead levels in soils of Gaborone were moderately high (222mg/kg) (Zhai *et al*., 2003). While the Government has phased out leaded petrol recently, lead from car exhausts may persist in the soil for many years as it has been the case in many other countries.

We also observed that most homes, particularly in the Old Naledi area, had backyard repair shops for batteries and motor vehicles. These practices, common in lower income families, may also expose children to lead as well as adding up to elevated lead levels in soil and house dust. Studies done elsewhere have shown that car lubricants from backyard repair shops may contain lead naphthenate $Pb(C_7H_{12}O_2)$, an additive that is also used in wood preservatives, insecticides, paint and varnish driers. Gear oil is one of the lubricants known to contain high levels of lead (Matte *et al*., 1989; Clausen and Rastogi, 1977). These and many other practices in the homes of poorer families increase the potential for adverse health effects of lead exposure in children. Young children often place objects in their mouths, resulting in dust and soil being ingested and therefore increasing the chance of lead intake. This is supported by Norman *et al*., (2000), who concluded that even with leaded petrol phased out in South Africa, exposure to lead from its ongoing para-occupational exposure and its use in what they termed as "backyard or cottage industries" will remain an important public health hazard in South Africa for decades. They further concluded that children, especially those from disadvantaged communities, will remain particularly vulnerable to lead exposure and poisoning (Norman *et al*., 2007).

Studies done elsewhere show that peeling paint increases the risk of elevated blood lead levels. However, in this study the opposite was observed. We observed a protective effect of peeling paint indoors (OR=0.41) and outdoors. This observation cannot be explained and may warrant further investigation. We also found no relationship between child elevated blood-lead levels and either finger sucking or playing outside the house. This finding is also not consistent with findings from related studies. Studies conducted in the Republic of South Africa showed elevated PbBs in a child who regularly ingested paint chips, putty and soil in play areas around its home (Mathee *et al*., 2002; Mathee *et al*., 2004). Some of the levels were over five times higher than the recommended action level of 10 µg/dL. Our findings therefore warrant further investigations to establish causes for the differences in the findings of this study and studies done elsewhere.

Parent's job involving lead as well as parents whose hobbies were associated with lead containing products were risk factors for elevated BLLs in children. In this study, we classified jobs and hobbies having a risk of exposure to lead to include battery-processing, painting, car repairs, working in cement factories, plastic manufacturing, radiator repairs, plumbing and soldering as in related studies (Gloag, 1981; Grandjean, 1979; Corzo and Naveda, 1998). These findings are consistent with results from other studies where exposure of family members to lead at their workplace was associated with elevated PbBs among their children (CDC, 2001; Kumar *et al*., 1995; Grandjean and Kon, 1981).

Children continue to be exposed to many other sources of lead such as toys, jewelry as well as lead-related practices or hobbies (Weidenhamer, 2009; Brondum, 2008; Iliano, 1980). All these, together with many other practices peculiar to Botswana, have not been studied to be able to influence policy decision on lead and human health. Some of the local practices that may expose children and other members of the public to high levels of lead include the use of battery contents or break-fluid as "topical treatment" on children with ringworm; ingestion of soil by adults, particularly pregnant women, and the use of dry cell batteries to strengthen shoe mending strings.

Conclusions

- The large range in blood levels (1.6 – 28.6µg/dL) in children from different parts of Gaborone suggests the presence of localised peaks of lead in these areas. Therefore, an in-depth and comprehensive study of the exposure levels in different localities is

recommended. These should include water analysis since certain areas in Gaborone still have old water reticulation pipes which may contain lead. It is expected that the newer areas are serviced with PVC pipes.

- Habits of children should be noted as some children have been reported to be highly geophagous. The occurrence of a significant number of children (31 %) with blood lead levels above the CDC action level (10 µg /dL) with 5 % of these having PbB>20 µg /dL is worrisome particularly since most of these children were from low income areas.

- Educational programmes for health officials, parents and the communities at large should be intensified and food supplementation programmes should be promoted or, where they already exist, improved to avert serious medical consequences from the effects of lead on malnourished children.

Several factors limit the generalisation of our results. The population sampled represents a major city in Botswana and therefore is not representative of the general population. Another major limitation is that the true sources of lead exposure to children in Gaborone have not been fully investigated. The sample size was modest for the environmental sources investigation and therefore did not allow us to detect small associations between exposure sources and elevated PbBs. Water, another known source of lead exposure, has not been investigated owing to limited funding. This is an important component of the study particularly in a developing country context where there is a possibility that water pipes and plumbing materials may contain lead. There is a need also to be aware of culturally specific sources of lead exposure such as lead-glazed pottery, traditional remedies, etc. Our questionnaire did not address these factors.

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Biochemical effects of occupational lead exposure to workers in small scale automobile workshops of North Karnataka (India)

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Abstract

In developing countries like India, the occupational exposure to lead still persists in the unorganised small-scale workshops. The workers are unaware of the toxic effects of lead exposure. We studied 30 automobile workers exposed to lead for periods from 2-15 years and normal healthy control subjects (N=30) who were non-occupationally exposed to lead from Bijapur, North Karnataka, India. Venous blood and urine samples were collected from both groups. The blood lead (PbB) 364%, p<0.001 and urinary lead (PbU) 176%, P<0.001 levels were significantly increased in these workers as compared to the control. The biochemical parameters related to heme biosynthesis like non-activated erythrocytes δ-ALAD (P<0.01, -18.51%), activated δ-ALAD (P<0.05, -13.29%), levels were significantly decreased and the ratio of activated/non activated δ-ALAD was significantly increased (P<0.001, 43.83%) in automobile workers as compared to the control subjects. Urinary δ-aminolevulinic acid (83.78%, p<0.001) and urinary porphobilinogen (37%, P<0.001) were significantly increased in the study group as compared to controls. The lipid peroxide, i.e. serum MDA concentration (19.31%, P<0.001) was significantly increased and the antioxidant enzymes like RBC-SOD (-16.69%, P<0.05), RBC-CAT (-11.48%, P<0.05) plasma ceruloplasmin (-29.81%, P<0.001) and plasma total antioxidant capacity (TAC) (-30.52%, P<0.001) were significantly decreased. These results indicate that the lead exposure is greater in small-scale industries.

Increased blood lead levels affect heme biosynthesis and cause imbalance between oxidative stress and antioxidant status. Therefore, early screening and regular monitoring of these workers will help to prevent the long-term deleterious effects of lead.

Key words: Automobile workers; Biochemical effects; Blood Lead (PbB); Car workers; Environmental health; Occupational health; Small-scale workshops; Urinary lead (PbU).

Introduction

Lead is a ubiquitous and versatile metal that has been used by human kind for over 7,000 years. It is highly resistant to corrosion, pliable, having high density, low elasticity, high thermal expansion, low MP, easy workability, easily recycled, an excellent antifriction metal and inexpensive. Because of these excellent properties, it is used in acid battery manufacturing, printing press, paints, soldering water distribution pipes, ceramic glazes, paper industry and silver jewellery industries. Today, it is considered as one of the most widely distributed toxins in the environment. Lead and its compounds can enter the environment at any point during mining, smelting, processing, use, recycling and disposal (Leon *et al*., 1994; Curtis *et al*., 2008).

Lead that is present in food, beverages, soil or dust and atmospheric air is absorbed by the gastro intestinal tract (GIT). The metal is rapidly taken up in blood and soft tissue and then to bone. Lead has been shown to cause adverse effects in several organs and organ systems including hematopoietic, nervous, renal, cardio-vascular, reproductive and immune. It is also mutagenic in mice (ATSDR 2005; WHO IPCS 1995; Patil *et al*., 2006).

The biological effect of lead depends upon the level and duration of lead exposure. Lead inhibits three enzymes of heme biosynthesis: δ-Aminolevulinic acid dehydratase, coproporphyrin oxidase and ferrochelatase. Several studies have reported that heavy metals like copper, nickel and lead produce reactive oxygen species (ROS) leading to lipid peroxidation, DNA damage and depletion of cells antioxidant defence system. Erythrocytes are more vulnerable to oxidative damage than other cells. Lead causes an alteration in antioxidant enzyme activity such as SOD, CAT, Glutathione peroxidase, changes concentration of certain antioxidant molecules and thus impacts upon overall antioxidant capacity in lead exposed workers (Monteiro *et al*., 1985; Ito *et al*., 1985; Sugawara *et al*., 1991; Chiba *et al*., 1996).

The automobile workers are exposed to lead by their routine activities like radiator repair, spray painting, battery recharging and recycling in small-scale automobile workshops. The overall activities of these workers serve as a source of lead exposure to their family members also. The drastic increase in the number of automobile vehicles in India in the last two decades has increased the exposure of this labour class to lead. These workers have been found to have high blood lead levels. Therefore, the purpose of this study was to evaluate the activity of the antioxidant enzymes and the concentration of products of ROS in blood with reference to heme biosynthesis related parameters in automobile workers of North Karnataka (India).

Methods

The study comprised an occupationally lead exposed automobile workers study group (N=30) and a normal healthy non-occupationally lead exposed subjects control

Table 1.0
Mean values of PbB, PbU and heme biosynthesis related parameters in automobile workers and control group.

Sr. No.	Biochemical parameters	Control group (N= 30)	Automobile workers (N= 30)
1	PbB µg/dl	10.2 ± 5.8 (2.0 – 23.0)	47.37 ± 23.22*** (5.0 – 85.0)
2	PbU µg/dl	6.28 ± 3.83 (1.0 – 14.0)	17.37 ± 12.5*** (1.0 – 41.0)
A	**Heme Biosynthesis Related Parameters Erythrocyte δ-ALAD (µmol δ-ALA utilised/min/litre of erythrocytes)**		
3	Activated δ-ALAD	19.70 ± 4.96 (4.73 – 28.62)	17.08 ± 3.75* (14.81 – 24.50)
4	Non-activated δ-ALAD	16.31 ± 4.54 (4.03 – 32.70)	13.29 ± 4.74** (3.46 – 28.39)
5	Act/N-Act ratio	1.46 ± 0.83 (0.42 – 2.28)	2.10 ± 0.99*** (1.27 – 4.05)
6	U-δ-ALA mg/l	9.62 ± 5.45 (2.5 – 17.5)	17.68 ± 4.42*** (4.69 – 27.94)
7	U-PBG mg/l	10.10 ± 2.87 (3.5 – 15.87)	13.84 ± 3.3*** (8.47 – 18.76)

Figures indicate Mean ± SD values and those in parenthesis are range of values.
* P<0.05, **P<0.01, ***P<0.001, •Non-significant as compared to controls.
PbB – Blood Lead, **PbU** – Urinary Lead, **Act-ALD** – Activated δ-Aminolevulinic acid dehydratase, **NA-ALD** – Nonactivated δ-Aminolevulinic acid dehydratase, **Act/NA** – Activated δ-Aminolevulinic acid dehydratase/Nonactivated δ-Aminolevulinic acid dehydratase, **U-ALA** – Urinary δ-Aminolevulinic acid, **U-PBG** – Urinary Phorphobilinogen.

group (N=30). All subjects were aged in the range of 20-45 years. Written consent was obtained from all automobile workers and control subjects and before the sample collection, demographic, occupational and clinical data were collected from both groups by questionnaire and interview. Male subjects of average socio-economic status, normal dietary intake, food habits, non-alcoholics and non-smokers, who were exposed to lead for more than six hours per day over 2-15 years, were selected for the study. Most of the workers consumed a mixed type of diet. The subjects who were taking drugs for minor illnesses and had past history of major illness were excluded from the study. The entire protocol was approved by the institutional ethical committee and utmost care was taken during the experimental procedure according to the Helsinki declaration of 1964.

Blood samples were collected by puncturing the antecubital vein in heparinised polypropylene tubes and 2ml blood was also taken in plane tubes. At the time of blood collection, random urine samples also were collected in small dark amber coloured plastic bottles. Collections of 24 hours urine sample from each subject were difficult because all subjects were busy in their routine work.

The blood lead and urinary lead concentrations were measured using a Perkin Elmer model 303 graphite furnace atomic absorption spectrophotometer connected to Hitachi 165 recorder. (Parson *et al.,* 1993)

Erythrocyte δ-aminolevulinic acid dehydratase (ALAD) was estimated by the Chisholm *et al.*, (1986) method. Erythrocyte ALAD acts on aminolevulinic acid (ALA) to form porphobilinogen (PBG), which further reacts with modified Ehrlich's reagent to form a pink coloured compound measured on a spectrophotometer at 555nm. Hg-TCA solution stops the reaction by precipitating the

Biochemical effects of occupational lead exposure to workers in small scale automobile workshops of North Karnataka (India)

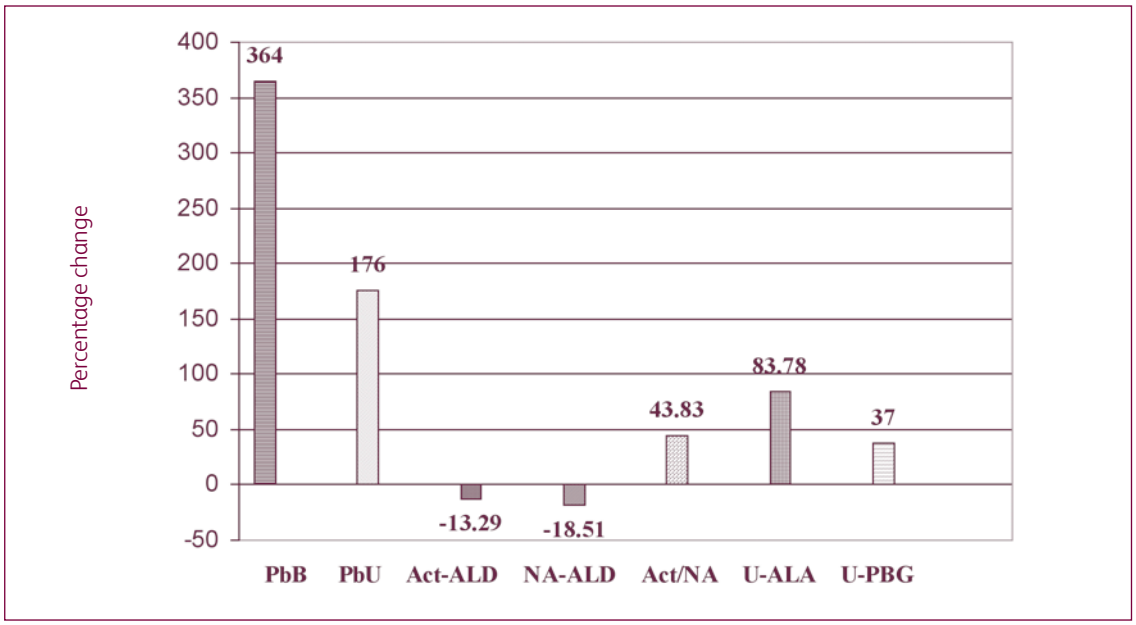

Figure 1.0
Percentage change of PbB, PbU and heme biosynthesis related parameters in automobile workers with respect to control group.

PbB – Blood Lead, **PbU** – Urinary Lead, **Act-ALD** – Activated δ-Aminolevulinic acid dehydratase, **NA-ALD** – Nonactivated δ-Aminolevulinic acid dehydratase, **Act/NA** – Activated δ-Aminolevulinic acid dehydratase/Nonactivated δ-Aminolevulinic acid dehydratase, **U-ALA** – Urinary δ-Aminolevulinic acid, **U-PBG** – Urinary Phorphobilinogen.

proteins. The erythrocyte ALAD activity activated by zinc acetate was also measured and the ratio of activated vs. non-activated ALAD was determined.

Urinary δ-aminolevulinic acid (δALA-U) was estimated by the method of (Osamu *et al*., 1969). δ-aminolevulinic acid reacts with acetyl acetone and forms a pyrrole substance, which reacts with p-dimethyl amino benzaldehyde. The resultant coloured complex was measured spectrophotometrically at 555nm.

Urinary Porphobilinogen (PBG-U) was estimated according to the Mauzerall and Granick (1956) method. Porphobilinogen in urine reacts with p-dimethyl amino benzaldehyde from Ehrlich's reagent in acid solution to form a red compound, which is measured at 555nm exactly after five minutes. The values were calculated according to the Rimington (1971) formula.

Serum lipid peroxide i.e. MDA concentration was measured by the Satoh (1978) method. Serum proteins were precipitated by trichloro acetic acid (TCA) and the mixture was heated for 30 minutes with thiobarbituric acid in 2M sodium sulphate, in a boiling water bath. The resulting chromogen was extracted with n-butyl alcohol and the absorbance of the organic phase was determined at a wavelength of 530nm. The values were expressed in terms of malon dialdehyde (MDA) using 1,1,3,3, tetra ethoxy propane as the standard.

Activity of erythrocyte superoxide dismutase (SOD) was measured by the method of Marklund and Marklund (1988). Superoxide anion is involved in the auto oxidation of pyrogallol at alkaline pH 8.5. The superoxide dismutase inhibits the auto-oxidation of pyrogallol, which can be determined as an increase in absorbance per two minutes at 420nm. The SOD activity was measured as unit mL^{-1} hemolysate. One unit of superoxide dismutase is defined as the amount of enzyme required to cause 50% inhibition of pyrogallol auto oxidation.

