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Chartered Institute of Environmental Health

Urban pests and their public health significance: A CIEH summary

Based on the book *Public health significance of urban pests* by Xavier Bonnefoy, Helge Kampen and Kevin Sweeney, published by the WHO Regional Office for Europe in 2008

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Foreword

During the latter half of the 20th century the CIEH became increasingly concerned about the lack of a comprehensive approach to policy creation and implementation in pest control. Its absence was wasteful of national resources and ineffective.

It set out to address this by talking to national governments and international agencies who were reluctant to address the issue without the benefits of such an approach being quantified. A comprehensive evidence base was called for to identify the costs of not having cohesive policies and legislation in place and to stimulate renewed thinking in this important area of public health.

"My good friends and professional colleagues Xavier Bonnefoy of the WHO Regional Office for Europe and Jonathan Peck of the CIEH National Pest Advisory Panel shared this concern and need for this project, which resulted in a book just released by the WHO Regional Office for Europe, *Public health significance of urban pests*, published with financial support from the CIEH Policy Board."

This summary book is taken largely from the conclusions of the WHO publication. It is not a subsitute for it. It also contains practical elements of policy and advice to assist the readers in understanding and implementing its findings.

We have done this in order to bring the concerns stressed in the WHO publication to a wider audience, segmenting the issues to ensure that pest management is taken seriously by all.

Personally and on behalf of the CIEH I am very proud to have been associated with the publication of the WHO book and in the creation of this summary as it makes a major contribution towards the furtherance of preventative public health strategies for the future.

Graham Jukes,
Chief Executive, CIEH

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About the CIEH

The Chartered Institute of Environmental Health

The Chartered Institute of Environmental Health (CIEH), a registered charity, is the professional and educational body dedicated to promoting environmental health in England, Wales and Northern Ireland. It encourages the highest possible standards in the work and training of environmental health professionals, whether they operate in the public or private sectors.

As the world changes, the CIEH responds by ensuring its members remain fit for purpose and by campaigning to raise greater awareness about environmental and public health issues.

CIEH sponsorship of the new Associate Parliamentary Group on Environmental Health in the British Parliament is a prime example of this activity.

The purpose of the group is to ensure that Members of Parliament, Peers and their advisers have access to good, sound, professional advice about current environmental health challenges and practical and specific information which will facilitate the passing of better legislation and more cohesive policy.

Preventative health is our aim

The way the world thinks about health and wellbeing is changing. Governments now agree with the CIEH's long-held position that to reduce health inequalities and enhance wellbeing, the emphasis should be on prevention rather than cure.

The CIEH believes that everybody is entitled to enjoy a healthy and satisfying life in a pleasant, peaceful and pest-free environment. Unfortunately this is not always the case. Indeed for some, life could not be more different. Our aim is to focus on the most needy.

What is environmental health?

The World Health Organization defines health as 'a state of complete physical, mental and social wellbeing, not merely the absence of disease or infirmity.'

Environmental health is concerned with all aspects of our living environment. It involves assessing, correcting and preventing the impact of environmental stressors on health. These stressors might be biological, chemical, physical, social, psycho-social. Only by having a good understanding of the living environment and how these stressors act upon it can we determine good intervention strategies.

Environmental health practitioners are key partners in local and national efforts to protect and improve health and quality of life. EHPs take a preventative approach to the causes of disease and ill health.

The environmental health contribution to public health includes:

- Improvement of housing conditions and urban regeneration
- Quality and availability of safe and nutritious food supplies and support for local food production
- Prevention of accidents and injuries in the home and at work
- Occupational health and safety
- Health protection and communicable disease control
- Control of public health and nuisance pest infestations
- Noise control
- Control of pollution, including nuisances
- Remediation of contaminated land
- Improvement of air quality

Environmental health is concerned with the health and wellbeing of individuals, the communities in which they live and the organisations for which they work.

Unfortunately, today's society has caused many of our current environmental health problems. If present and future generations are to enjoy a healthy and satisfying life, we need to identify the broad range of environmental health problems that face us and address them before they become unmanageable.

By improving the conditions in which we live and work, we can move forward with our aim of reducing the incidence of disease and enhancing wellbeing by better environmental health.

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What are the key issues?

Looking at the global picture, we continue to be concerned about the effects of climate change; the movement of goods, animals and people leading to the spread of emerging diseases and increased carbon emissions; and the possibility of a global illness, such as pandemic flu.