Erythrocyte catalase was measured by the method of Aebi (1983). Heparinized blood was centrifuged and the plasma was removed. The erythrocytes were washed two to three times with 0.9% NaCl and lysed in 10 volumes of cold deionized water. The whole mixture was centrifuged further for 10min at 3,000xg. The cell debris was removed and the clear hemolysate was diluted 500 times with

Table 2.0
Mean values of lipid peroxide, antioxidants enzymes of automobile workers and control group.
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Sr. No.	Biochemical parameters	Control group (N= 30)	Automobile workers (N= 30)
A	Lipid peroxide [nmol/ml of MDA]	0.88 ± 0.28 (0.50 – 1.37)	1.93 ± 0.35*** (1.5 – 2.7)
B	**Antioxidants Status**		
1	RBC – Superoxide dismutase [Unit/ml of hemolysate]	13.12 ± 4.16 (8.0 – 22.4)	10.93 ± 3.32* (5.0 – 27.0)
2	RBC – Catalase (mM H_2O_2 decom/mg Hb/min)	17.32 ± 5.81 (8.5 – 25.35)	15.33 ± 5.88* (4.2 – 25.35)
3	Plasma ceruloplasmin [mg/dl]	29.55 ± 10.3 (18.9 – 57.05)	20.74 ± 6.95*** (3.5 – 30.65)
4	Total Antioxidant Capacity µmol/L	1352 ± 164.4 (1058 – 1878)	939.34 ± 359.3*** (500 – 1550)

Figures indicate Mean ± SD values and those in parenthesis are range of values.
* P<0.05, ** P<0.01, ***P<0.001, as compared to controls.
LP – Lipid peroxide, **SOD** – Superoxide Dismutase, **CAT** – Catalase, **CP** – Ceruloplasmin, **TAC** – Total antioxidant capacity.

phosphate buffer (60mM) pH 7.4. Catalase decomposes hydrogen peroxide (H_2O_2) to form water and molecular oxygen. In the UV range, H_2O_2 shows a continual increase in absorbance with decreasing wavelength. At 240nm, H_2O_2 absorbs maximum light. When H_2O_2 is decomposed by catalase then the absorbance decreases. The decreased absorbance was measured at 240nm at 15 second intervals up to 1min and the difference in absorbance (ΔA at 240nm) per unit time was taken to be a measure of the catalase activity. The unit of catalase activity was expressed as mM of H_2O_2 decomposed mg^{-1} Hb min^{-1}.

Plasma ceruloplasmin was measured by the method of Herbert A Ravin (1961). Ceruloplasmin oxidizes p-phenylenediamine in the presence of oxygen to form a purple coloured oxidized product. The ceruloplasmin concentration was determined from the rate of oxidation of p-phenylenediamine at 370°c at pH 6.0, measured at an absorption peak at 530nm.

The plasma total antioxidant capacity (TAC) was estimated by FRAP assay method of Miller (1997). The antioxidant power of plasma converts ferric ions to ferrous ions at low pH forming a pink coloured ferrous tripyridyl triazine complex. Ferrous reducing antioxidant power values were obtained by comparing the change in the absorbance at 593nm in mixture with those of ferrous ion of known concentration. The TAC in serum was expressed as µmol L^{-1}. The statistical analysis was done by student 't' test.

Results

The mean and SD values of lead in blood [PbB – 47.37 ± 23.2µg/dl (364 %, P < 0.001)], and urine [PbU 17.37 ± 12.5µg/dl (176%, P < 0.001)] in automobile workers were significantly increased as compared to the control group (PbB 10.2 ± 5.8µg/dl PbU 6.28 ± 3.83µg/dl). Non-activated erythrocytes δ-ALAD (P<0.01, -18.51%), activated δ-ALAD (P<0.05, -13.29) levels were significantly decreased and the ratio of activated vs. non activated δ-ALAD (P<0.001, 43.83%) was also significantly increased in automobile workers as compared to the control subjects. Excretions of δ-ALA (P<0.001, 83.78%) and PBG (P<0.001, 37%) in urine were significantly increased in the study group as compared to the controls (Table 1.0 and Figure 1.0).

Serum lipid peroxides i.e. MDA concentration (P<0.001, 19.31%) levels were significantly increased in automobile workers as compared to the controls. Activities of antioxidant enzymes such as RBC-SOD (P<0.05, -16.69), RBC- CAT (P<0.05, -11.48), plasma ceruloplasmin (P<0.001, -29.81%), and Plasma TAC

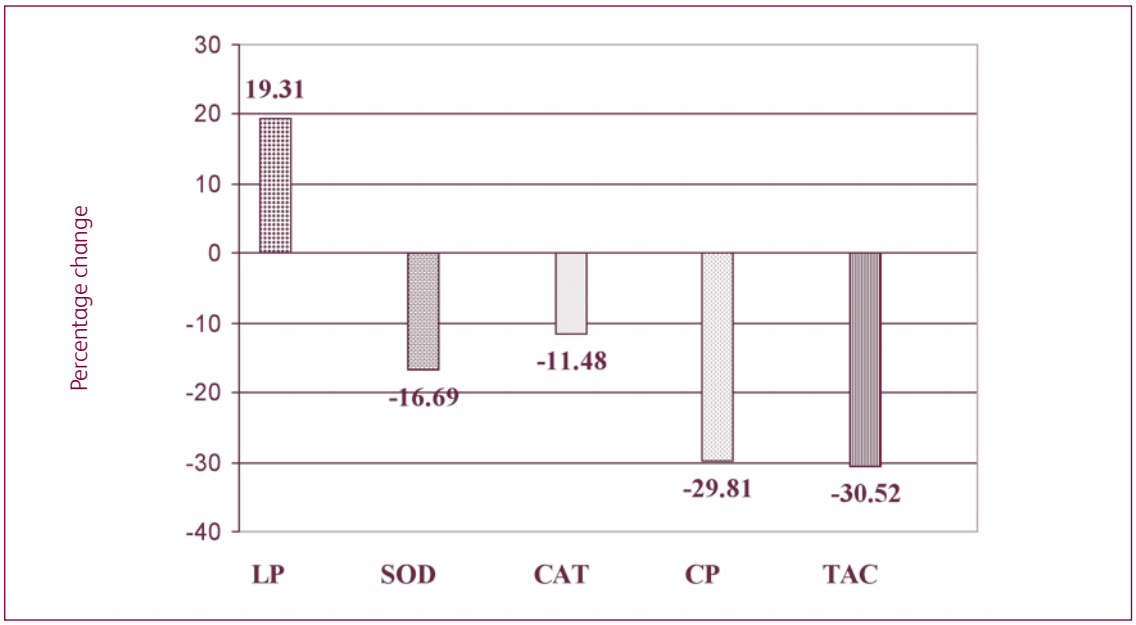

Figure 2.0
Percentage change of mean values of lipid peroxide, antioxidants enzymes of Automobile workers with respect to control group.

LP – Lipid peroxide, **SOD** – Superoxide Dismutase, **CAT** – Catalase, **CP** – Ceruloplasmin, **TAC** – Total antioxidant capacity.

(P<0.001, -30.52%) were significantly decreased in automobile workers as compared to the control group (Table 2.0, Figure 2.0)

Discussion

Blood lead (364%, P<0.001) and urinary lead (176%, P<0.001) levels were significantly increased in automobile workers as compared to control subjects, indicating more exposure of lead. Lead absorption results in its rapid urinary excretion. PbB levels generally reflect acute (current) exposure because of short half-life of lead in blood (28 to 36 days), but it is also influenced by previous storage. The PbB level is the best and most sensitive biomarker for identifying lead pollution, human exposure and its adverse effects. Single PbB measurement does not show the body burden of lead, because the metal is circulating in three compartments i.e. blood, bone and soft tissues (ATSDR, 2005). Erythrocytes activated δ-aminolevulinic acid dehydratase (-13.29% P<0.05), non-activated δ-aminolevulinic acid dehydratase (-18.5% p<0.01) activity were significantly decreased and ratio of Act/NA ALAD was significantly increased (43.83% p<0.001) as compared to control subjects, indicating that lead inhibits the activity of δ-aminolevulinic acid dehydratase enzyme in these workers. The level of δ-ALAD decreases as early as the fourth day after the exposure begins. Once the δ-ALAD level is reduced, persistence of abnormality correlates with the amount of lead in body tissues (body burden), so that the δ-ALAD level remains reduced as long as significant quantities of lead remain. Therefore, after chronic lead exposure, low δ-ALAD values may persist for years even though exposure has ceased. The level of δ-ALAD is also a very sensitive indicator of lead toxicity and is usually reduced to 50% or less of normal activity when blood lead values are in the 30-50µg/dl range. Unfortunately, the δ-ALAD level reaches a plateau when marked reduction takes place, so it cannot be used to quantify the degree of lead exposure (WHO 1995). Decreased δ-ALAD activity caused by lead can be reversed by adding Zn or dithiothreitol (DTT) or by heating (Sakai T, 1980). Possible mechanisms of reactivation include reduction of sulfhydryl groups, which are essential for enzyme activity, or, in the case of DTT, chelation of lead from binding sites on the enzyme. Exposure to lead does not decrease the concentration of δ-ALAD in erythrocytes, but substantially decreases δ-ALAD activity (Kajimoto M. 1982), as well as other tissues (Schlick E 1983). Measurement of δ-ALAD activity in the erythrocytes offers a good and simple method of evaluation of lead poisoning.

Urinary excretion of ALA (83.78%, P<0.001) and PBG (37%, P<0.001) increased significantly in automobile workers as compared to the control group, indicating that there is inhibition of the enzymes of the heme biosynthetic pathway resulting in the accumulation and increased excretion of the intermediate in the biosynthesis in the heme biosynthetic pathway namely ALA and PBG. Lead interferes with the biosynthesis of heme by altering the activity of three enzymes ALAS, ALAD and Ferrochelatase. Lead indirectly stimulates the mitochondrial enzyme ALAS, which catalyses the condensation of glycine and succinyl COA to form ALA. The activity of ALAS is the rate limiting step in heme biosynthesis; increase of ALAS activity occurs through feedback depression. Lead inhibits the zinc-containing cytosolic enzyme ALAD that catalyses the condensation of two units of ALA to form porphobilinogen. This inhibition is non-competitive and occurs through the binding of active site of ALAD. Lead bridges the vicinal sulfhydryls whereas zinc, which is normally found at the active site, binds to only one of these sulfhydryls. Inhibition of ALAD and feedback depression of ALAS results in accumulation of ALA. Estimation of urinary ALA and PBG are also useful markers for screening lead exposed workers.

The levels of lipid peroxide (19.31%, P<0.001) were significantly increased with the significant decrease in the activity of antioxidant enzymes like SOD (-16.69%, P<0.05), CAT (-11-48%, P<0.05), plasma ceruloplasmin (CP) (-29.81%, P<0.001) and decreasing the overall plasma total antioxidant capacity (TAC) (-30.52%, P<0.001). This indicates increased oxidative stress owing to exposure to lead and its compounds in these workers while engaged in workplace activities including radiator repairing, battery repairing or replacing/recharging and spray-painting. The workplaces were unhygienic; the workers ate food and drank water in the same atmosphere. Also, their hands and clothes were not clean while taking food. This might lead to an increase in the ingestion of food contaminated by lead particles. These workers were unaware of the side effects.

Erythrocytes Superoxide Dismutase (SOD), Catalase (CAT) and Glutathione peroxide (GPx) are enzymes that scavenge free radicals during lipid peroxidation. The cytotoxicity of the molecular oxygen is checked by the delicate balance between the rate of generation of the partially reduced oxygen species and the rate of their removal by different defence mechanisms. A shift in this delicate balance can lead to cellular damage. In the lead exposed occupational workers, the decreased activities of SOD, CAT, GSHPx, CP and the primary antioxidant enzymes suggest an interaction between the accumulated free radicals and the active amino acids of these enzymes (Amrita Das Gupta *et al*., 2007).

Catalase is a heme containing protein. The biosynthesis of heme is inhibited by lead, resulting in decreased erythrocyte catalase activation. Ceruloplasmin is a copper containing glycoprotein with enzymatic activity as ferroxidase. It plays a crucial role in iron metabolism, whereby it assists the release of iron from cells before its uptake by transferrin. (Osaki *et al*., 1971). The enzyme converts Fe^{2+} to Fe^{3+} and removes Fe^{2+} from the blood, which could otherwise become involved in the generation of harmful ROS.

Plasma total antioxidant capacity (TAC) was decreased (-30.52%, P<0.001) in the automobile workers in this study as compared to the control. Serum has a number of low molecular weight antioxidant molecules either water or lipid soluble. Evaluation of the TAC gives more biological relevant information than that of the individual levels of specific antioxidants of a given body fluid such as plasma. The overall TAC considers the cumulative effect of all antioxidant (known and unknown, measurable and not measurable) present in plasma/serum of several physiological conditions in humans and animals. (Mohammadi *et al*., 2006). Decreased TAC in this study is owed to the adverse effect of lead in these workers to compensate the increased oxidative stress.

Conclusion

- Increased blood lead levels may arise in automobile workers in small scale workshops owing to greater lead exposure.
- Despite modern technical advancements considerable lead hazards still exist in this industry.
- An increased blood lead level in automobile workers affects the heme biosynthesis by inhibiting the three enzymes (δ-ALAD, Coproporphyrinogen oxidase and heme synthase), resulting in increased urinary δ-ALA, and PBG.
- Increased lipid peroxidation and several impaired antioxidant enzymes in this study might be owed to increased blood lead, which impairs the oxidant/pro-oxidants balance of cells resulting in oxidative damage. Therefore, the supplementation of

antioxidant vitamins could be beneficial to the lead exposed workers.

- Estimations of urinary δ-ALA, PBG and erythrocyte δ-ALAD are most valuable in screening for occupational lead exposure.
- Medical examination and estimations of blood and urinary lead should be done not only at the pre-employment stage but also at regular intervals during their service to identify workers with potential lead toxicity.
- The implementation of modern risk assessment techniques could improve the preventative element in the workshops.

Acknowledgements

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Youth contraceptive switching: Increasing risk of STI transmission with age?

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Abstract

Background and methodology: Current US demographic trends show an opposing relationship between teen pregnancy and youth HIV/AIDS and sexually transmitted infection (STI) diagnoses, with teen pregnancies on the decline and STI diagnoses on the rise. This article tests the hypothesis that youth switch to a more risky method of contraceptive, in regard to STI protection, as they move into adulthood, which may be a leading cause of this discrepancy. Data were obtained from the National Longitudinal Study of Adolescent Health (Add Health), and included 1,976 participants, aged 14-25, who were examined for changes in contraception use decisions across a five-year span as they entered adulthood.

Results: Analyses suggested that youth contraceptive use as a whole remained relatively stable. However, odds ratios showed that youth who used a condom as their primary method at their most recent sexual experience were up to three times more likely than those not using a condom to switch to an oral contraceptive (OC) five years later.

Discussion and Conclusion: Findings provide evidence to suggest that the majority of emerging adults do not use contraceptive methods that protect them from STIs, despite many beginning his or her sexual careers using such methods. Results provide important information to assist in designing intervention research targeting contraceptive decision making in adolescent and young adult populations.

Key words: AIDS/HIV; Childhood; Adolescence; Adolescent Sexuality; Contraception; Environmental Health; Health Education; STIs.

Introduction

Throughout the life course, a person is often faced with decisions regarding contraceptive behaviour. These decisions involve first, whether to use a contraceptive, and second, which method(s) to employ. Although many studies have examined contraceptive behaviours and choices as adolescents move into emerging adulthood, few have examined the relationship between contraceptive method choices as youth move through this developmental time period (Baldwin and Baldwin, 1988; Capaldi, Stoolmiller , Clark and Owen, 2002; Herlitz and Ramstedt, 2005; Wellings *et al*., 2001; White and Johnson, 1988). Because of the high rates of teen pregnancy in the US and the steady increase of sexually transmitted infections (STI), it is important to understand the process of contraceptive decision making as adolescents enter this developmental period of their lives.

According to research, condom use decreases as youth develop and enter adulthood (Ku, Sonenstein and Pleck, 1994), leaving many individuals without protection from STI acquisition since the condom is widely considered the most reliable method of protection from STIs (Davis and Weller, 1999). Some have argued that this finding can be attributed to the fact that individuals are less likely to use condoms when in "regular" or "steady" relationships (Anderson, Wilson and Doll, 1999; Macaluso, Demand, Artz and Hook , 2000). However, even if relationship status is in fact a cause of contraceptive changes, these changes are still problematic. Beyond the social stigma against condom use in relationships (Conley and Ravinowitz, 2004; Woodsong and Koo, 1999) is the fact that contraceptive choices are not typically discussed in relationships until a particular level of trust has been established, which is most times after coitus has occurred (Woodsong and Koo, 1999). Further, because of the sometimes low expectations of monogamy in youth relationships found in previous research (Bauman and Berman , 2005), and the low rates of STI screening before entering a relationship (Kraut-Becher and Aral, 2006), we cannot rely on the fact that these committed relationships do not bring with them the risk of STIs.

Emerging adulthood

A time period characterised by extensive identity exploration (Arnett, 2000), emerging adulthood is a phase of development ranging from age 18-25 years and follows adolescence. Youth in this developmental stage are no longer dependent on others, but also do not have the full responsibilities of adulthood (Arnett, 2000). Research has shown support for a peak in general risk-taking occurring during this time (Arnett, 2000), including a decrease in condom use (Arnett, 1999; Desiderato and Crawford, 1995). However, the literature fails to examine the relative use of other contraceptive methods, such as the oral contraceptive (OC), that arguably become more obtainable during this time period (Baldwin and Baldwin, 1988; Capaldi, Stoolmiller , Clark and Owen, 2002). It is therefore reasonable to examine whether the contraceptive use of these youth is decreasing as a whole or whether there is actually a change in contraceptive methods occurring. If, in fact, this change does occur, perhaps youth are not intentionally becoming more risky, but instead are failing

to regard STI acquisition as a credible risk, focusing only on methods that only protect from conception. It is also reasonable to argue that emerging adulthood is a time period when many decisions begin to change and reflect more lasting behaviour than those decisions made in earlier adolescent years. Considering this is a time in which youth are more sexually active (Lefkowitz, Gillen and Shearer, 2004), it could be intuited that this is when many important decisions regarding contraceptive behaviours will have lasting effects.

Unwanted youth pregnancy and sexually transmitted infection rates

Although there has been a steady decrease in US teen pregnancy rates since 1991, there was an increase for the first time in 2006 (Martin *et al*., 2009). The National Center for Health Statistics (NCHS) reported the US teen pregnancy rate was 41.1 live births per 1,000 women aged 15-19 years (Martin *et al*., 2009). It has also been shown that over 80% of births from this age group are unintended (Chandra, Martinez, Mosher, Abma and Jones, 2005). Regarding STIs, research shows that adolescents and young adults are the most at-risk group for STI acquisition, compared to other age groups (Centers for Disease Control and Prevention [CDC], 2008a). The CDC (2008b) has reported that nearly half of all STIs occurring annually appear in youth ages 15-24. The HIV/AIDS Surveillance report shows an increase in HIV and AIDS for this same population since 1980, with 2,490 youth diagnosed with AIDS in the year 2004 alone (CDC, 2008b). It has also been shown that many other STIs including the human papilloma virus, chlamydia and syphilis are also at high levels (CDC, 2007).