Climate change will bring about a shift in the pattern and ecology of pests. Most emerging diseases are zoonotic, they are transmitted from animals to humans. This increases the need for competent monitoring and management of vector control programmes. This will include better control of the sale and use of pesticides throughout Europe to ensure that pests are controlled successfully without unacceptable adverse effects on the environment, workers and consumers.

The CIEH is based in the UK but is keen to see standards rolled out internationally. We work to help support all those involved in environmental health in governments and businesses worldwide, including those in developing countries.

The National Pest Advisory Panel

The CIEH set up its National Pest Advisory Panel in 2002 to provide expert advice on all matters relevant to pest management and health. Its members come from Government agencies, local government, the pest control industry and academia.

To date, it has:

- Produced guidance notes for pest controllers in public service
- Produced the definitive guide to the control of mosquitoes in the UK
- Organised specialist seminars on mosquitoes and West Nile virus, mice and Toxoplasmosis and ticks and Lyme disease, as well as on the need for carrying out environmental assessments when using second generation anti-coagulant rodenticides
- Produced the training DVD *Pests on the menu* in 16 languages

It has provided speakers at conferences and meetings in the UK, the US, Ireland, Belgium, France, Germany, Poland, Hungary, Italy, Spain, Japan and Australia.

It is currently working with the London Olympic Development Authority to ensure that visitors to the 2012 Games will enjoy a safe, comfortable and pest-free environment.

Public health significance of urban pests

Working with the WHO European Centre for Environment and Health as a collaborating centre, the CIEH suggested and co-funded the development of the book *Public health significance of urban pests* in 2001. This summary is based on the book, by Xavier Bonnefoy, Helge Kampen and Kevin Sweeney, which was published by the WHO Regional Office for Europe in 2008.

While this summary reflects very closely the contents of the book, it includes material from the CIEH designed to aid practical implementation. It is aimed at a variety of audiences who would not necessarily consider pest control strategy in their work. In that sense it makes an important additional contribution in extending the book's readership.

'We cannot hide from the fact that poor health often results from poor environments'

(Stephen Battersby, President, Chartered Institute of Environmental Health)

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Introduction

Urban sprawl, irresponsibly discarded litter, international travel and the onset of climate change are all factors caused by human behaviour that expose us increasingly to pests and pest-related diseases.

It is the CIEH's view that in the UK and other parts of Europe some of the relevant ministries and agencies currently lack the capacity, the legal basis for action and, even more worryingly, the political will to address future urban pest management issues.

A new book from WHO Europe, *Public health significance of urban pests*, tells us that to protect public health we must improve pest and pest-related disease management at international, national and local levels, through legal action, education, institutional capacity building and research.

Public health significance of urban pests considers our main urban pests, the medical conditions they create and the resulting economic burden of disease. It proposes technical and policy options to enable governments to implement adequate surveillance and contingency plans.

This summary outlines, from a CIEH perspective, WHO policy conclusions that should be addressed by all decision-makers; from government ministers and their civil servants to householders; and from community health workers to housing developers.

Perhaps surprisingly, it shows how modern living and certain practices considered exemplary by government or ethical by 'good citizens' can encourage pests and pest-borne diseases into the urban environment.

Wall-to-wall carpets, cavity wall insulation, urban green spaces, walks in the country, affordable warmth, composting and feeding the birds can all present opportunities for pests to colonise built-up areas. These apparent contradictions represent important challenges to public health and wellbeing for government, business, academia and the public today and tomorrow.

Relics of the past?

As the book points out: 'The second half of the 20th century and the beginning of the 21st century have witnessed important changes in ecology, climate and human behaviour that favour the development of urban pests.

'Most alarmingly, urban planners are faced now with the dramatic expansion of urban sprawl, where the suburbs of our cities are growing into the natural habitats of ticks, rodents and other pests. Also, many city managers now erroneously assume that pest-borne diseases are relics that belong to the past.

'All these changes make timely a new analysis of the direct and indirect impacts of present day urban pests on health. Such an analysis should lead to the development of strategies to manage them and reduce the risk of exposure.

'To this end, WHO has invited international experts in various fields – pests, pest-related diseases and pest management – to provide evidence on which to base policies.'

Looking to the future

In his foreword to the book, Dr Roberto Bertollini, then Director of the Special Programme on Health and the Environment, WHO Regional Office for Europe, says: 'Recent developments in pest-borne diseases, such as cases of West Nile fever in the US and the spread of Lyme disease in both Europe and North America, have signalled strongly the crucial need to carefully assess the potential threat of urban pests to public and environmental health.

'Also, modern living conditions, urban sprawl and emerging changes in climate make the spread of pests and pest-borne diseases increasingly likely. The effects of these conditions and changes need to be properly monitored and understood.'

Globalisation and the spread of pests

'Moreover, the lesson learned from the outbreak of Severe acute respiratory syndrome (SARS) is that modern forms of transport enable infected travellers to move quickly from one continent to

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another, with the ability to arrive at their destination before any symptoms appear. This same speed of travel also enables pests to spread freely and quickly from area to area in trucks, boats and planes.

'These factors, together with increasing concern about pathogens undergoing mutation and changing their host species and mode of transmission, need careful scientific evaluation.'

'Urban planners are faced now with the dramatic expansion of urban sprawl, where the suburbs of our cities are growing into the natural habitats of ticks, rodents and other pests'

(From *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Expertise applied

'The book is based on contributions from international experts in the fields of pests, pest-borne diseases and pest management, invited by the WHO European Centre for Environment and Health.

'WHO is very grateful for the contributions of these experts and believes that the recommendations in the report, if implemented, will reduce the health hazards caused directly and indirectly in Europe and North America by pests and unhealthy pest control practices.'

The impact of climate change

The WHO's conclusions are based on currently available evidence but the book also recognises that the impact of climate change on landscapes, ecosystems and vector-borne diseases will be very important in the future.

The book explains: 'Climate change is particularly relevant because it is expected to alter not only the natural environment as a result of flooding or drought but also the urban environment as a result of changes in land use.'

Increasing capacity

The WHO's conclusions are designed to help national governments to understand the public health relevance of urban pests and prepare for increased technical capacity and ability for action.

The book says: 'A fundamental requirement for implementing the right and effective preventive and control measures is having adequate legal requirements in place that allow appropriate ministries and agencies to take appropriate action and that provide them with the authority to take these actions.'

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Of public health and medical importance

Institutional capacities

'WHO Regional Office for Europe member states, through co-ordinated efforts of their public health authorities, would benefit from:

- **developing the capacity needed to identify pest-related risks in the urban environment, that is, identify pests and pest-borne diseases that occur at present or have the potential to occur**
- **determining and recording the prevalence of various infections**
- **keeping track of existing reservoirs of host species and the geographical distribution of various pests and their transmission dynamics. They would also benefit from keeping an updated list of high-risk areas'**

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

Up-to-date data on the distribution of pests and pest-related diseases are generally scarce or even non-existent in the European Union. In the past, government departments and agencies dealt with pests and collected data. However, this activity has slowly but substantially been reduced or even discontinued by budget cuts.

Vital surveillance

'Governments of the European region – as well as other countries – would benefit from ensuring that surveillance agencies and suitably educated staff are available. A well-trained public health force, available and prepared for pest and pest-related disease management, is needed to protect the public from the threats to health associated with urban pests. For example, it is needed at vulnerable sites, such as ports and airports.

'Educated specialists in such disciplines as medical entomology, medical zoology, toxicology, ecotoxicology and public health management are needed to:

- **train pest managers**
- **help develop control programmes, including strategies and pesticide use**
- **reach agreements on action thresholds and defined control goals**
- **ensure that harmonious cooperation takes place between all the stakeholders involved, including government departments and agencies, local authorities, industry, consumer groups and the public**

'At both national and local levels, authorities in charge of vector-related information should be clearly identified. The role of partners, as well as mechanisms for co-ordinating partner efforts, should be defined and put in place.

'While there are European agencies that collect information on disease, there is a need for a similar organisation that would collect information on vectors, because most data collection activities in this area are carried out at a local level nationally and no co-ordination exists.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

Although there has been a pest renaissance for several years, pertinent government agencies have not been upgraded or established anew with adequate staff, equipment and funds. It is of general concern that in Europe there are neither national nor international institutions responsible for collecting vector-related information and co-ordinating pest control.

Proactive and integrated

'While establishing Integrated Pest Management programmes may prove more costly and time-intensive at its onset, the success of such programmes are well established. It is also likely that the long-term costs of using a proactive, integrated approach will be far less than those of continuing reactive non-integrated programmes that rely on chemical control.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

IPM is a common sense approach using a hierarchy of control practices including public education, sanitation, pest exclusion and other biological and mechanical control methods, while limiting pesticide

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application. This way, long-term pest management can be achieved while minimising environmental and public health hazards.