Contraceptive choices

In an attempt to explain the above statistics, numerous research articles show adolescents do not consistently use birth control (DeLamater and Friedrich, 2002; Luster and Small, 1994). The CDC (2008a) reported that 39% of adolescents did not use a condom during the last incidence of coitus. Many may perceive that these statistics alone present enough information to warrant intervention research preventing adolescent risky sexual behaviour. However, before such programs can work effectively, more information regarding contraceptive behaviours needs to be examined beyond condom use.

It is important to note that while teen pregnancy rates were on a steady decline for a number of years, STI rates have been increasing during this same time period, particularly among individuals age 20 to 24 years. These statistics seem puzzling. If these youth are *not* protecting themselves while engaging in coitus, would these numbers not be more aligned, both showing an increase in rate? Many have attempted to explore this relationship by examining the perceived risks of both STI acquisition and pregnancy (Cooper, Agocha and Powers, 1999; Langer, Zimmerman and Katz , 1994). Having found evidence for higher fear of pregnancy among many youth compared to fear of STI acquisition, it suggests that youth contraceptive changes are likely to be playing a role in this divergent relationship. To test this hypothesis it should be noted that the two primary forms of contraception used by this age group (not including less reliable methods such as the rhythm method, withdrawal, or vaginal/cervical barriers) are the condom and OC (Abma, Martinez, Mosher, Dawson, 2002).

This highlights an important unanswered question; what is occurring with OC and contraceptive use in general as this decrease in condom use occurs? Previous studies have found that a trade-off occurs between these two contraceptive methods, such that individuals use condoms until their fears of pregnancy outweigh their fears of STI acquisition (Ku, Sonenstein and Pleck, 1994; Ott, Adler, Millstein, Tschann and Ellen, 2002 Santelli, Davis, Celentano, Crump and Burwell, 1995). However, these studies examined samples of individuals either prior to (Ott, Adler, Millstein, Tschann and Ellen, 2002) or in the middle (Ku, Sonenstein and Pleck, 1994; Santelli, Davis, Celentano, Crump and Burwell, 1995) of emerging adulthood, and thus were unable to offer conclusions as to how contraceptive decisions are made through the process of entering this developmental time period. This study will test three hypotheses using a national longitudinal sample: (a) overall contraceptive use remains stable as youth enter adulthood, (b) as youth enter adulthood, they will transition from condom use to OC use, and (c) as youth enter adulthood their protection against STI acquisition will decrease.

Methodology

Participants

Participants were obtained from Waves II and III of the National Longitudinal Study of Adolescent Health (Add Health; Udry, 2003). The purpose of the Add Health was to examine the current health status of adolescents and to explore the possible causes of their health-related behaviours (Udry, 1998). The Add Health was collected from a sample of 80 high schools and 52 middle schools

around the nation, with an initial sample size of 6,504 adolescents during a period that spanned from September 1994 to December 1995. Participants were selected to match the socioeconomic status of the US. Wave II was collected in 1996, between April and August, which consisted of in-home follow-up interviews with these same adolescents. Finally, Wave III of the study was collected on 4,882 of the original participants between August 2001 and April 2002.

From the initial sample, participants were determined to be eligible for the current study if they (a) were between ages 15 and 20 at wave II, (b) provided data on their contraceptive choices at both time periods, (c) reported that they had sexual intercourse prior to Wave II, and (d) reported they had sexual intercourse within the last 12 months of Wave III. Thus, only adolescents who were non-virgin and sexually active were selected for this study. This requirement decreased the number of subjects from the original 4,882 to 1,967.

Participants were evenly split across gender (48.9% Male), and the majority were White (50.3%) and Black or African American (30.2%), with 12.1% Hispanic or Latino, 1.3% American Indian or Native American, 2.5% Asian or Pacific Islander, and 4.2% another, non-listed race. The average age of participants at Wave II was 17.3 (*SD*=1.44) and ranged from 14 to 20 years. At Wave III participants were 19 to 25 years. Most youth (77.7%) were never married at any point across the study. Youth completed an average of 12.79 years of education (*SD*=2.06), and had an average personal income of $14,321 (*SD*=$13,394) at Wave III.

Measures of contraceptive choice

Contraceptive choice at Wave II was determined by examining a set of questions in the Add Health. Participants were asked to select their primary, secondary, and tertiary method of contraceptive used at their most recent occurrence of vaginal intercourse. Participants were given a list of 14 options to choose from. From these questions three dichotomous variables were created through recoding. First, participants were recoded as either using any method (condom and/or OC) or not using any method (no condom or OC). Second, participants were recoded as using a condom or using OC. Third, participants were recoded as using either a protective method to prevent STIs (use of a condom alone or with any other combination of methods) or a non-protective method (use of OC without concurrent use of a condom or no method used).

Contraceptive choice at Wave III was assessed by multiple questions in the Add Health. Participants were asked "Did you use *** in the last 12 months?" for nine contraceptive options. Participants then selected either "no", "yes", or other options including "don't know", and "not applicable". Participants responded to each question, and thus could report the use of multiple contraceptive methods. From this, the data were recoded to create the same three variables as done for the Wave II data.

Data analysis

Data were examined through both cross-sectional and longitudinal analyses. Cross-sectional examinations were conducted by creating graphs of contraceptive behaviours across age of participants. Longitudinal examinations were conducted by separating participants into four age groups (14-15 year olds, 16-17 year olds, 18-19 year olds, 20 year olds; ages at Wave II of the data). Age groups were used rather than individual ages due to the low N for some age groups. Three Pearson Chi-square tests were then conducted examining the change in contraceptive method from Wave II to Wave III for the three types of variables created. The odds ratio (OR) was also examined in each of the analyses. Pearson chi-square and ORs were conducted using SPSS v. 17.0.

Results and discussion

Gender differences

Gender differences in sexual behaviour were found to be supportive of previous literature, with young men being more sexually risky in regard to (a) number of vaginal intercourse partners (M male=11.21 *SD*=11.67; M female=7.64 *SD*=7.25; t[1624.2]=6.66, $p<0.001$) and (b) number of vaginal intercourse partners in the past 12 months (M male=2.62 *SD*=3.08; M female=1.74 *SD*=1.56; t[913.93]=6.62, $p<0.001$), see Table 1.0. However, it was found that females were more risky than males in regard to protection against STI acquisition, as evidenced by the percent who used a condom at Wave III (% female=25.2; % male=30.5; $\chi^2[1, N=1842]=6.64$, p=0.01).

Contraceptive changes

Any method of contraception vs. no method of contraceptive

An initial description of the data was conducted through cross-sectional linear graphing of the six variables created. This was done by creating percentages of participants using each method across age, see Figure 1.0. A break in

Table 1.0
Gender differences in demographics, sexual behaviour, and contraceptive use

Variable	Male [M (SD)] N (%)	Female [M (SD)] N (%)
Number of vaginal intercourse partners[1]***	7.64 (7.25)	11.21 (11.67)
Number of partners past 12 months[1]***	1.74 (1.56)	2.62 (3.08)
Age at first vaginal intercourse[1]	15.21 (1.77)	15.27 (1.96)
Percent used a condom (Wave II)[2]	45.1%	48.7%
Percent used a condom (Wave III)[2]**	25.2%	30.5%
Percent used a condom and/or OC (Wave II)[2]	51.9%	52.6%
Percent used a condom and/or OC (Wave III)[2]	55.3%	54.2%

Note: Data obtained from Wave III data unless specified.
[1]Gender differences examined through independent samples t-test.
[2]Gender differences examined through Pearson χ^2.
*p<0.05 **p<0.01 *** p<0.001.

each line of the graph reflects the two cohorts of data presented. The line for 'Any Method' in Figure 1 shows that contraception use in general remains relatively flat across age, while there is evidence for a peak of use at ages 18 and 19. Examining the data longitudinally, Pearson chi-square tests revealed a significant relationship only for the 18-19 year group, see Table 2.0. Thus use vs. non-use of a contraceptive method at Wave II is statistically significantly related to use vs. non-use at Wave III, $\chi^2(1, N=765)=7.40$, p=0.007. This relationship can be interpreted through the OR which shows that participants who use a method at age 18-19 (Wave II) were 49% more likely to not use a method at age 23-24, than those who did not use a method at 18-19.

Condom use vs. OC use

Contraceptive use was further examined to discriminate condom users and OC users, see Figure 1.0. The cross-sectional graph shows that up until age 18 youth show consistent numbers of condom use, but more youth begin to use OC. The second cohort of data shows much lower numbers of condom users, and higher numbers of OC users, suggesting that older individuals switch from condoms to OC. For the longitudinal data, Pearson chi-square tests only revealed a statistically significant relationship for the 18-19 year group, $\chi^2(1, N=264)=9.33$, p=0.002, see Table 2.0. The OR=3 suggests that those who use a condom at 18-19 (Wave II) were 3 times as likely to use OC at 23-24 than those who used OC at 18-19.

Protective contraceptive method vs. non-protective method

Contraceptive use was next examined as a protective method (condom use) preventing STIs or a non-protective method (OC or no method), see Figure 1. The cross-sectional graph shows that non-protective method use remains relative flat in the first cohort of data, but shows much higher numbers of individuals in the second cohort of data. This trend also suggests that youth begin to use methods that do not protect from STIs as they age. For the longitudinal data, Pearson chi-square tests revealed a statistically significant relationship for the 18-19 year group, $\chi^2(1, N=765)=4.07$, p=0.044, see Table 2.0. Also important is the near statistically significant finding for the 16-17 year group, $\chi^2(1, N=731)=3.71$, p=0.054. Interpretation of the OR for the 18-19 year old group suggests that participants who used a protective method of contraception at 18-19 were 40% more likely to use a non-protective method at 23-24, than those who used a non-protective method at 18-19. For the 16-17 year old group the OR=1.37 suggests that youth who used a protective method at 16-17 were 37% more likely to use a non-protective method at 21-22 than those who used a non-protective method at 16-17.

To summarise the data presented, the percentage of youth who made contraceptive changes or remained the same across age groups is presented in Table 3.0. This table suggests that the majority of youth for all age

Age Group	*N*	χ^2	Odds Ratio	95% CI for Odds Ratio
Any method of contraceptive vs. no method of contraceptive [a]				
14-15	210	0.059, *p*=0.807	0.934	0.538 – 1.620
16-17	731	0.917, *p*=0.338	1.153	0.861 – 1.543
18-19	765	7.404, *p*=0.007	1.493	1.118 – 1.994
20	66	0.347, *p*=0.556	1.342	0.503– 3.578
Condom use vs. OC use [b]				
14-15	45	1.400, *p*=0.237	†	†
16-17	210	2.814, *p*=0.093	3.093	0.777 – 12.309
18-19	264	9.327, *p*=0.002	3.007	1.450 – 6.238
20	18	2.813, *p*=0.094	†	†
Protective method vs. non-protective method [c]				
14-15	210	0.146, p=0.702	0.891	0.493 – 1.610
16-17	731	3.706, p=0.054	1.368	0.994 - 1.883
18-19	765	4.070, p=0.044	1.399	1.009 – 1.940
20	66	0.247, p=0.619	1.298	0.463 – 3.638

Table 2.0
McNemar Test and odds ratios for contraceptive changes by age group

Note: Calculated from two-by-two contingency tables of contraceptive use at Wave II and Wave III.
[a] Wave II data: a method=1, no method=0; Wave III data: a method=0, no method = 1. A method=condom and/or OCP. ORs interpreted as odds of no method use at Wave III for a method use vs. no method use at Wave II.
[b] Wave II & III data: OC=1, condom=0. Condom use includes dual method (condom and OC) use. ORs interpreted as odds of OC use at Wave III for condom vs. OC use at Wave II.
[c] Wave II & III data: protective method=1, non-protective method=0. ORs interpreted as odds of non-protective method use at Wave III for positive use vs. negative use at Wave II.

groups continuously use a non-protective method across the five-year time period, with a range of 38.6 to 40.9% falling into this category. The second largest group for all ages comprises those that make a negative contraceptive use change with the age groups ranging from 24.2 to 35%. These percentages suggest that youth are most likely to use a non-protective method of contraception (in regard to STI prevention) at Wave III regardless of age group, which provides further evidence that if an individual makes a change in contraception it is likely to occur at or before age 19. It also shows that relatively few individuals make a positive contraceptive change, with only 11.4 to 20.5% of participants falling into this group.

Discussion

Contraceptive behaviour was found to vary across age groups for both condom and OC use. Of primary importance in this study, according to the cross-sectional analysis, is that contraceptive method use in general did not decrease as youth entered emerging adulthood. The graph across ages showed that there

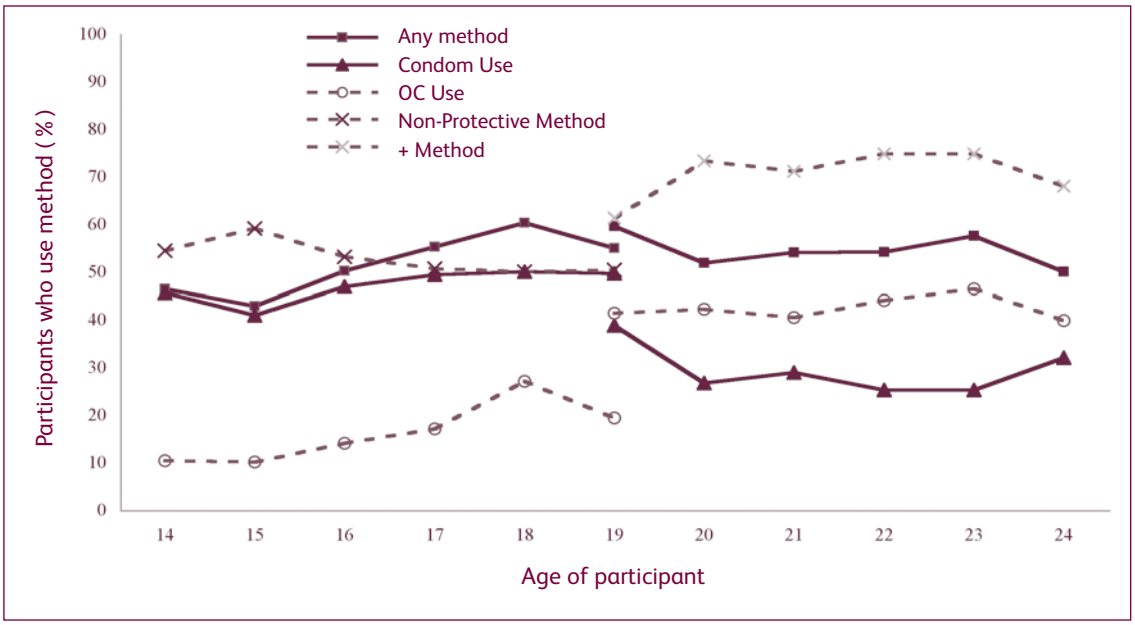

Figure 1.0 Use of contraceptive methods across ages of Wave II and Wave III.

Note: A method=condom and/or OC. Condom use includes condom and OC use as a dual method. Non-protective method=no condom.

Table 3.0 Percent contraceptive changes from Wave II to Wave III for age group

Age Group	Negative Change	Positive Change	Stayed Negative	Stayed Positive
14-15	27.1	20.5	40.0	12.4
16-17	32.1	13.7	38.6	15.6
18-19	35.0	11.4	39.5	14.1
20	24.2	19.7	40.9	15.2

Note: Participants aged 14-20 at Wave II, and 19-25 at Wave III.

was a relatively flat trajectory of both contraceptive use and non-use, regarding condom and OC use only. This finding was supported by most age groups for the longitudinal analyses, with the exception occurring in the 18-19 year group.

When contraceptive use was separated into condom users (including those that used both condom and OC) and OC only users, it was discovered that a likely reason for the above flat trajectory is that a switch occurs between these two methods. This finding lends support to previous research which has consistently shown a decrease in condom use as youth enter adulthood (Desiderato and Crawford, 1995). The longitudinal analysis through Pearson chi-square found that the 18-19 year old group was three times more likely to use OC five years later if they used condoms rather than OC at age 18-19. Further analysis, through the use of the cross-sectional graph, suggests that the change occurs in condom use around 19 years of age, while OC use begins to rise around 18 years.

When contraceptive methods were separated into those that protect against STIs (protective method) and those that do not (non-protective method; OC and no method), a large difference was viewed through the cross-sectional graph. This change suggests that at age 19, a reciprocal change occurs that increases non-

protective method use and decreases protective method use. This finding is supported by the longitudinal analysis for the 18-19 year group, and somewhat by the 16-17 year group (which obtained near statistical significance). The ORs for these groups suggested that these youth were 37-39% more likely to use a non-protective method five years later when they used a protective method vs. a non-protective method at 16-19 years.

Finally, when the percent of contraceptive changes or non-changes were examined between Wave II and Wave III of the data, it suggested that most youth used a non-protective method at Wave III. This finding is in support with previous statistics suggesting that any changes in contraceptive behaviour are likely to occur at or previous to age 19.

Limitations

Although this study helps to fill in some gaps in the literature, it is not without limitations. Concerning the participants used for the analysis, the sample was disproportionately white, with especially low numbers of Hispanic youth. The sample was also higher than the average national population pertaining to participant education. Regarding measures, the questions used to analyse contraceptive behaviour were different for Wave II and Wave III. This change in questioning could create biased reporting of contraceptive behaviours, as well as inaccurate representations of the youth's average contraceptive choice. However, it could also be argued that examining contraceptives over the last year may provide more accurate depictions of the individual's contraceptive use. Also important is that only the use of OC, condoms, and no method were examined in this study while other methods were reported by participants in the Add Health. These methods were not examined because, as stated earlier, condoms and OC are the most used, among reliable methods, by this age group (Abma, Martinez, Mosher, Dawson, 2002).

Another limitation concerning the use of the Add Health database is that the data collection was completed in 2002, creating a long lead time from data collection to publication. However, the Add Health dataset has many advantages over other, possibly more recent data sources. Such advantages include the longitudinal nature of the data which allows the tracking of contraceptive behaviours over time, the large number of participants, and the national representation of the dataset. These advantages make the Add Health an attractive source for addressing the current research question.

Finally, data suggest that contraceptive changes as youth age could be a factor attributing to the inverse relationship between teen pregnancy and STI trends; however, other factors could also have an additional effect. For instance, the fact that as youth age they are more likely to get married or form lasting relationships, is a plausible factor explaining this relationship. However, it was previously discussed how 'committed' relationships still bring with them the danger of STI diagnosis.

Implications and recommendations

Despite its limitations, this study contributes to the literature and provides evidence to assist in designing intervention strategies targeting contraceptive behaviours among emerging adults. The findings suggest that interventions based primarily on increasing condom use are needed among older adolescents and youth whom are entering adulthood, as these youth appear to abandon this method in favor of OC. Additionally, it could be inferred from these results that such interventions need to place greater emphasis on the risk of STI acquisition. These results suggest that youth do not appear to be regarding STIs as a credible risk, based on their lack of protection, which would be consistent with previous literature (Cooper, Agocha and Powers, 1999; Langer, Zimmerman and Katz , 1994).

According to the health belief model (HBM), individuals make health decisions by weighing their perceived susceptibility and perceived severity (Rosenstock, 1974). The HBM states that if individuals do not view a negative outcome as severe or likely to occur, they are unlikely to engage in protective behaviours against it. Considering the current findings, youth are likely to either begin their sexual development without concern for STIs or begin with concern, but lose this concern with age. The current study cannot determine which of these paths is the true state of affairs; however, it may be more likely that they begin without a concern for STIs, as much literature has reported a lack of STI concern. Many factors may be attributed to this, one of which may be socialisation of sexuality in general. For instance, even the terms used for contraceptives may be a factor in what youth look to prevent. While *prophylactic* is perhaps a more accurate term for condoms, many youth are socialised to refer to them as *contraceptives* or *birth control*. Both these terms refer to protection against conception not STI transmission. From early in their sexual development, youth are reminded of the effects of unwanted pregnancy and not sexual infection. Regardless of the rationale for why this occurs, the findings of the current study suggest that

compartmentalising sexual education by keeping prevention of pregnancy and STIs separate issues is undesirable. Instead, a more holistic approach is warranted, which incorporates discussion of both negative outcomes, so youth learn to negotiate both realms of sexual protection. This study also highlights the need for further research into the reasons why little emphasis is placed on the acquisition of STIs for these youth, as well as their perceived risk of acquiring such an infection.

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An investigation into ultraviolet emissions from artificial tanning equipment available in salons across South East Wales

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Abstract

Research conducted in Scotland has identified that many sunbeds generate UVR emissions which pose a cancer risk comparable to exposure to the Mediterranean midday sun. These findings prompted similar research, funded by CIEH Wales, to be undertaken in the South East Wales region, looking specifically at whether salon owners were operating artificial tanning equipment within the specification and guidelines in the British and European Standard (BS EN 60335-2-27:2003).

Emissions data were collated using a UV Spectro-radiometer, from 65 sunbeds in 24 establishments. Questionnaires were also administered to determine the operational practices of such establishments.

The emissions survey shows that well over a third (42%) of sunbeds monitored were emitting levels of UVA that exceeded the operating limit of 0.15W/m^2, a limit required by the British Standard guidelines, with the majority of these sunbeds found in unstaffed premises. Where the salon was supervised, operating practices were also found to be inadequate and variable, mainly owing to the lack of staff training and supervision.

The results suggest that the self regulation of the industry is not working effectively, as operating practices differ greatly from one site to another, and there is evidence that some users, who are under the recommended age limit of 16, are at risk of being seriously burned. There is a very strong case for tighter regulatory control, particularly with regard to unstaffed facilities where there is virtually no control at all over the use of sunbeds by clients.

Key words: Artificial tanning; Environmental health; Malignant melanoma; Sunbeds; Skin cancer; Tanning Salons; Training and Supervision; Ultraviolet emissions (UV).

Introduction

The use of artificial tanning equipment gained popularity in the 1970s with the sunlamps being used then mainly emitting UVB and a small proportion of UVC light (Gallagher *et al.*, 2005). During the 1980s the character of these devices altered, with UVA becoming the main component of emissions with a small amount of UVB present, since this, rather than UVA, can help to produce a "more substantial tan" (Diffey and Farr, 1991, cited in Westerdahl *et al.*, 2000). The International Agency for Research on Cancer (IARC) has recently made the move to classify tanning equipment as 'carcinogenic to humans', stating that both UVA and UVB rays can cause tumours (El Ghissassi *et al.*, 2009).

There has been a recent increase in the use of artificial tanning devices, particularly by younger people (Cancer Research UK, 2008) and concern for the health of sunbed users has also increased, as research has found that those beginning to use sunbeds under the age of 35 years are considered to be increasing their risk of developing malignant melanoma by 75 per cent (IARC, 2006).

Many of the sites offering tanning facilities advertise their service as a cheap, quick and safe alternative to sunbathing, together with specific 'health benefits' such as increased Vitamin D production, protection from burning by development of a 'base tan' (prior to going on holiday) and even the alleviation of the symptoms of Seasonal Affective Disorder (SAD). However, as noted by the All Party Parliamentary Group on Skin (APPGS, 2008) the dangers to health posed by using these facilities are rarely advertised. Furthermore, following the introduction to the UK in 1996, of completely unstaffed salons (Consol, 2009) which allows for almost unrestricted access to sunbeds, Cancer Research UK (2009) has expressed concern that the current economic crisis in Britain, will lead to an increase in sunbed use as a cheap alternative to holidays abroad.

The Sunbed Association (2006) states that exposure to UVR during the use of a sunbed is 'controlled' as, unlike exposure to the sun, the total UVR output is claimed to be 'balanced' to reduce the likelihood of burning. However, many authorities accept that the evidence base shows that there is no such thing as a 'safe tan'. "Any visible sign of tanned skin is an indication of tissue damage, regardless of the source of the UVR" (APPGS, 2008).

The leading health organisations around the world are keen to eliminate any claims of health benefits being associated with the use of artificial tanning equipment, and a growing body of research-based evidence now suggests that the use of such equipment may lead to skin damage and an increased risk of developing skin cancer (World Health Organisation, 2005; El Ghissassi *et al.*, 2009). However, it should be noted that, because of the number of possible confounding factors and recall bias, the inability to check the intensity of the sunbeds used in the past and accurately differentiating between the exposure of individuals to solar radiation and to artificial sources, it has so far proved difficult to demonstrate a definitive link (Chen *et al.*, 1998; Young, 2004; IARC, 2006).

Table 1.0
Limits of effective irradiance for appliance 'types'.

UV type appliance	Effective irradiance W/m^2	
	UVB Wavelength (250nm < λ > 320nm)	UVA Wavelength (320nm < λ > 400nm)
Type 1	<0.0005	>0.15
Type 2	0.0005 to 0.15	>0.15
Type 3	<0.15	<0.15
Type 4	>0.15	<0.15

(Source: British Standard BS EN 60335-2-27: 2003)

Table 2.0
Classification of UV appliances by 'intended use'

UV type appliance	Intended use
Types 1 & 2	Intended to be used in tanning salons, beauty parlours and similar premises under supervision of appropriately trained persons
Type 3	May be used by unskilled operators
Type 4	Medical advice required

(Source: British Standard BS EN 60335-2-27: 2003)

Until the introduction of Part 8 of the Public Health etc. (Scotland) Act 2008 (UK Government, 2008) there had been limited, formal regulation of the sunbed industry in the UK, and at the present time, enforcing authorities have to rely on relatively weak guidance published by the Health and Safety Executive (HSE, 2009a) and the belief that the industry is able to successfully self regulate through The Sunbed Association. Increasingly, evidence of teenage children suffering significant burns to their bodies is appearing in the media and this suggests that the regulatory system is not working effectively (EHN, Vol 24 No 8, 2009; EHN, Vol 24 No 17, 2009; BBC News online, 2009) and that a more effective regulatory system should be introduced.

The UK, along with most other countries continues to allow this self regulation but the few countries that actively regulate and control the use of sunbeds include Austria, Belgium, Finland, France, Norway, Portugal, Spain, Sweden, USA, Australia and New Zealand (Committee on Medical Aspects of Radiation in the Environment (COMARE) 2009).

Coupled with this lack of formal regulation, consumers are faced with conflicting information on how to tan 'safely'. There is currently no strict definition as to the length of one 'session', with advice from The Sunbed Association (2009) stating 'a session will depend on the type of sunbed being used, the skin type of the person using it and the development point of their tan'. The HSE merely advises customers to rely on the operator of the tanning facility to make the judgment on session length for individuals (HSE, 2009b). The Sunbed Association recommend 60 sessions a year, apparently in line with the BS EN recommendation (The Sunbed Association, 2009) while the HSE recommends 20 sessions a year (HSE, 2003). This kind of uncertainty creates an environment where sunbed users may easily receive an overdose of UVR, which may result in serious skin damage in the short term and possibly an increased risk of developing skin cancer in the longer term.

Bodies such as the European Society of Skin Cancer Prevention, or EUROSKIN, have been campaigning for a single Code of Practice to be implemented across the European Union. Such a Code would provide a minimum set of consistent standards aimed at protecting the health and safety of the public using commercial tanning equipment throughout Europe, and also place stricter requirements on those offering an artificial tanning service in relation to engineering standards, labelling and the operation of the equipment (EUROSKIN, 2007).

Classification of UV emitters

At the present time, the British and European Standard BS EN 60335-2-27:2003 (referred to as BS EN hereafter)

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sets down particular requirements for appliances that expose the skin to ultraviolet and infrared radiation in the UK, with equivalent standards existing across Europe. These are designed to be followed at the manufacturing stage. The main duties imposed by the above standard involve the classifying and labelling of UVR emitting devices, along with the production of safety information and instructions for use. The standard classifies UVR emitters into four 'types' depending on the wavelength of the UVR emitted and the levels of irradiance in W/m^2 (see Table 1.0). This classification will also dictate to the operator the circumstances under which the appliance can be used (see Table 2.0). It should be noted that a fundamental weakness of this systems is that an operator of a sunbed can undertake a complete re-fit of the tubes, which could essentially change the 'UV type', unknown to the users and perhaps even the operator.

It should also be noted that, for the purpose of determining the intended use of the product, Type 1 and Type 2 appliances are combined.

Aims and methodology

In 2007, research undertaken in Scotland, concluded that the typical sunbed tested had an erythemal effective irradiance that was significantly stronger than that produced by mid-day, southern European sun (Oliver *et al*., 2007).

As a result of these findings, it was decided that similar research would be undertaken across a number of local authority areas in South East Wales. The initial aim was to produce a set of results that would be comparable with those achieved in Scotland. However, as the study progressed, it became apparent that the methodology employed, would need to be adapted, as the BS EN does not prescribe a complete field monitoring methodology for operational sunbeds. The research also aimed to identify the normal working practices within each premises surveyed by completion of a questionnaire. In particular, questioning the training and competence of staff, and how customer safety was ensured.

Fieldwork

During the period from September 2008 to January 2009, a total of 24 sites offering the use of sunbeds to the public were selected from three local authority areas across South East Wales. The local authorities included were the Vale of Glamorgan, Rhondda Cynon Taf and Merthyr Tydfil. Lists of possible sites were compiled using the local authority premises database, internet search engines and through local knowledge.

Figure 1.0
A standard 'vertical' sunbed

Appointments were made with a responsible person at each selected site (except in the unstaffed salons). Only one site refused to co-operate voluntarily and so access to the premises was authorised by the Environmental Health Department using the statutory Powers of Entry under the Health and Safety at Work etc Act 1974.

Two types of artificial tanning units were included in the study, which are referred to as 'vertical' (Figure 1.0) or 'horizontal' (Figure 2.0) sunbeds. These types of sunbeds are commonly referred to by operators as either (a) 'stand up beds' or 'sun showers' where the customer stands in a chamber, closes the door and is completely surrounded by UVR tubes or (b) 'lie down beds', where the customer lies on the clear plastic base of the sunbed and lowers the upper canopy so that it sits above them. Here, the customer is irradiated by UVR tubes located below and above the user. The majority of horizontal sunbeds included in the study were noted to have additional separate halogen facial 'lamps' or 'burners'. These facial lamps are designed purely to provide additional UVR tanning to the facial area (Figure 3.0).

Figure 2.0
A standard 'horizontal' sunbed

Figure 3.0
Sunbed showing 'facial burners'

Onsite measurements were made using the *Sola-Check* hand held UV Spectroradiometer supplied by Solatell UK Ltd, Stroud, Gloucestershire, UK. The instrument was calibrated in August 2008. The Sola-Check is wavelength and intensity calibrated to a traceable National Physical Laboratory standard.

Training on the use and the capabilities of the equipment was provided by a company representative from Solatell UK Ltd. The equipment was enabled with the 'Solarium mode', which helps to eliminate possible distortion of the readings as a result of reflective light. As a result of the advice given during the training, it was decided to take three measurements from each vertical sunbed at face, torso and lower leg height. To achieve these heights with consistency, a large camera tripod was used, and the measurement positions were based on the field researcher's body height, which was approximately 1.6m. The sensor head was always orientated opposite to the door of the sunbed. For the horizontal sunbeds, a small camera tripod was used to simulate the depth of a person lying on a bed. Readings were taken at the same positions of head, torso and lower leg, with the sensor pointed towards either the canopy or the base, as appropriate, along the unit's centre line. An additional reading was also taken from the area directly beneath the 'facial burners', where present.

Each bed was allowed 30 seconds to warm up; this was decided on by using advice given by several sunbed operators. This 'warm-up' period is not specified in the BS EN, and again, could lead to variability in monitoring results. Each measurement was given a unique reference number to ensure correct identification during the collation of the results. Each measurement took approximately 30 to 60 seconds to complete.

The equipment was set to identify the wavelengths between 250nm to 400nm to include the UVA and UVB aspects of the spectrum. The Sola Check equipment was programmed to apply the erythemal action spectrum to the spectral data collated, which has been accepted as the standard index for normal skin response to UVA and UVB radiation (McKinlay and Diffey, 1987). An average irradiance was determined for each bed by calculating the mean of the spectral measurements. Also, as a result of discussions with the UK Health Protection Agency, we were advised that a 'worst case scenario' reading should be used to classify the UVR type of the sunbed as the BS EN requires the highest level of radiation to be recorded. At all times during the survey, the personal safety of the field researcher was paramount. Personal protective clothing was worn during the collection of the results. This consisted of a Howie-style laboratory coat, goggles and the application of UVR protective factor 50 sun cream before each measurement session for any remaining exposed areas. Also, to reduce the risk as much as reasonably practicable, operating tokens or coins were inserted one at a time wherever possible, so that the sunbed was off whenever the position of the sensor, in or on the sunbed, required alteration by the researcher.

For each premises surveyed, a responsible person was asked a number of questions relating to the operation of the tanning services offered. In the case of unstaffed sites, the researcher collected relevant information as far as possible, using information provided for customers.

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Questionnaire results

A total of 65 sunbeds in 24 sites across the survey area was included in the investigation. Each site was classified according to the main work activity and then given a unique reference number to ensure confidentiality. The majority of the sites visited were solaria, four of which had no staff present with the sunbeds being operated by a coin meter located in the reception area.

Sunbeds were available in four local authority leisure centres operated by the Vale of Glamorgan, which were provided on 'profit share' basis with a local supplier. This is one of only three local authorities in Wales currently operating sunbeds in their sports and leisure facilities. Both Rhondda Cynon Taf and Merthyr Tydfil councils have removed the equipment from the sites that they own.

The number of sunbeds available in the sites surveyed, ranged between 1 and 8 units with 62% of the sunbeds surveyed being vertical units and the remaining 38% being horizontal units. The vertical beds generally were marketed as having the stronger tubes, with the highest wattage found to be 235W, although 160W tubes (29%) and 200W tubes (27%) were commonly found. Once again this means that the consumer may not be aware how powerful the tanning equipment is. Even where they have used the same sunbed before, a tube change will affect the emission levels, and therefore session length would need to be adjusted accordingly.

Although the Sunbed Association is the recognised governing body for the tanning industry, offering a range of advice and guidance to their members, only 38% of the sites visited claimed to be members. 62% of the sites visited either stated they were not members, or were unsure. Of the nine sites, that indicated that they were members of the Sunbed Association, only three had the guidance provided as part of their membership available at the premises.

Supervision

Twenty of the 24 sites had a member of staff available at the time of the visit; however, the level of supervision of the sunbeds varied greatly. It should be noted that in every case, the customer enters a private booth, and therefore the level of 'supervision' must be questionable. In the unstaffed salons CCTV was present and signage indicated that it was actively monitored. In relation to how the equipment was operated, 45% used pound coins and 55% operated using a form of token that was purchased at the site.

Forty six percent of those premises that controlled usage by administering tokens made no visual check once the tokens had been sold to the customer. This allows for the customer to keep back tokens so as to have a longer session during their next visit, or to even use those tokens in other premises. Of the 11 premises using a coin meter to operate the sunbed, only six visually monitored the session lengths of customers.

Information and training

Although 17 out of the 24 operators questioned (71%) stated that first time users underwent a consultation with a member of staff, only four claimed to give a detailed consultation. This consultation would then result in a course of sessions being recommended based on the client's skin type. The same four operators also recorded the number of sessions received and the duration (in minutes) of those sessions on each occasion that the client visited. In four of the sites visited it was disclosed that unless a person became a 'member', no attempt would be made, to record the client's usage and session length.

Operators were also asked to provide information on whether staff members, or indeed themselves, had undergone any type of training. Six of the 24 premises (25%) either had no staff to train or replied 'no'. Only one premises claimed to have received all of their training from The Sunbed Association, with three having received training from the supplier of the bed. The majority of sites (41%) stated that training was undertaken in-house, but were unable or unwilling to produce training records.

Information provided in every site visited indicated that session lengths were dependent upon the customer's skin type. However, 65% of the operators questioned either had no way of enforcing this practice, or stated that they did not reinforce this, and only advised customers verbally. Sixty seven per cent of those questioned did not know the recommended 20 session yearly limit advised by the Health and Safety Executive (HSE, 2003), and out of the nine operators who claimed to be members of The Sunbed Association, only two were able to state the recommended annual number of 60 sessions Sixty three percent of operators made no verbal recommendation to clients on a maximum number of sessions per year.