Pest problems are complex and require integrated responses. Public health practitioners should be aware that focusing on one aspect of asthma control, for example, would not necessarily result in an improvement in the prevalence of asthma at the community level.

'Although there has been a pest renaissance for several years, pertinent government agencies have not been upgraded or established anew with adequate staff, equipment and funds'

(From *Public health significance of urban pests*)

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Of planning and building importance

Urban sprawl

'By destroying the borders between urban and rural environments, urban sprawl makes urban areas more susceptible to pests and the disease agents they carry. Since many zoonotic pathogens – pathogens that can be transmitted to people from animals – are more likely to be transmitted between vectors and their reservoir hosts in rural environments, the risk of infection increases as rural amenities, such as woodland and recreational areas, are promoted. This increase in the risk of infection is due to the likelihood of inhabitants of inner-city areas coming into contact with such disease-bearing pests as ticks and rodents.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

The development of cities and towns has dramatically changed our lifestyle, especially our increased reliance on motorised transport. As inner city areas became crowded, degraded and in some cases unsafe urban sprawl began, with more affluent residents moving to new, greener suburban areas. This has changed the economic and health balance in the community.

Considering risk

'City planners and developers often seek to integrate, visually and ecologically, construction projects, such as housing developments and recreational areas, with their natural surroundings; however, they often do so without considering the risk of increased pest infestation.

'This risk could be reduced by regulations about city planning, landscaping, design of recreational areas, taking into account the risks of pest infestation and disease transmission and construction regulations ensuring that new buildings are pest-proofed and do not create conditions conducive to pest infestation.

'The main purpose of this report is to identify approaches to urban pest prevention and control that beneficially reduce the impact of these pests on public health. Passive control through improved design and construction of our cities and our housing stock is certainly the most sustainable approach.

(Excerpts from *Public health significance of urban pests*, WHO Regional Office for Europe)

When pests lack the conditions they need to breed, such as food, drink, warmth and safe harbourages, they simply cannot survive. This very basic approach is valid for all pests.

Unfortunately, suitable conditions often exist where we live, work and play, which means that pests usually can coexist perfectly in our environment and that passive measures have to be very specific to control either their presence or development.

Our increasing desire to change the environment will bring new risks from pests and the diseases with which they are associated.

An example of this is the rise in tick-borne diseases. As cities expand and more houses are built on their wooded outskirts, people will be more exposed to tick-borne diseases, such as Lyme disease and tick-borne encephalitis. These severely disabling diseases have been able to spread over the past 30 years, in part because of our new lifestyles, despite the management techniques now available to control urban pests.

Building design

Changes in building design aimed at meeting modern lifestyle and legal requirements can provide conditions more conducive to pest infestations. One example of this is the effect of humidity on house dust mites:

'Public funding for reducing the number of dwellings with raised humidity levels due to low maintenance standards or to designer construction faults should be continued. More stringent building codes that minimise dampness rising in ground floors and basements should be considered.

'Throughout the building industry (from legislative controls to design and construction), more emphasis should be placed on the means of providing adequate ventilation through suitable technology and improved window design. For new and refurbished dwellings, thermal comfort and airtightness must not be achieved at the expense of adequate ventilation.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

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Simple maintenance failures, such as broken roof tiles, damaged water pipes and overflowing cisterns, together with common mistakes in design or construction, such as excessive use of impermeable membranes, can lead to excessive moisture in buildings.

Studies have found that relative humidity and HDM proliferation are higher in dwellings where the ground floor consists of a concrete slab in direct contact with the ground. If the floor covering is absorbent – a carpet, for example – it can act as a reservoir, leading to long-term dampness.

New homes have generally become more airtight, and with rising fuel prices, householders have become more energy conscious. At the same time occupants rely more on heating.

The combination of more airtight dwellings and lower ventilation standards are often suggested as principal reasons for the rise in the prevalence of asthma in cold winter countries.

Older dwellings tend to be much less airtight but because of less tolerance of draughts, older housing is being gradually converted to suit modern lifestyles.

Ventilation helps create conditions that kill mites in cold winters and reduces exposure to mite allergens and other indoor airborne pollutants. Although the health benefits of insulation are similarly obvious, its effect on mite populations is not so clear-cut. Modelling studies suggest that the favourable effect on mite growth of rising room temperatures tends to be outweighed by the unfavourable effect of the fall in relative humidity.