Operators were also asked whether there was a maximum session time imposed on customers during any one session, 14% would not allow more than a 9 minute session, 30% said 12 minutes and 26% said 15

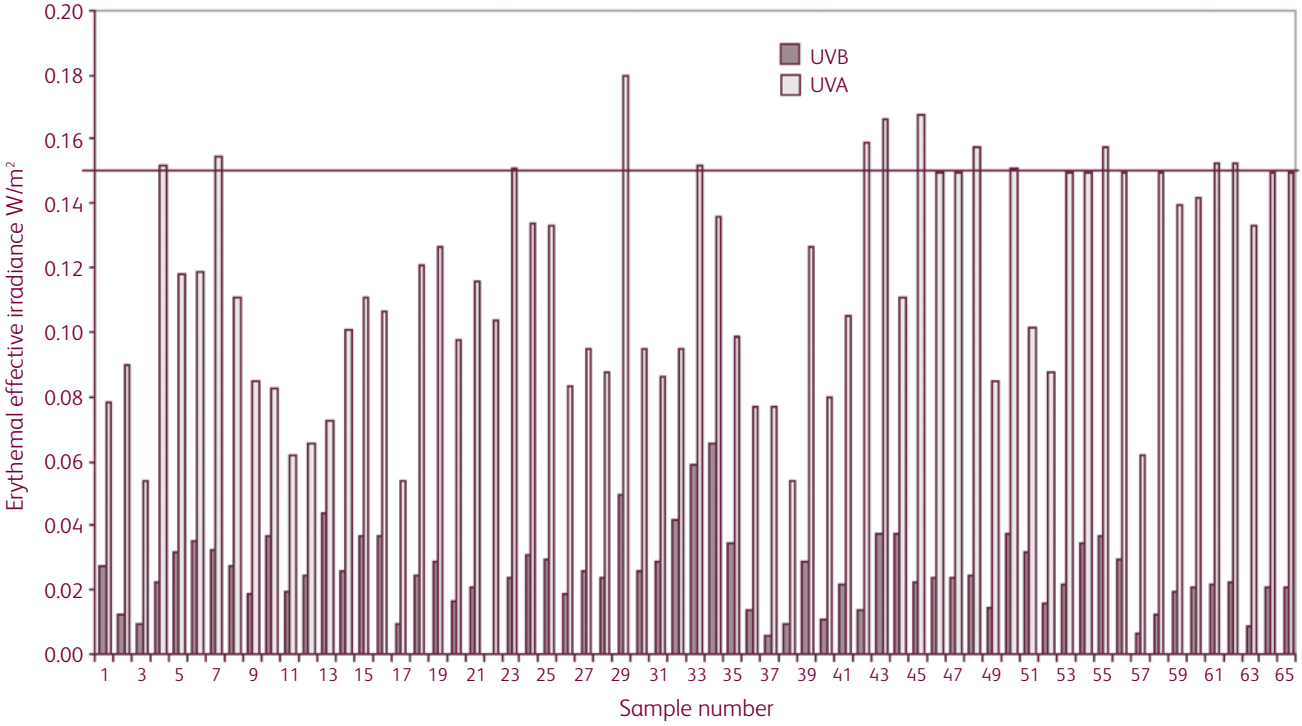

Figure 4.0
Average erythemal effective irradiance in W/m² for UVA and UVB

minutes, with 30% not knowing of, or being feasibly able to impose, a maximum limit.

Survey results

The measurements taken at each point provided separate readings for both UVA and UVB. Values for UVB ranged from 'no UVB being detected', up to 0.11W/m², with values for UVA ranging from 0.04 W/m² up to 0.23W/m². The classification of all sunbeds surveyed was made by taking both UVA and UVB into account, as is required by the BS EN.

When considering the 'average irradiance' of the 65 sunbeds surveyed, 21 (32%) were classified as being UVR Type 2 emitters, which are classified within the BS EN for use only under the supervision of appropriately trained persons. Figure 4.0 shows the average effective irradiance for UVA and UVB. The horizontal line indicates the 0.15W/m² limit on UVA and UVB output that when exceeded, can alter the classification. Ideally, all of the sunbeds surveyed should have UVA and UVB levels that are below the 0.15W/m² limit. A maximum of 0.18W/m² was recorded after the readings had been averaged. Forty seven percent of these UVR Type 2 emitters were found in unstaffed salons; the remainder fell within the limits for UVR Type 3 emitters, which are the only category, intended for unskilled use.

When the results were considered by the 'worst case scenario' readings, it was found that 27 (42%) of sunbeds were classified as UVR Type 2 emitters. It can be seen in Figure 5.0 that the maximum irradiance recorded of 0.23W/m² far exceeds the maximum for those readings that have been averaged. Almost half (48%) of these UVR Type 2 emitters were found in unstaffed salons, the remainder fell within the limits for UVR Type 3 emitters.

Of the sample of 30 'facial burners' that were taken, UVB values ranged from 'no UVB detected' up to 0.06W/m² , and ranged from 0.05W/m² up to 0.26W/m² for UVA. It should be noted that these were opportunistic samples which included more than one measurement being made

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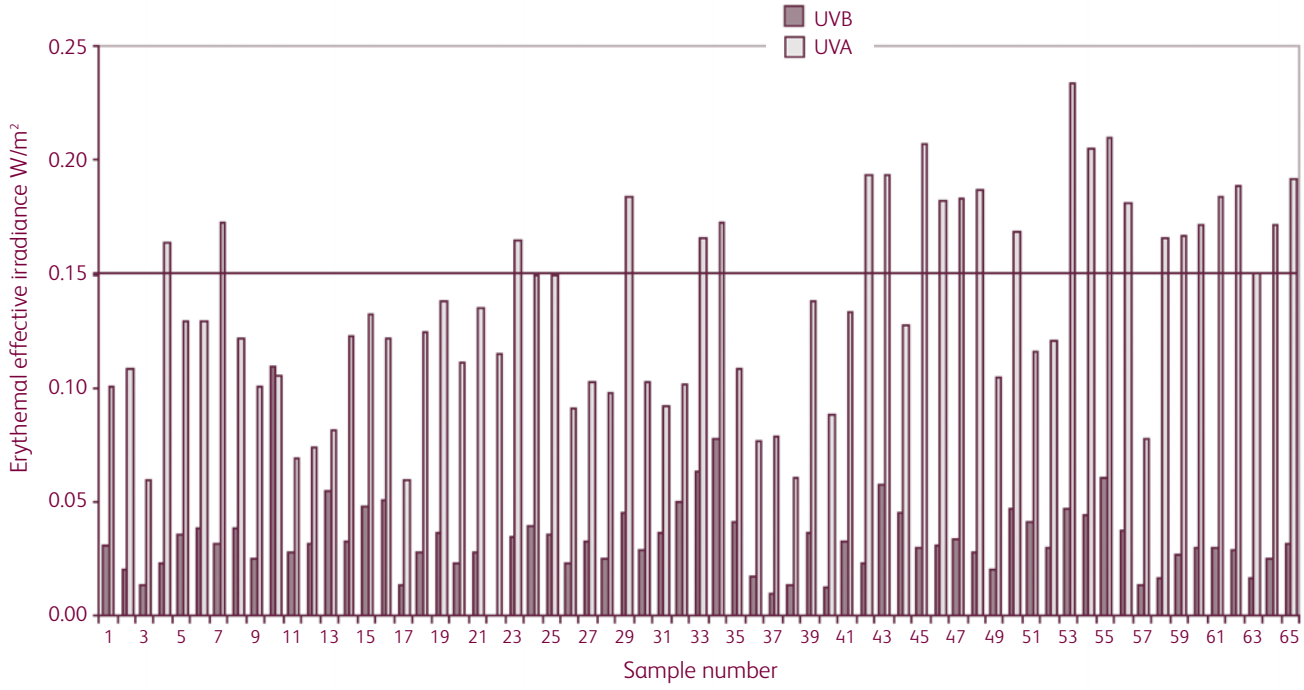

Figure 5.0
The 'worst case' erythemal effective irradiance in W/m² for UVA.

for some of the sunbeds, and therefore the 'sample number' in figure 6.0 cannot be compared with figures 4.0 and 5.0. Fourteen of the samples taken were classified as being either UVR Type 1 or 2 emitters (Figure 6.0), with fifteen samples being classified as UVR Type 3. However, one sample was classified as being a UVR Type 4 emitter. All 'facial burner' measurements were taken from sunbeds in unstaffed salons. Thirty percent of the lamps surveyed had no wavelengths within the 250nm to 320nm range (UVB). Again, the horizontal line indicates the 0.15W/m² limit that when exceeded, can alter the classification of a sunbed.

Discussion

Discussion of survey

It was found that when the measurements were averaged, the true level of effective irradiance was underestimated, thus confirming the importance of trying to determine the area of the sunbed with the highest radiation when taking measurement, i.e. hotspots.

This is confirmed when considering the 'worst case' readings, where 27 (42%) of units were classified as UVR Type 2 emitters, when compared to the readings that had been averaged, where only 21 (32%) were classified as UVR Type 2 emitters. Also, the measurements from the 'facial burners', (all taken in unstaffed salons), showed that nearly half were UVR Type 1 or 2. According to the British Standard, UV Type 1 and 2 emitters are "intended for use in tanning salons, beauty parlours and similar sites, under supervision of appropriately trained persons". Alarmingly, one measurement was classified as a UVR Type 4 emitter. This type should only be used with medical advice. Clearly, from the evidence obtained by this survey, the required level of supervision and information is not being provided in many sites in South East Wales. This is an unacceptable practice as it puts the public at risk.

The recent report released by COMARE (2009) comments that there will always be a certain amount of variation in the output of UVR along the tubes used in artificial tanning equipment. This generally leads to areas known as 'hot spots', which has resulted in the

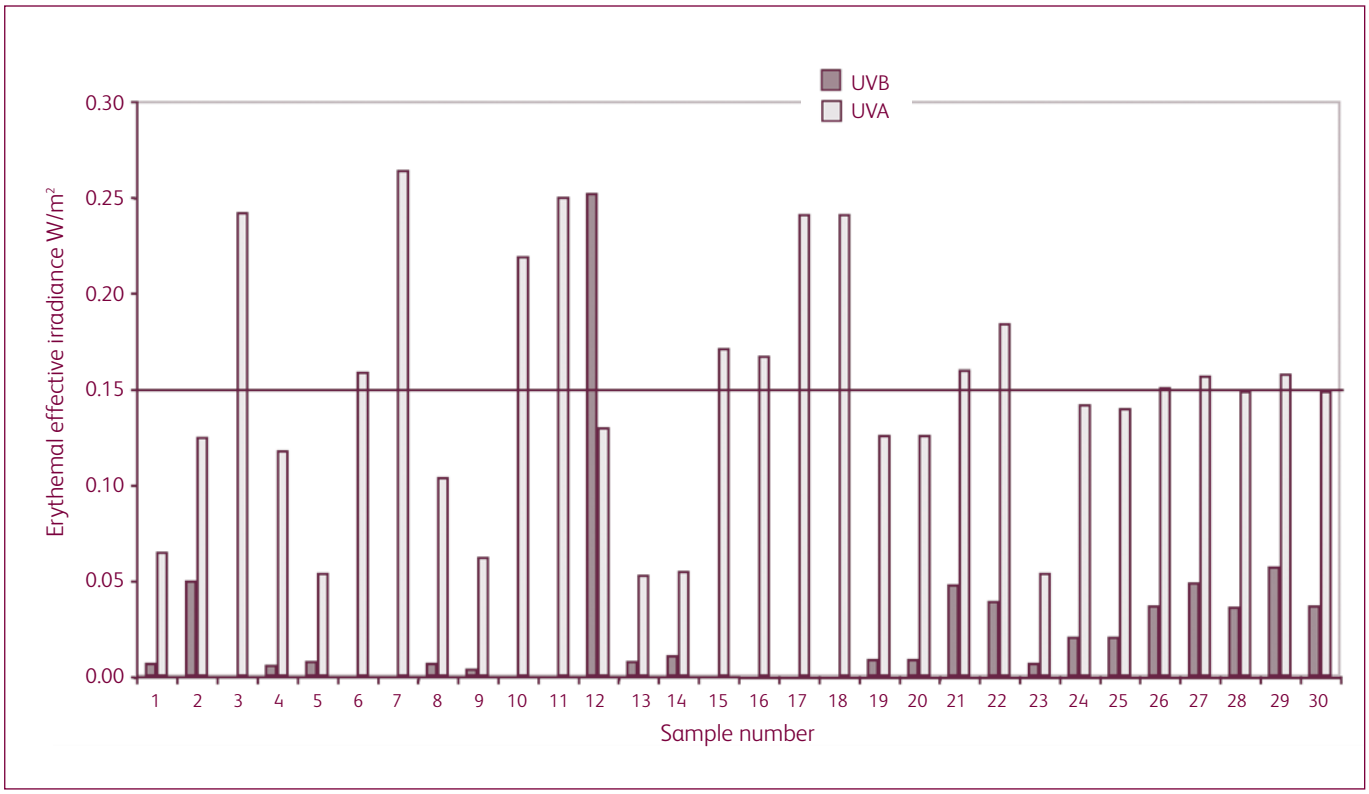

Figure 6.0
The 'facial burner' erythemal effective irradiance in W/m² for UVA.

need to identify the 'worst case' reading from a bed. The British Standard requires that the measuring instrument is positioned so that the 'highest level of radiation is recorded'. However, the research team did not have the means available to them to locate such an area, so where the results are reported as the 'worst case' sample from those taken, it may not necessarily be the 'worst' sample from the bed as a whole.

Application of the British Standard

A key issue here is that there is only a requirement for manufacturers of sunbeds to follow the British Standard, and not on the operators running these establishments, who are effectively able to change the classification of a sunbed just by replacing some or all the tubes for stronger alternatives (Email communication from HPA, 2009). This also poses the question as to who can be held responsible for ensuring that an appliance is used in the appropriate setting according to the BS EN. Regardless of where responsibility lies, there are several ambiguities that require clarification.

First, there is no definition within the British Standard of what would qualify an operator as being 'appropriately trained'. This survey has found that in unstaffed premises there is clearly no supervision, other than the use of CCTV. However, where UV Type 2 emitters were found in premises that did have staff present, there was little evidence to show that they were 'appropriately trained'. The majority of operators questioned simply answered that training was completed in-house. This training appeared focused on accepting money and issuing basic instructions on operating the equipment. Only one operator questioned stated that they had undergone a specific training course, which was a requirement of membership of the Sunbed Association. This involved the completion of a written assessment of the attendee's knowledge associated with the use of tanning equipment.

Second, the level of 'supervision' required is also undefined by the BS EN. Approximately half of premises visited had sunbeds that were operated via a coin meter, rather than token meters, therefore allowing the customer to decide upon the session length they receive simply by inserting

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more coins into the machine. Only three sites kept adequate records for monitoring customer's use of sunbeds. A number of sites had sunbeds that were located some distance away from any visual supervision of staff; therefore questioning the concept of 'supervision' in such sites. The unstaffed salons were wholly reliant on CCTV for supervision purposes. An interesting observation made while undertaking measurements was that more than one person could occupy a booth at any one time in unstaffed salons. This aspect gives rise to concerns regarding the social acceptability of tanning, especially among young children.

The third point of concern is that although the British Standard does prescribe a methodology for determining UVR emissions, it is inadequate. There is only mention of horizontal sunbeds, and no mention of vertical units, suggesting that it is out of date. The monitoring equipment that was used as part of this research seems to eliminate some of the previous issues that needed attention, for example, the requirement to cover or remove the upper or lower radiating surface of a horizontal bed when testing is in progress so as to reduce the impact of reflective light. However, no indication is given within the BS EN as to how this coverage or removal should be achieved in practice. As a result, the methodology used in this survey was an adaptation of that set down in the British Standard. Clearly there is a need for the development of a monitoring methodology which will enable reproducible results to be obtained, in the field, by either operators or regulators.

It became apparent throughout the course of the survey that there would be obvious confounding factors that would be beyond the control of the research team. First, every sunbed tested had been used for varying degrees of time prior to the measurements being taken. Also, some beds had newly changed tubes; others claimed not to have been changed for as long as four years. Once again the BS EN needs to prescribe a monitoring regime that will enable consistent results to be obtained.

Discussion of questionnaire findings

The findings of the questionnaire have revealed that operating practices can differ from one business to another. One tanning salon displayed instructions on 'safe' tanning that effectively resulted in a customer exceeding the recommended 20 sessions per year within four months. A significant number of operators are not providing the depth of information and advice that is necessary for customers to make an informed decision. Only four operators gave a detailed account of the consultation that a first time user would experience.

A major concern highlighted during the survey was the obvious lack of staff training. All but one operator stated that training was completed in house. There is no legal requirement for any formal training that would cover issues such as health concerns, medical conditions that would prohibit the use of tanning equipment and customer skin typing. This is a serious omission in relation to the operation of commercial tanning equipment.

A particular concern that was highlighted during this study was the unstaffed tanning salons that appear to be growing in numbers, particularly in low income areas (COMARE, 2009). Oliver *et al.,* (2007) noted that such premises were not operating when their initial research in 1998 was conducted. It would appear therefore that in the intervening period, entrepreneurs have been quick to exploit the fact that there is no formal control in the operation of unstaffed salons, coupled with the social demand for the service. These salons are not even permitted to become members of the Sunbed Association, as operating without staff on the premises is against their Code of Practice (The Sunbed Association, 2009).

The most obvious concern with these sites is that there is no control over who uses the sunbeds, or for how long. Unstaffed salons have come under much scrutiny owing to the incidents involving children, referred to previously, all occurring in unstaffed salons. In one such premises visited, a sign was displayed detailing a mobile phone number for contact in an emergency. This number was called several times while monitoring was carried out, only to be greeted with a standard answer phone message.

Conclusions

The emissions survey has demonstrated that there are many sunbeds within the survey area emitting levels of UVA well above the limit of 0.15W/m^2. It can be seen that considering the results on a 'worst case scenario' basis can give a more realistic reading, and in particular, it highlights the issue of 'hot spots' on sunbeds. Although the majority of UVB emissions were within the required emission limit, the level of UVA was high enough to ensure that many premises are not fully compliant with the requirements of the relevant BS EN. It appears that many operators of commercial tanning facilities, and their customers, are not aware of the classification and labelling requirements of the equipment.

The BS EN needs updating and elaboration, in particular, by specifying the methodology to be employed for

monitoring UVR emissions from sunbeds, and also by stipulating when testing or re-testing should take place, e.g. immediately after partial or complete tube change. The current best practice from other countries with a more formal regulatory system for controlling UVR exposure should be adopted.

The BS EN needs to clarify how those undertaking monitoring of UVR emissions can identify the highest level of radiation, by means of an appropriate protocol, which is lacking at the present time. This would allow monitoring techniques to become more consistent, in the case of both operators and regulators, thereby providing an appropriate level of reassurance for the public.

There should be a clearer definition of key terms such as 'appropriately trained' and 'supervision', in order to protect people using commercial tanning equipment, as the current research has found both of these to be inadequate in South East Wales.

This research has shown that there are obvious inconsistencies when it comes to the level of training received by staff working in premises that offer UV tanning facilities to the public. Regulation is required to bring a consistent, minimum level of training. This will ensure that staff can make correct skin type assessments and provide adequate warning of artificial tanning.

In the interests of public health it is essential that premises offering the use of tanning equipment as a commercial service should have at least one member of staff available at all times, to advise and assist customers. Unstaffed premises should be prohibited as they allow unrestricted access to sunbeds, which will invariably result in the facilities being abused. In particular children are currently gaining access to the equipment, putting them at risk of developing skin cancer.

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Good practice in risk communication: A case study related to people residing on an infilled clay pit

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Abstract

This paper discusses how risks and actions were communicated to residents on a contaminated site in Conwy County Borough, North Wales during a local authority housing stock transfer process. The risk communication strategy describes the process for community engagement during the investigation and remediation phases at the site. Emphasis is given to the joint risk communication process, particularly the importance of maximising access to advice through involving all relevant stakeholders from the outset and co-ordinating the multi-agency response required. Particular aspects of the response that are highlighted as good practice include: humanisation of the process to aid the development of a good relationship between stakeholders and experts, and maintenance of a designated point of contact to maintain consistency and approachability throughout the process.

Key words: Contaminated land; Environmental Health; Land Remediation; Multiagency; Partnership; Public Health; Risk communication.

Introduction

Minimising the impacts on health from chemical contamination of the environment is an important task, which is incumbent upon public health professionals from a broad range of organisations. This paper explores these potential impacts and describes how early multi-agency co-operation between all parties with health protection responsibilities was effective in managing the wider health impacts of a chemically contaminated residential site.

When dealing with chemical contamination and the effects on human health, it is easy to focus solely on the toxicology of the contaminants present, and try to assess whether exposure is sufficient to result in harm. However, this focus can divert attention from other wider public health implications. The World Health Organisation defines health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" (WHO, 1946). This broad definition encourages us to look beyond the direct toxicological effects of chemicals and consider the potential impact of the whole process on the people involved.

Living on, or near, land with elevated levels of chemical contamination can affect health in a number of ways. Of principal concern in risk assessments is the direct toxicological impact of exposure to the chemical(s) of concern. Owing to the presence of many confounding factors and the conservative nature of exposure assessment models and toxicological standards, it is difficult to prove the causality of impacts directly associated with the toxicological health effects of soil contaminants (Abrahams, 2002; Wood, 1996). When the potential for exposure is identified, the risk can often be easily reduced by simple practical measures such as washing and peeling home grown vegetables or removing outdoor footwear when inside the home. Furthermore, risk assessment may also ultimately prove that contamination is not present in sufficient quantities to pose a significant risk to health.

It is, therefore, important not to underestimate the wider public health implications that could arise during any protracted land investigations and remediation processes. Such implications may include stress and anxiety fuelled by feelings of powerlessness and concerns about economic or health impacts (Barnes *et al.*, 2005), and should not be overlooked. They will occur as a result of the process whether the final results indicate that land is contaminated or not, and can lead to observable ill-health effects in the short term (Gatchel & Newberry, 2006).

Given the importance of both potential direct and indirect public health impacts, it is essential that public health professionals work collaboratively to identify, assess and manage public health risks, and take action to communicate these risks effectively to all affected parties. Key outcomes of effective communication include less stress and anxiety, reduced feelings of powerlessness, improved co-operation, and the delivery of important messages. In order to achieve this, stakeholders need to work together to build confidence and trust between all parties, increase knowledge and understanding within the communities, and return a feeling of control and ownership of the process to those most affected. Should that relationship break down, vital information may be lost or ignored, and the regulators may find themselves working amidst opposition, exacerbating an already difficult situation. Good risk communication will not always improve a situation, but poor risk communication will nearly always make it worse (Hall & Crawford, 1997).

This paper discusses how, during a local authority housing stock transfer process, a contaminated site in Conwy was identified, public health risks assessed and managed and remediation action initiated. Emphasis is

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given to the joint risk communication process, particularly the importance of maximising access to advice through involving all relevant stakeholders from the outset and co-ordinating the multiagency and multisectoral response required.

The site

During 2008, Conwy County Borough Council conducted a review of potential environmental liabilities prior to the transfer of council housing to a private housing group, termed Housing Stock Transfer (HST). During this process, a housing development of about 50 dwellings was identified as having been built on the site of an infilled clay pit. Based on available historical mapping records, the former clay pit and associated brickworks buildings were believed to be operational during the 1890s. Later map records indicated that the abandoned clay pit had been infilled and the site put to allotment use during the First World War. Local authority housing was then built at the site during the 1920s, in several phases. Being part of a former industrial area, several brickworks, a refuse destructor and gasworks were all located within a 1km radius of the site. These activities all provided a steady supply of ash and clinker material requiring local disposal. The expansion of the urban area following the First World War was a driver for housing development.

Within the area identified, about half of the properties on this development had previously been sold to private owner occupiers under the Right to Buy scheme, while the remainder were council-owned and subject to the HST. The council properties were geographically distributed in a random pattern across the development.

The site investigation consisted of a desktop study of all available information followed by a site reconnaissance using non-intrusive and intrusive techniques. An independent consultant was commissioned to take soil samples from the gardens of properties under local authority ownership to determine the nature of the fill material and, where necessary, advise on remedial action. Samples from between 0m and 0.3m below ground level were taken from the gardens of properties with exposed grass or soil.

Sampling confirmed there to be a substantial visible content of ash and clinker in surface soils with elevated concentrations of associated contaminants. The levels of contamination were sufficient to require remediation of the site. Being built 80 years earlier, several properties had gardens that had been altered and re-worked many times. It was evident that imported soil had been mixed with the ash, accounting for substantial visible differences between localised areas as well as chemical variations. However, sufficient contamination was present in areas where garden users had easy access to the soil, mainly bare soil at borders and under allotment use for home grown vegetables, to present an elevated risk to health.

A remediation strategy for the local authority properties was developed to remove contamination presenting a potential risk to human health and resolve potential liabilities that could affect the progression of the HST process. The proposal involved excavating areas of soft landscaping including soil borders and lawns to a depth of 600mm prior to placement of a break membrane, and backfill with validated imported topsoil. This was in line with accepted good practice and covered both food crop growing and soil contact under normal use that would contribute to overall human exposure. Paved areas and general hard standing areas in rear gardens were assumed to have been laid on original soil and could revert to soft landscaped use in the future so would benefit from the excavation to 450mm depth. Placement of a break layer membrane and compacted imported sub-base material would form a robust foundation for re-instatement with paving or decorative hard-standing.

The extent of this remediation meant that significant disruption at the site would be anticipated. Furthermore, the local authority believed that the same remedial specification should be offered to the private owners in addition to those properties in the HST process in order to maintain a consistent approach across the development and ensure that any potential public health risks are minimised for all involved. This could be argued as not falling within the direct liability of the authority as the information was not known at the time of the sale of the former council housing under the Right to Buy scheme. However, a view was taken early that there should be no differentiation between the two groups to reduce the potential anxiety faced by owner occupiers in a potentially protracted site investigation and evaluation process. It was also pragmatic to avoid the need for the local authority to carry out a further detailed assessment under Part IIA of the Environmental Protection Act 1990 which would have incurred significant costs to the council and delay the likely conclusion that remedial action of the agreed specification would be required. Furthermore, in the event that a Part IIA assessment of liability was carried out it was probable that the former local

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authority, having in-filled the former brick pits with municipal incinerator ash and later by building council housing on the site, would form a substantial part of the liability group.

Effective communication of risk

As previously discussed, effective risk communication is important in helping reduce anxiety, conflict and stress related ill-health. In order for the relationship between all stakeholders to be successful, there are a number of key factors to take into consideration.

First, it is essential that any relationship is based on *trust*. Trust is a major factor for providing orientation in unfamiliar situations, and therefore is key in reducing anxiety. Furthermore, a sense of trust will help reduce any suspicion of hidden motives as it is associated with believing the source is expert, unbiased, and not sensationalising (Breakwell, 2000). A significant factor in gaining trust is an organisation's ability to demonstrate empathy (Lundgren & McMakin, 2009). In order to maximise trust, the risk communication process in this instance involved delivery of a co-ordinated message via key named individuals. As a result, residents were able to build up a relationship with real people, rather than deal with faceless organisations. However, any trust formed is easily destroyed by inconsistency. Therefore, partners worked closely to ensure that consistent messages were communicated by all agencies involved.

The second factor to consider in planning effective risk communication strategies is *control*. Risks are more likely to be acceptable if they are voluntary (Otway & von Winterfeldt, 1982). The process of examining land contamination is involuntary by its very nature and consequently there is a limit to the extent to which this unwelcome burden can be cushioned. However, it is important to exercise control at as many opportunities as possible. In order to do this, it is important to engage with the residents as partners in the process, rather than direct a one-way flow of information at them. Providing opportunities for residents to feed concerns and questions into the process, and resolving these quickly, is key to building participation.

In order to ensure that these two basic risk communication principles were met, a strategic multi-agency response team (SMART) was convened. The SMART (comprising representatives from Conwy County Borough Council, Health Protection Agency, Public Health Wales and Conwy Local Health Board) had two aims: to assist the local authority by providing advice on the potential public health implications of the contamination, and to co-ordinate response activity to manage public health risk. A risk communications strategy was developed in line with appropriate guidance: *An Outline Model Framework for Working Together to Communicate with the Public* (Welsh Assembly Government, 2008).

The goals of the risk communication strategy were twofold. Foremost was a requirement to provide health information and public health advice without generating alarm, or alienating the residents. The second goal was to encourage voluntary take-up of the remediation offer and ensure action was not needed under Part IIA of the Environmental Protection Act (considered to represent the most efficient resolution of the problem).

With these goals in mind, the SMART agreed a risk communication approach based around five separate phases. At each phase, necessary action was assessed in advance of implementation to determine its likely impact on the residents involved and how it could be perceived. As a consequence of this, strategies for impact minimisation and mitigation were developed. The success of the plan was continuously monitored and the strategy modified to make use of any additional information that became available.

The stages of the response were:

Investigation phase

This covered all the desktop and intrusive investigations at the site. During this stage, the local authority took the decision to limit intrusive investigations to the council owned properties. The authority was conscious of the sensitive nature of any investigation work required and the need to avoid causing undue concern or anxiety pending the outcome of the investigation. It was also decided that as the HST process, rather than contaminated land legislation, was the primary driver for the investigation, the initial focus would be on the council owned properties where there was existing right of access to the land. The random location of the local authority owned properties across the site made the SMART confident that a comparable level of contamination was likely to exist in the privately owned properties. Samples were taken from shallow soils in a manner which maintained a low profile by avoiding plant and machinery. This reduced the disruption and allowed the works to be carried out without drawing attention to the potential problem.

Preparation phase
Following initiation of the investigations, the local authority convened the first SMART meeting to prepare a full strategy for risk communication at the site. During this phase a full plan for communication was prepared including drafting a schedule for when actions would take place. Support was provided by the dedicated communications team of Public Health Wales. As much material as possible was prepared in advance of the problem becoming public knowledge. The local councillors and cabinet member were briefed on the significance and sensitive nature of the issue to obtain their support for the proposed action. It was decided early in the process that there should be minimal delay between queries being raised and answered. This was a key facet of the strategy, as it was felt that the longer the residents had unanswered questions, the more concerned and anxious they would become. Therefore, the process was designed specifically to minimise the time concerns had to build while questions remained unanswered. In addition to materials aimed at the residents themselves, the SMART also developed a joint reactive press release in case of press enquiries, but these were not forthcoming.

Notification phase
This stage of the response was the first point at which the public became aware of the presence and extent of contamination at the site. Initial notification, including basic public health advice, was by hand-delivered letter. The local authority's environmental health officers (EHOs) delivered the letters and also gave verbal explanations of the action that was proposed at the site. The letter included a site-specific question and answer (Q&As) briefing paper for residents which had been developed by the SMART. Delivery of the letters was timed to coincide with the decision of Conwy County Borough Council cabinet to approve progression of the scheme. This was done to reduce the likelihood of residents learning about the scheme from other sources. It was also scheduled so that as many residents as possible would receive the news verbally from an EHO and the letter was there for them to consider the information in their own time. This ensured that the residents could ask any pressing questions immediately and would not be left with a letter they potentially did not understand. Furthermore, it added to the humanisation of the process. The accompanying Q&As were developed carefully to be sure that as much basic information on the health effects of the contaminants as possible was available, so that the residents would not be alarmed while looking for further information on the internet. It was felt that the residents should not learn anything they had not been told in order to ensure the correct reassuring messages were foremost, and demonstrate that the council were being honest about the problem. This 'no holds barred' approach was considered vital to building trust between the residents and the EHOs managing the process on site.

Response phase
The SMART agreed that face to face access to the health specialists and named council representatives as soon after notification as possible was vital, to reduce anxiety and increase trust. Residents were encouraged to visit a mobile drop-in vehicle placed on site on the day the letters were delivered and kept on-site for three days. The mobile was manned by a small number of case officers with an in-depth knowledge of the site investigation work and the potential health concerns and remedial action to be taken. The majority of residents attended the mobile drop-in sessions with a diverse range of enquiries ranging from health concerns to impact on property values. These were used to ensure residents felt ownership of the process, and that it was not being imposed upon them.

The mobile drop-in sessions enabled face to face contact with residents with the support of the local members and council cabinet. These one-to-one sessions were convened rather than a full-scale public meeting because it allowed people's concerns to be addressed individually and a relationship to be established between the case officers and residents.

For specific health queries another drop-in session was held at a local community venue the following week, attended by the local public health director, consultant in environmental health protection, local consultant in communicable disease control and EHO. This was run during an afternoon and evening to allow residents who worked to attend. It enabled residents to discuss their individual health concerns with professionals who had been involved in the decision-making process, and obtain advice on any follow-up needed. All members of the public who attended the community centre had previously visited the local mobile drop-in session. If queries could not be answered at the meeting, each question was recorded and answered as soon as possible. This was all carried out to ensure the residents felt their concerns were being taken seriously and addressed quickly.

The main concerns raised by the residents at these drop-in sessions included:

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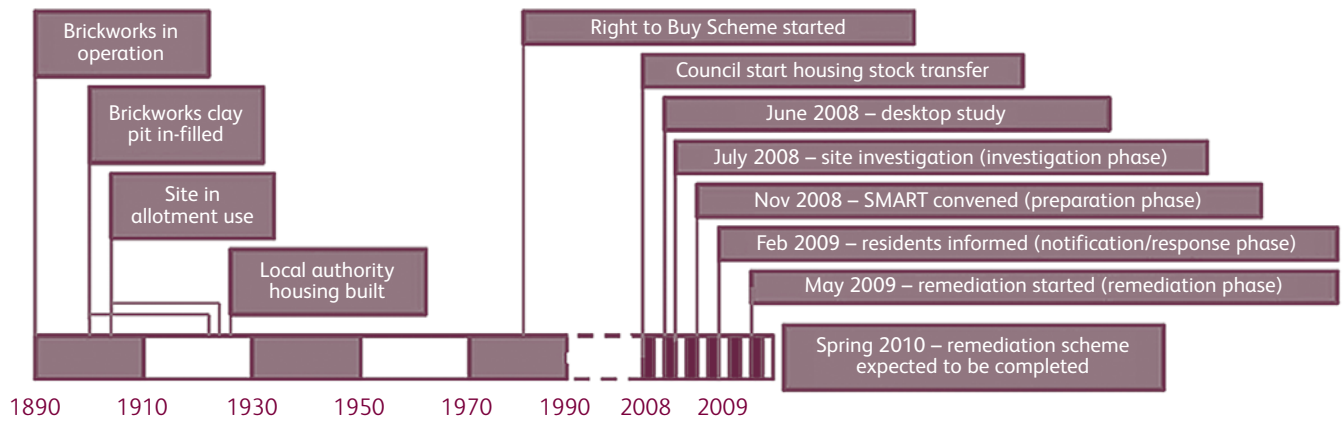

Figure 1.0 Timeline for development and actions on site

- Contaminants being a potential cause of existing health conditions or exacerbating non-related health conditions;
- Uncertainty that long term exposure to contaminants may have had on resident's health;
- Substantial money had been invested in current garden layout and the effect that re-laying the garden would have on this;
- Potential negative effect that the disclosure may have on the value of the property and potential saleability;
- Structural stability concerns where excavation work could potentially undermine building foundations;
- Potential difficulty that disabled or elderly residents may have in accessing their property during remedial works;
- Some private owners initially considered their gardens were unaffected by significant contamination so questioned the need for remedial work particularly where garden soil had been replaced owing to noticeable poor quality;
- Model of exposure to contaminants and potential impact from ground beneath the house floor slab that is not subject to remedial action.

Remediation phase

It was possible to explain the proposed remedial work in detail during property visits as the remedial strategy had already been developed prior to the publicity. This enabled the remedial actions to be communicated in clear terms and to satisfy residents that work would cover all likely future uses of the garden areas by having long term durability. It also removed any uncertainty residents might have regarding the scope and extent of the remediation funded by the council for each individual property.

All remedial action would take place in the garden areas and although no access was required to the internal property, significant disruption was anticipated. A decision was made to focus on the remediation of up to six properties at a time, to minimise road congestion. A remediation plan was provided to each householder including the anticipated duration of site work to be followed up by a detailed site report on completion of the remediation.