This means that modifying the home environment without sacrificing affordable warmth can potentially control mite populations. The key is adequate ventilation. Studies have shown that ventilation heat loss can be relatively modest, so adequate ventilation is not necessarily incompatible with energy efficiency.

'The main purpose of this report is to identify approaches to urban pest prevention and control that beneficially reduce the impact of these pests on public health'

(From *Public health significance of urban pests*)

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Of domestic and citizenship importance

Public awareness

'Information should be developed for the public, to raise its awareness of how to protect itself through simple sanitary and behavioural measures. Such information should also familiarise them with how to best store and use pesticides.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

Public information and education are fundamental to efficient, successful pest management. Most people are unaware how their behaviour and their homes can attract pests and allow them to thrive.

Many are largely unaware that pests may carry pathogens and that simple personal measures can be taken to avoid contact with pests. The public is also largely unaware of how to handle pesticides and use them responsibly in the environment.

Public information is not only a basic need but also economically sound. Successful treatments contribute considerably to preventing infestations and illness.

Pesticide applications

'Indoor applications of pesticides, which are regulated by a complex risk assessment before and after they are put on the market, do not pose a high level of risk to human health if the application of the product and the management of the application take place according to proper and adequate procedures. This adherence to proper procedures, together with recent efforts to produce pesticides with a lower overall toxicity, is able to reasonably assure the absence of any unacceptable risk to human health and the environment.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

The citizen's guide

Pest problems are everyone's responsibility. Building on the conclusions of Public health significance of urban pests, the CIEH has created this citizen's guide to preventing pest problems. It is not exhaustive, but following its advice will help achieve a pest-free environment:

Preventative measures in the home

Deny insects cracks and crevices in which to breed and hide. By ensuring homes are maintained properly, homeowners and occupants can minimise harbourages for pests like cockroaches, rodents, bedbugs and flies.

Keeping the house clean and tidy is an important way of denying pests food and places to hide and breed. Vacuuming and dusting reduces house dust mites and their allergens. Pests including rodents and cockroaches like clutter and removing it can help prevent infestations.

Correct storage of rubbish in closed bags or containers, particularly when waiting for collection, is essential in preventing rat and fly problems. Particular care should be taken with food waste.

Well-insulated, energy-efficient homes are desirable, but not at the expense of adequate ventilation. House dust mites, an important source of asthma allergens, thrive in humid conditions. Ventilating homes properly during cold winters can help control them.

Wall-to-wall carpets and soft furnishings can encourage house dust mites and fleas. Wood, tile and laminate flooring and leather and vinyl furniture can be easier to clean.

Preventative measures in the garden

Composting should be encouraged, but at temperatures below 50°C flies can use compost to develop. Biological control could help deal with fly problems in compost.

Rats find compost heaps ideal places to live and breed. Make sure your compost is on a hard surface to stop rats burrowing under it, stick to composting green waste, that is no food waste, and cover your compost securely to deter flies and rodents.

Water butts, ponds and water features may provide breeding sites for flying insects, such as midges and mosquitoes, especially when stagnant. Keep water levels high and replace water regularly if it looks polluted. Pools with developed ecosystems are unlikely to support midge and mosquito breeding, as larger carnivores like fish and newts prey on their larvae.

Turn over wheelbarrows, buckets, dustbin lids and other containers that harbour rainwater. Keep gutters and flat roofs clear from dead leaves, which can trap water.

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Don't keep rubbish and waste, particularly used tyres, lying around.

Use a proper bird feeder and don't throw bread or food waste on to lawns or bird tables. Bird feeding by well-meaning members of the public is a common cause of rat and pest bird infestations.

Encouraging hedgehogs and other small mammals into gardens can be part of a chemical-free garden pest control strategy but may also bring infected ticks nearer to homes. These ticks may then be transferred on to pets and domestic animals. Check pets and domestic animals regularly for ticks.

Good neighbours

When pests like mice, cockroaches and bedbugs infest a block of homes, the problem is extremely difficult to control without co-operation from every householder affected. It is important that householders allow access to their property, contribute to sanitation efforts and communicate with landlords, councils and pest controllers about new and recurring pest problems.