Discussion

It was felt by partners that the multi-agency response to the incident coordinated by the SMART had worked well, particularly the risk communication. Following completion of the risk communication strategy, residents were consulted about their opinions on the process during follow-up site contact. Verbal responses were positive, indicating that a suitable degree of information had been provided in a manner that residents could understand. No adverse comment was made by any residents about continuing to live on the site pending completion of the remedial action, suggesting that technical information was accepted in its proper context. The feedback showed that the strategy had completed its aims of ensuring no unnecessary anxiety through building trust with officials. Furthermore, complete uptake of the remediation offer was achieved without the requirement for regulatory

action. The lack of press interest in the site is also perhaps testament to the fact that residents felt that their worries had been addressed.

The success of this approach demonstrated that it is worth taking time with the response. Although development of a comprehensive risk communication strategy may seem human resource intensive and be a task for which there is little or no time or resource to accomplish, it is essential to make that time available. Successful two-way interaction between all partners in this process will inevitably save time and effort in the long run. Mistakes made can be difficult to rectify later as once the relationship between the community and the professionals involved is damaged and trust is lost, it is very difficult to regain. Additionally, from experience, the team found it less resource-intensive to organise and plan the communication strategy before commencing than to rescue a situation that is rapidly getting out of hand.

Once the risk communication and remedial strategy has been conveyed successfully, it is important that the process maintains momentum through to the remediation stage. This has particular significance where home-grown vegetables are consumed by the householder or children continue to play in soft landscaped garden areas before the work is carried out as the perception of risk to these groups is now heightened.

An important aspect in developing a good working relationship with the residents was humanisation of the process and maintenance of a designated point of contact that maintained consistency and approachability. The mobile drop-in sessions provided the initial face to face contact to allow the residents to talk to the case officer about their concerns. It was anticipated that there would be limited time for individual enquiries, particularly during peak periods. An enquiry log was therefore maintained which recorded the contact details of each resident when visiting the mobile unit, summarising their main queries requiring follow-up. An offer was made to visit each property in the resident's own time. This was welcomed by all residents and assisted the case officer in making a positive connection with them. Residents appeared more comfortable to discuss their concerns at the property, being already familiar with the officer from the mobile drop-in session.

Conclusions

One of the most important aspects of any response to a potentially contaminated site is risk communication as stress, anxiety and concerns about property blight are much more likely to occur to residents than direct impact on health. This paper has highlighted an approach taken by the SMART in responding to such a site in Conwy County, North Wales, which has worked well, particularly highlighting aspects of risk communication. Important lessons are as follows:

- It is worth taking the time to understand the target audience for any public health message;
- It is important to work out how this message will be perceived and planning the response methodically to minimise public concerns. Once the risk communication and remedial strategy has been conveyed successfully, it is important that the process maintains momentum through to the remediation stage;
- Humanisation of the process and maintenance of a designated point of contact for residents maintains consistency and approachability and helps to develop a good working relationship with residents;
- Aim to be completely transparent, especially with bad news.

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The effect of behaviour and beliefs on the effective use of sunscreen

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Abstract

Exposure to ultra violet radiation is the principal cause of skin cancer and much effort has been expended in educating the general public about ways in which they can protect themselves against over exposure to UV radiation through use of sunscreen. Using a questionnaire this research sought to ascertain whether the study group understood how sunscreen should be used and whether those who claimed to use sunscreen did so in such a way as to afford them the maximum protection. Questions were also asked about the relative dangers of using sun beds as compared with that of being exposed to natural sunlight. A sample of 202 adults attending an outdoor activities in south Wales was interviewed.

The study shows that there is a high level of understanding of the need for protection against over exposure to the sun but that the practice of protection is poor, leading to a strong optimistic bias in favour of the adequacy of protection, possibly creating over-exposure. There is misunderstanding about the relative safety of 'natural' tans when compared to tans obtained using UV tanning equipment.

We recommend that health practitioners build on the existing recognition of the need for protection and devise and promulgate strong messages about the way in which protection should be managed to avoid over exposure and the consequent elevated risk of developing skin cancer.

Key words: Awareness; Attitudes; Behaviour; Dosage; Environmental health; Skin cancer; Sunscreen.

Introduction

Skin cancer is the most common type of cancer in the UK. It is also one of the most preventable types of cancer. Malignant melanoma incidence rates in Britain have quadrupled since the 1970s, and over the last twenty-five years, rates of malignant melanoma in Britain have risen faster than any other common cancer. The reasons for the rise in incidents rates are several and include increasing accessibility of long and short haul foreign holiday taken in hot climates, increased use of Ultra Violet (UV) sun beds and increased amounts of leisure time spent in both active and passive outdoor activities with consequent exposure to the sun, in addition to promotion of tanned skin as being fashionable and desirable by the popular and niche press. It is well recognised that exposure to UV radiation is the principal cause of basal and squamous cell carcinomas of the skin and that protecting skin from UV radiation is one of the most effective ways of reducing rates of skin cancer.

Public health messages targeted at reducing rates of skin cancer have been based around campaigns designed to encourage individuals to keep out of the sun when it is at its strongest, between the hours of 11.00am – 3.00pm, to cover up in the sun – protecting the body from direct exposure – and to use sunscreen on exposed body parts when in the sun. Campaigns such as the 'Slip, Slop, Slap' campaign are widely recognised and the messages are understood. However, the effectiveness of the message relies on individuals both recognising the need to act and acting appropriately in the sun. The requirement to keep out of the sun when it is at its hottest and to cover exposed body parts is easy to understand and the necessary action easy to implement. Studies by Thieden *et al.,* (2005) suggest that there is great variation in sunscreen use with people tending to overestimate and adopt risky behaviour such as staying out in the sun for longer when wearing sunscreen. There is further misunderstanding of the purpose of wearing sunscreen with the belief that sunscreen is a tanning aid rather than protection from exposure to and the damage from harmful UV rays.

While public health messages promote the use of sunscreen, there is evidence that people using sunscreen are under-protected simply because they do not apply the sunscreen correctly to achieve the expected protection. The protection offered by a sun screen is indicated by its sun protection factor (SPF) which is assessed after photo testing in vivo at an internationally agreed application thickness of 2 µl/cm^2. To achieve the rated protection over the whole body, a typical adult of surface area 1.73m^2 would need to apply 35ml of sunscreen, being approximately one seventh of a typical 250ml bottle. Several studies (McGregor *et al.*, 1993, Stenberg *et al.*, 1985) show that individuals use much less than this, typically using an average of 0.5-1.3µl/cm^2, with a consequent reduction in protection, in some cases being closer to half the sun protection factor expected.

According to the European Commission, the estimated retail value of the sunscreen products industry in Europe was approximately £1.35bn in 2005, and the market is recognised as growing. There is wide customer choice within the market being segmented into products for children and babies, products that are waterproof and products with SPFs ranging from 3 to 50. Autier (2000) suggests that there is considerable consumer confusion regarding the meaning of SPF and particular confusion

about the increasing benefits to be obtained from using increasingly high SPFs. There is a general belief that safe exposure time can be calculated by using the SPF as a simple multiplier against normal burning time, and a failure to understand that increasing SPF does not equate to increasing 'strength' of the sunscreen used.

The market also includes 'after sun' products that are designed to complement the sunscreen range, the purpose of which is advertised as to cool and sooth skin that has been burned after exposure to sun. The existence of these products is a tacit acceptance by the industry that sunscreen has not been used at all or is not used effectively and evidence suggests that there is confusion among consumers about the purpose of after-sun lotions, with a belief being that the use of sunscreen and after-sun are complementary and that sunscreens work better when used with an after-sun lotion (Fleming *et al*., 1996).

The aim of this study was to analyse the beliefs held by individuals about the purpose of sunscreen and the way in which it should be used. It particularly considered knowledge relating to the dose required for effective protection and necessity for reapplication. In addition, it sought to identify beliefs held by individuals about natural sun tans when compared to sun tans obtained by using UV sun beds.

Methodology

The study was undertaken in south Wales in May 2009. A sample of 202 adults attending outdoor activities was asked to take part in an interview asking them about their use of sunscreen and the beliefs that they held about the way in which sunscreen should be used. The survey also asked them to consider whether a sun tan achieved through exposure to the sun was healthier than one achieved through use of UV sunbeds.

Study population

The subjects chosen for interview were adults who were at the time of the interview at an outdoor location. They were self selecting in that they were asked if they would like to take part in a short survey. No inducement was offered to the participants. The study group consisted of only adults as adults are able to make their own decisions as to whether to use sunscreen and as to how much should be applied. Children were not part of the study group since decisions about whether to use sunscreen, how much to apply and how often are more usually made for them by an adult than the decision being that of the child (Bennetts *et al*., 1991), and further the dosage questions asked related specifically to adult body doses. The study group was taken from 3 locations, being a town centre, a beach and a golf course.

A beach location was selected as individuals going to the beach were considered likely to be engaging in activities that would result in being exposed to the sun for a considerable period of time and further considered likely to be involved in water based activities. A study in New Zealand showed that beach or water-based activities to be associated with the highest number of reported episodes of burning in a population whose sun exposure, sunburn and sun protection activities were studied (McGee *et al*., 1995). For individuals in this group to be adequately protected, their level of knowledge in respect of the effective use of sunscreen needed to be high.

The golf course was selected as another location where adults would be exposed to the sun for a considerable period of time, commonly in excess of four hours where a round of 18 holes of golf was being played. Research in Tasmania (Herlihey *et al.,* 1994) suggests that individuals commonly under estimate the duration of personal exposure in recreational settings such as golf courses and that they fail to adequate protect themselves from the sun in consequence of this.

The town centre location was selected as being a 'non-recreational' and 'non occupational' setting; adults visiting were often doing so in the course of what was perceived as neither business nor recreation. Research suggests that where activity is not considered to fall into either of these categories even individuals who consider themselves to have a good level of awareness in respect of the need to use sun protection fail to take adequate steps to protect themselves from exposure to the sun (McGee *et al*., 1995).

Information requested during interview

Sun protection used

Interviewees were asked if they protected themselves from the sun, and those who responded positively were asked which protection methods they employed.

Dosage

Interviewees who mentioned use of sunscreen were then shown five identical bottles, each containing a measured amount of sunscreen, being 15ml, 20ml, 25ml, 35ml and 45ml, and were asked which of the numbered bottled most closely related to the amount of sunscreen they would apply to themselves as a single dose. If asked, the

interviewers advised that the sunscreen in the bottles was SPF 15. In order to check the veracity of the answer given, interviewees were then shown a full 250ml bottle of sunscreen and asked how long the bottle would last them if used continuously by them, if they were the only person using it. Using 35ml and applying every two hours and assuming exposure to the sun between 10.00am and 4pm, the appropriate answer would be approximately 1.5 days.

They were also asked in their view how long the same bottle would last a family of two adults and two children aged under 10 years on a beach holiday. Again taking 35ml as the adult dose and 15ml as the dose for a child under 10 years of age and applying every two hours and assuming exposure to the sun between 10.00am and 4pm, the appropriate answer would be about 0.5 days – or fewer than three complete applications.

Time lag for maximum effectiveness

In order to determine whether interviewees had an understanding of the way in which sunscreen works, they were asked how long after application sunscreen operated at maximum effectiveness and were offered four choices of response, being immediately after application, 15 minutes, 30 minutes and 1 hour after application. Advice is that sunscreen should be applied at least 30 minutes before exposure to the sun and reapplied every 1.5 to 2 hours thereafter.

Sun protection factor

Interviewees were asked to explain the difference between sunscreen with a sun protection factor (SPF) of 15 and one with an SPF of 30. SPF is a measure of the effectiveness of the sunscreen at preventing UVB rays from reaching the skin. A sunscreen of SPF 15 filters out 93% of UVB radiation, a sunscreen of SPF 30 filters out 96% (Cancer Research UK). It is a common misconception that SPF 30 is twice as strong as SPF 15 and therefore that a sunscreen of SPF 15 should be applied twice as often as one of SPF 30. Auiter *et al.,* (2007) reported failure to understand difference between SPF levels leads to the belief that higher SPF allows for longer safe exposure time and that use of higher factor sunscreens commonly leads to overexposure and burning.

Sun tan vs Sun bed

Interviewees were asked whether a 'natural' sun tan was safer than a sun tan obtained using a sun bed. The best medical view is that there is no such thing as a healthy tan and that any colouring of the skin is indicative of skin damage. The 'no tan at all' prompt was not given as it was considered a leading response and that interviewees would select it believing that it to be the correct response. Autier (2004) notes that there is a misconception among individuals that tanning in a UV sun bed is 'controlled' and is therefore safer than uncontrolled tanning in sunlight. This suggestion is not supported by epidemiological data. There is also a belief that a pre-tan, acquired from a sun bed offers some protection from burning when skin is exposed to natural sunlight, and that this erroneous belief leads people to use less sun protection and to engage in more risky behaviour in the mistaken belief that their sun tan will afford them a degree of protection. Again there is no epidemiological or laboratory evidence to support this belief.

Interviewees who identified that a natural tan was safer than a sunbed tan were asked the basis for their belief. The question was a deliberate reversal of the misconception noted by Autier (ibid).

Use of after sun products

Interviewees were asked whether they used after sun products and those who responded positively were asked why they did so. The research team wished to establish interviewees attitude to use of after sun products and specifically whether they considered that the purpose of after sun products was to treat sunburned skin. Such a belief would suggest that interviewees were willing to overexpose their skin and considered that after sun products could be used to treat the over exposure.

Protective effect of sun tans

Interviewees were asked whether they believed that having a sun tan protected them from the risk of developing skin cancer. Research suggests that individuals are over-optimistic in their assessment of the protective effect of a number of factors, the protective value of a pre-existing sun tan being one such factor. There are a number of beliefs, such as that 'having a sun tan is a good base for further tanning and protects against burning' and 'having a sun tan can reduce the risk of skin cancer'. Neither is correct. The research wished to establish whether the interviewees believed that having a sun tan offered any protection against the risk of developing skin cancer.

Results

Interviews were carried out with 202 adults. When asked what they were doing when interviewed, 21.3% said that they were working or visiting the town centre for business purposes, 45% said that they were on holiday and 33.2% were engaged in a sporting activity.

Table 1.0
Answers to questions about dosage

Response (ml)	% of respondents
15	5.4
20	15.3
25	14.8
35	25.6
45	12.3
Don't use	26.6

Table 2.0
Answers to question about how long a bottle of sunscreen would last an individual

Response	% of respondents
2 days	3.9
3 days	8.8
4 days	4.9
5-6 days	5.9
7-10 days	35.3
2 weeks	20
3 weeks	4.9
1 month	8.8
2 months	0.5
1 year	0.5
3 summers	1.0
Don't know	5.4

Use of sun protection

74.7% (151) of interviewees claimed to use some form of sun protection, 24.7% (50) said that they did not use any form of sun protection. Of the interviewees claiming to use sun protection 91.5% said they used sun screen either as a lotion, spray or oil, 2.5% said that they relied on clothing and covering up in the sun and 0.6% (one interviewee) indicated that they did not go out in the sun, preferring to stay in shade at all times

Dosage

Questions in respect of dosage were put to the interviewees. When asked to identify which of the doses of sunscreen most closely approximated to the dose that an individual would use if applying it to themselves, there was a broad range of responses (Table 1.0). The correct response is 35ml.

The same interviewees were then asked how long a 250 ml bottle of sunscreen would last during a hot dry spell if they were the only person using it. The correct response, based on an adult person applying a 35ml dose every two hours as recommended is 6.5 applications, which was rounded up to two days. This did not take account of increased usage in the event of the sunscreen being reapplied after events such as swimming etc. Responses times were self selected and are shown as percentages (Table 2.0).

A question was then asked about how long a 250 ml bottle of sunscreen would last a family of four, consisting of two adults and two children under 10 years during a hot dry spell if applied correctly. The correct response is four hours or half a day (two full and one part application). Response times were self selected and are shown as percentages (Table 3.0).

Time lag for maximum effectiveness

Interviewees were asked how long it took for sunscreen to become fully effective after application. Four possible responses and a 'Don't know' option were offered. The correct response is 30 minutes after application. Responses are shown as percentages (Table 4.0).

Sun protection factor

Interviewees were asked to describe the difference between a sunscreen marked SPF 15 and one marked SPF30. The correct response is that a sunscreen marked SPF 30 blocks 4% more UVB than one marked SPF15 (97% v. 92%). Interviewees provide a freeflow response.

66.6% thought that the protection offered by SPF 30 was higher but did not quantify by how much. 16.5% thought that when using SPF 30 the user could stay out in the sun for longer.

0.5 % thought that SPF related to sun temperature and that the higher the sun temperature the higher the SPF required. 0.5% thought that different skin types required different SPF factors. 1% thought that there is no difference between SPF 15 and SPF 30. 15% gave a 'don't know' response.

Sun tan vs Sun bed

Interviewees were asked whether a 'natural' sun tan was safer than a sun tan from a UV sun bed. 48% of interviewees said that a 'natural' tan was safer, 39% said that a UV sun bed tan was safer and 13% gave a 'don't know' response.

The interviewees who responded that a 'natural' sun tan was safer were asked why they believed that to be the case. Freeflow responses were recorded. Reasons cited for the belief were:

- *'sunlight is more natural and therefore less harmful* (28%)
- *'sunlight is not as intense as artificial UV'* (31%)
- *'the sun is less dangerous than a sun bed'* (11.5%)
- *'different UV is emitted by a sun bed'* (8%)
- *'no sunscreen is used on sun beds'* (5%)

14% gave a 'don't know' response.

Use of 'after sun' products

Fifty-four percent of interviewees said that they used 'after sun' products, 46% said that they did not.

Those interviewees who said they did use 'after sun' products were asked why they did so. 65% said that they used 'after sun' products as a remedy when their skin has been over exposed, citing reasons such as 'to take the sting out', 'take the heat out of burned skin' ' reduce pain from red skin' 'reduce temperature of the skin' and to 'stop peeling'.

Other reasons cited were to moisturise skin (30%), to help maintain tan (0.9%) and to prevent aging (1.8%).

Protective effect of sun tan

11% of interviewees said that having a sun tan provided a degree of protection from skin cancer. 73% said that there was no protection given by having a sun tan, 16% gave a 'don't know' response.

Discussion

Seventy five percent of respondents said that they used sunscreen as a form of protection against the effects of the sun and around 25% correctly identified the recommended dose when asked to select the dose that most closely correlated with the amount that they would apply to themselves. The validity of this figure as an accurate estimation of awareness and practice is undermined when compared to the responses given to the question regarding how long a 250ml bottle of sunscreen would last an individual and a family if properly applied, where only 4% and 2% respectively gave the correct response. The results show that although a significant percentage (38%) of those interviewed recognised the appropriate dose of sunscreen for one application this is not the dose applied in practice, where it would appear that bottle of sunscreen is made to last as long as it is required.

One of the factors that may be contributing to use of insufficient amounts of sunscreen is cost. 250ml bottles of SPF 15 sunscreen range in costs from £2.00 for a basic product, sold as a supermarket own brand, no frills product to £9.00 for a heavily marketed, high visibility brand. Based on a supermarket offer of nine brands, the average

Response	% of respondents
0.5 days	2.0
1 day	24.5
2 days	24.5
3 days	7.5
4-5 days	6.0
1 week	27.5
2 weeks	2.5
3 weeks	0.5
1 month	0.5
Don't know	4.5

Table 3.0 Answers to question about how long a bottle of sunscreen would last a family

Response	% of respondents
Immediately	30.5
15 mins after application	25.5
30 mins after application	30.5
1 hour after application	6.0
Don't know	7.5

Table 4.0 Answers to the question about lag time before full effectiveness of sunscreen

price for a 250ml bottle of SPF 15 sunscreen was £5.31. Thus the average cost of a 35ml adult dose of sunscreen is around £0.75. This means that one adult holidaying for one week would have to spend £21 and a family of two adults and two children £60.58 on sun screen if applied at the recommended dose and rate of application.

The results show confusion regarding SPFs and what they mean. Sixty-six percent of interviewees believed that a higher SPF gave greater protection in terms of longer exposure time but were not able to say by how much. Sixteen percent believed that a higher SPF allowed the user to stay in the sun for longer and more than 10% suggested that SPF 30 was twice as strong as SPF 15 and allowed the user to remain in the sun twice as long for a single application.

Thirty percent of interviewees understood that there is a 30 minute time lag between sunscreen being applied and it offering maximum protection which of course suggests that in 70% of cases a degree of unprotected exposure has taken place.

The responses to the question in respect of the relative safety of a 'natural' tan when compared to a tan obtained by using a UV sun bed show that that there is a lack of understanding that all exposure of skin to UV radiation, irrespective of source is potentially dangerous. Some interviewees pointed to reports carried in the local media at the time of the research regarding children being burned on UV sun beds as reasons not to use artificial tanning equipment, but failed to appreciate that exposure to the sun carries a similar risk. There was little recognition that neither is safe, with both those who elected a natural tan and those who supported the safety of tans obtained using tanning equipment citing reasons in support of their respective belief. It is impossible to say from the research whether this belief affected the way in which these individuals behaved, either by not using artificial tanning equipment or by using it in preference to tanning in the sun; however the confusion that exists suggests that there is a need for clear and unequivocal health messages addressing the issue to be promulgated.

Over 70% of those interviewed appreciated that having a sun tan did not offer any protection against skin cancer. 11% of interviewees did believe that there was a degree of protection afforded by having a sun tan and 16% gave a 'don't know' response. It is perhaps a matter of concern that individuals appear to know there is no health benefit in terms of protection against skin cancer to be gained from having a sun tan, but do not appear to realise that there is a elevated risk of getting skin cancer associated with getting a sun tan in the first place.

Conclusion

- While a high percentage of individuals understand the need for protection against the effects of the sun and use sunscreen as protection, there is strong optimistic bias about the degree of protection the sunscreen affords.
- Individuals recognise the required dose and claim to apply it, but in practice do not do so.
- Based on the understanding of the level of delay in sunscreen taking effect, it may be that in many cases a period of unprotected exposure takes place owing to the late application of the sunscreen.
- Confusion over the meaning of the SPF system may lead to unintended over exposure.
- The high proportion of interviewees who stated that they used 'after sun' products to deal with the adverse effects of over-exposure supports the evidence in respect of over-exposure, as individuals appear to have an expectation that they will suffer from a degree of sun burn and believe 'after sun' products are intended to deal with this.
- It appears to be recognised that a sun tan confers no health benefit in terms of protection from skin cancer.
- There is misunderstanding about the relative safety of 'natural' tans when compared to tans obtained using UV tanning equipment.
- Health professionals should build on the existing awareness of the need for protection with clear and simple messages about how sun screen works and the need to ensure that it is used properly if over exposure and the elevated risk of skin cancer are to be avoided.

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Development of a UK Recovery Handbook for Chemical Incidents

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Background

History has shown that major chemical incidents have happened both in developed and developing countries. Although rare, these incidents can cause mass disruption, many casualties and fatalities and can have long-lasting effects on the communities involved. Chemical incidents will occur again in the future and therefore responders must be prepared not only for the initial response but also for the subsequent recovery phase. This phase is key to the restoration of normality in the areas affected by a major chemical incident. The term recovery refers to all aspects of society: health, environmental remediation, social and economic issues (HM Government, 2009). This holistic approach means that responders must not only be competent in their area of specialisation but also be able to interact and plan for contingencies alongside other agencies that have roles in recovery.

The Health Protection Agency (HPA) therefore felt that detailed guidance was necessary to establish good practice based on lessons identified from responding to, and recovering from, emergencies both in the UK and internationally. Table 1.0 lists incidents which involved chemicals that had significant impacts on communities. From these parallels can be drawn, lessons identified and practical management options identified for the recovery phase of chemical incidents.

The aim

By mirroring the well received UK Recovery Handbook for Radiation Incidents (HPA, 2009), the HPA has been tasked by our partners to develop a UK Recovery Handbook for Chemical Incidents. These partners include:

- Department for the Environment, Food and Rural Affairs
- Food Standards Agency
- Home Office
- Northern Ireland Environment Agency
- Scottish Government.

Development of the Handbook will take three years, 2009-2012. On completion, the product is intended to provide a user-friendly online reference handbook in PDF format, which will aid all relevant government departments, agencies, local authorities and other stakeholders involved in the recovery phase of a chemical incident.

There are thousands of different chemicals that could be potentially involved in a chemical incident. Rather than attempting to study a large number of these, the UK Recovery Handbook for Chemical Incidents will concentrate on a select list of chemicals with a wide range of toxicological and physiochemical characteristics, including examples of those previously involved in chemical incidents.

The main aim of the project is to develop a framework for choosing an effective recovery strategy and a compendium of management options soundly based on science, taking into account acceptable, practicable and achievable practices through the involvement of various stakeholders.

Your involvement?

For this reason, the team are seeking to engage a range of stakeholders who may wish to contribute to this project. We are looking to identify potential stakeholders who will be crucial to complete our 'skills mix'. Their co-operation would be sought to review one of the three parts (which best suits their profession/ interest) of the handbook which covers Food Production, Water Management and Inhabited Areas. Stakeholders would be asked to share any knowledge from previous experiences in recovery working groups or chemical incidents and provide general ideas in developing the project further.

Involvement is voluntary and further details about the logistics of the stakeholder workshops, terms of reference and others involved will be provided on contact with the team. If you or someone within your organisation has an interest in contributing to this project, it would be ideal to get in touch with the project team at the address above, who will provide further information.

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Table 1.0
Summary of selected major chemical incidents

Date	Incident	Incident Type	Chemicals Involved	Fatalities	Injured
2001	World Trade Center, New York (USA)	Terrorist attack	A 'chemical cocktail' containing asbestos, carbon monoxide, respirable silica, dioxins, polyaromatic hydrocarbons, inorganic acids, oxides of nitrogen and sulphur and metals	2,993 (mainly non-chemical)	6,000 (mainly non-chemical)
	Summary		A series of co-ordinated suicide attacks on four commercial passenger jet airlines by Al-Qaeda. Two planes were intentionally crashed into the World Trade Center (OSHA, 2003; Smith, 2005).		
2000	Enschede, Netherlands	Explosion at a fireworks storage plant	A 'chemical cocktail' composed of gunpowder, charcoal and heavy metals	22	947
	Summary		An explosion occurred in a fireworks storage plant in which 100 tonnes of explosives were detonated (Messner, 2000).		
1995	Tokyo, Japan	Terrorist attack	Sarin, acrylonitrile and methyl cyanide	12	5,510
	Summary		Members of the religious cult 'Aum Shinrikyo' punctured newspaper wrapped bags and released a chemical mixture into the carriages of underground trains on three lines during the morning rush hour (Masuda, 1995; Kato, 1996; Okumura, 1998).		
1984	Bhopal, India	Industrial chemical incident	Methyl-isocyanate (MIC)	2,000 (reported initially) 4,000 (reported 15 years later)	250,000 (reported to have permanent disabilities)
	Summary		54,000 lbs of extremely toxic MIC were released from a stock for approx. two hours. The gas cloud covered an area of 2.5km wide and 4.5km long over a densely populated area exposing approx. 200,000 people (Bhopal Information Centre, 2001).		
1975	Seveso, Italy	Industrial chemical incident	2,4,5-trichlorophenol (TCP), ethylene glycol and 2,3,7,8-tetrachoro-dibenzo-para-dioxin	1 (as a direct cause)	Many (no exact figure)
	Summary		A safety valve failed and a toxic cloud containing dioxins was released into the atmosphere. This contaminated humans, animals, crops and land in the vicinity (Ramondetta1998).		
1932 to 1968	Minamata, Japan	Industrial pollution	Inorganic and organic mercury (methyl mercury)	101 (direct cause) 800 (contributing factor)	No clear figure
	Summary		Company malpractice led to the by-products of the chemical processes used for the manufacturing of plastics being dumped into Minamata Bay. As a consequence of approx. 32 years of pollution many diseases and strange occurrences, like cats committing suicide, within the community were observed (Trade and Environment Database).		

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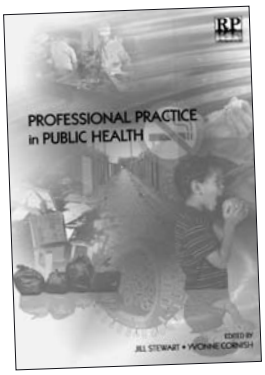
Book reviews



Professional Practice in Public Health

Edited by Jill Stewart and Yvonne Cornish

Reflect Press, 2009. ISBN 978 1 906052 20 1 (paperback). £18.50.

If you are an environmental health student or practitioner with an interest in the broader public health agenda then *Professional Practice in Public Health* will be of great assistance. The somewhat uninspiring cover and slightly misleading title, which does not hint at the heavy focus in places on environmental health practice, belies the fact that the book provides a comprehensive and contemporary overview of the public health territory in a way that should have wide appeal.

The book, edited by Jill Stewart and Yvonne Cornish from the University of Greenwich, was a collaboration of 23 contributors from a wide range of backgrounds across academia and practice. While the book is aimed primarily at Masters level students, the accessible style and chapter organisation will make it a useful reference resource for undergraduate students and practitioners alike. The book is divided into three parts and the 21 chapters are structured to be complementary to the competence framework for the UK Public Health Register.

The first part of the book provides a concise yet comprehensive overview of public health theory, policy, practice and organisational delivery. Chapter 4 on developing and implementing policy provides some useful and important insights into how issues get onto the policy agenda and why some policies get implemented while others do not. Readers will need to access a range of other key texts and policies to get a more complete understanding but the authors have sewn a huge amount of material neatly together to provide helpful context and a platform for further study.

One of the difficulties in attempting to map out the policy and organisational context of any agenda in a book such as this is that it can only provide a 'snap shot' in time. On-going programmes of change now seem to be the norm and I fear that parts of this text will date very quickly. Acknowledgement of UK regional differences in the earlier chapters, including the sections on the organisation of public health and the NHS, may have given the book a wider appeal. The examples and case studies used throughout the book are helpful in bringing the theory and practice to life and I would have liked to have seen a few more in places. I was particularly taken with the reflective exercises which were well thought through and clearly designed to stimulate thinking and maximise learning.

Part two of the book provides some context and background on policy and processes in public health. Chapter 6 neatly draws together the interconnected threads of sustainable development, environmental justice, climate change and a range of environmental protection issues. Chapter 7 then builds on this to underline the importance and relationship between these agendas and poverty, inequality and social exclusion. Chapter 8 is also of note in terms of the way it sets out a multi-causal approach to health promotion and in particular, the application of the Beattie Model of health promotion to assist with the critical evaluation of different approaches.

Part three emphasises the importance of environmental health in public health and explores the potential of environmental health practitioners (EHPs) to contribute more effectively in delivering evidence-based interventions to improve health. The early part of Chapter 18 on environmental health practice is useful to EHPs and others alike in terms of describing the role of the EHP, how current practice fits within the public health agenda and how this contribution might be developed further going forward. This is particularly important at a time when resource and regulatory reform pressures may result in unintended consequences in terms of a forced retreat into narrow, restricted regulatory roles. The latter part of the chapter focuses in some detail on education and training requirements for EHPs and on NHS and local government modernisation. This section, unlike most of the rest of the text, is likely to be of very limited to interest to non-EHPs and will date very quickly; indeed some of it

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already has. The final chapter takes the reader back to the strategic level, reminding us that public health is multi-faceted and fundamentally about improving health and reducing health inequalities. It concludes with a rallying call, which acknowledges that much has been done but warns against complacency and the need to strive harder to work with others to protect and improve the health and lives of everyone in our communities.

We need more texts like this that help to guide EHPs in this complex agenda, particularly at a time when the role at local authority level has never been under such scrutiny and where a lack of resource and competing pressures and ideologies are arguably creating something of an identity crisis for the profession. For all those with a passion for public health or an interest in learning more, *Professional Practice in Public Health* will help you get your head around this diverse and complex area and convince you that there is so much more to be done.

Professor Nigel McMahon
Chief Environmental Health Officer, Department of Health, Social Services & Public Safety, NI.

Book review recommendations

Have you found a new book that you think would be worth reviewing by JEHR? Have you produced a book that you would like to be considered for review by JEHR? If so, please contact the Editor at haroldharvey@gmx.com and haroldharvey@yahoo.com for details of the review process.

Invitation to peer reviewers

JEHR operates the double-blind peer review process. When a manuscript is received from the author(s), it is sent to specialist reviewers whose identities are not known to the author and the identity(ies) of the author(s) are not known to the reviewers – thus the 'double blind' terminology. Only the editor knows both the identity of the author(s) and those reviewing the manuscript. This is designed to assure the independence and objectivity of the review process. Wherever possible, we like to select one academic reviewer and one practitioner reviewer for each manuscript submitted.

As a result of the increasing number of submissions to JEHR, we would like to supplement our panel of reviewers in both categories. If you would like to be considered for the Peer Review Board, please send a short CV and a covering email to indicate which subjects you would feel confident about reviewing to: haroldharvey@yahoo.com and haroldharvey@gmx.com. There is a small thank-you remuneration for each review carried out.

Letters to the editor

The editors welcome letters on the content of published papers, on general matters relating to the Journal and on environmental health research issues. Please email your contributions to Prof. H Harvey, Editor in Chief, at haroldharvey@yahoo.com, haroldharvey@gmx.com or via the website www.jehr-online.org

Notes for authors

Aims and scope of the Journal

The Journal of Environmental Health Research (JEHR) is published by the Chartered Institute of Environmental Health (CIEH). The Journal publishes original research papers, technical notes, professional evaluations, review articles, workshop/conference reports and short communications covering the diverse range of topics that impact on public and environmental health.

A new category of paper introduced in 2009 is the 'first-author, first paper' which is designed to encourage new authors by providing more active and tolerant editorial support when a manuscript is submitted. Authors in this category are encouraged to inform the editors at the time of submission.

Particular emphasis is placed on applied research and reviews that facilitate the improved understanding of a particular aspect of environmental health. It is intended that the Journal will help to promote improvements in the professional practice of public and environmental health, as well as contribute to the research knowledge base.

Invitation to contributors

Contributions are invited on any of the diverse aspects of public and environmental health including occupational health and safety, environmental protection, health promotion, housing and health, noise and health, public health and epidemiology, environmental health education, food safety, environmental health management and policy, environmental health law and practice, sustainability and methodological issues arising from the design and conduct of studies.

Contributions should have the potential to improve practice through the dissemination of the results of research projects, reviews based on scholarly reflection and technical notes and professional evaluations that provide critical insights into practice issues.

Contributions are expected to be of a high standard, not only in respect of subject matter and its treatment, but also in the quality of the writing. Particular attention should be paid to clarity and conciseness of expression.

Originality

Only original manuscripts are considered for publication. Submission of a manuscript represents certification on the part of the author(s) that the manuscript submitted has not been published, nor is being considered for publication, in another similar journal. Contributions may, however, be based on a prior conference presentation. A statement confirming originality should accompany the manuscript.

Peer review

All contributions that are considered by the Editors to be within the aims and scope of the Journal are subjected to peer review by at least two reviewers. It is likely that one reviewer will have an academic research background and the other a practitioner or management background. Decisions on publication are made by the editors who are informed by the comments of the reviewers and the responses from the author(s) to the peer review reports.

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These notes are intended to guide authors in some details of presentation so that papers conform to a consistent Journal style. More details on style and paper preparation can be found by examining past papers published in JEHR, which can be accessed at www.jehr-online.org.

Authors must comply with the style requirements in every respect. For example, manuscripts that are too long, have too many headings or tables or references that do not fully conform to the Harvard protocol will be returned to the author(s). Thus authors are encouraged to study these notes and previously published papers while preparing their manuscript.

Length

- Research Papers: 3,500 to 6,000 words.
- Professional Evaluations and Technical Notes: not normally more than 4,000 words.
- Literature Reviews: up to 6,000 words, but preferably shorter.
- Workshop/Conference Reports: up to 3,000 words.
- Communications: normally up to 1,000 words.

Tables, charts and photographs

These should be kept to a minimum consistent with the concise nature of the papers published in this Journal. Each item should be numbered as follows; 1.0, 2.0, 3.0 etc. and should carry a short descriptive title.

Notes for authors

Language

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