Pesticide applications

Most treatments involve the use of some form of pesticide. Where this is the case, the following measures are recommended:

- Read the label and follow directions. It is illegal to use any pesticide unless it is approved for that use. It is illegal to use a pesticide in a manner inconsistent with the approval. Always read the label carefully and follow the directions for use
- Professional-only pesticides should only be sold to professionals. Don't buy or apply a pesticide unless you are competent and eligible to use it
- Using concentrates requires a level of understanding appropriate to that particular product and their mixing should always be carried out in properly ventilated areas
- Pesticides can adversely affect non-target species. Always ensure reasonable steps are taken to reduce such risks
- Young children should not be allowed to move freely shortly after applying certain pesticides
- If using a pest control company, ensure it is fully qualified
- Don't store unwanted pesticides in the home and dispose of empty containers safely
- If in doubt contact the manufacturer or distributor for advice

'The whole community should address rodent problems, which should be seen as a symptom of a vulnerable and more often than not degraded urban environment'

(From *Public health significance of urban pests*)

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Of importance to governments

Confused responsibilities

'A single government department should have the ultimate responsibility for supervising monitoring programmes and implementing pest management measures; this should be accompanied by the political will to implement programmes and measures.

'With regard to pest management, adequate regulations should make clear the liabilities of contractors, building managers, homeowners, apartment occupants and local authorities.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

Because pest management involves health, housing, work and the environment, it is often difficult to decide which government department or agency should be responsible for it. At local government level, it is often unclear who is responsible for pest prevention, surveillance and control.

Notification

'At the international level, there should be an agreement on expanded and standardised notification requirements for pest-borne diseases, as well as other adequate mechanisms to collect and analyse data centrally and to make biological and epidemiological data publicly available. Early notification, a clear requirement for developing adequate public health policies, should enable member states to be properly informed.'

'Because of differences among European Union member states, the notification system in Europe is inconsistent. For example Lyme disease, the most frequent arthropod-borne disease in Europe, is reportable in some EU member states but not in others.'

(Excerpts from *Public health significance of urban pests*, WHO Regional Office for Europe)

It is therefore extremely difficult to collate reliable data. Also, where diseases are reportable, notification rules often differ from country to country, making it impossible to compare data. Finally, data are generally unavailable to the public, are not presented in easily accessible databases or are not offered in a user-friendly form.

Changing times, changing needs

By the 19th century, the major threats to community health were recognised as coming from poor housing, poor management of sewage and drainage, foul air in industrialised towns, unsafe drinking water and inadequate control of pests. Early environmental health practitioners fought to remedy these defects and spurred the founding of the environmental health movement.

In the 20th century, engineering and construction techniques went a long way towards removing the problems of air pollution, sewage, drainage and poor water quality in cities and towns.

At the same time, the development of pesticides that benefited public health made the control of pests much easier in increasingly urbanised areas. Subsequently, the new science of hazard or risk analysis filtered out a number of environmentally unacceptable products.

Following major advances in medical research, antibiotics can now control most pest-borne diseases, while improved sanitation practices and immunisation programmes have further reduced the adverse effects of infestation.

Moving forward

Since 1989, ministers responsible for health and the environment have met every five years to discuss the major environmental factors that adversely affect public health.

In June 2004, at the Fourth Ministerial Conference on Environment and Health in Budapest, Hungary, ministers of health and environment adopted a declaration affirming that ministers have:

- recognised the importance of properly assessing the economic impacts of environmental degradation – in particular, the direct and indirect costs of diseases related to the environment
- recognised that housing, lifestyles,

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social conditions and the immediate environment of homes should all be considered when developing healthy and sustainable housing policies
- recognised that preventing ill health and injury is infinitely more desirable and cost effective than trying to address the diseases
- noted that large quantities of chemicals, currently produced and marketed with largely unknown effects on human health and the environment, constitute a potential risk to the people working with them, as well as to the general public
- recognised that delay in addressing a suspected health threat can have public health consequences.

Based on these premises, ministers have:

- recommended that the WHO Centre for Environment and Health should continue to provide member states with evidence to support policy-making in environment and health
- called for initiatives and programmes aimed at providing national and local authorities all over Europe with guidance on integrating health and environmental concerns into housing policies
- committed themselves to contributing to developing and strengthening housing policies that address the specific needs of the poor and the disadvantaged, especially with regard to children.

'Because pest management involves health, housing, work and the environment, it is often difficult to decide which government department or agency should be responsible for it'

(From *Public health significance of urban pests*)

The WHO book has been prepared so that ministers responsible for public health and the environment can better fulfil these commitments in an area of growing concern – possible threats to public health from urban pests and attempts to control them.

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Of regulatory and product stewardship importance

The rising cost of approvals

'The prohibitive costs associated with obtaining pesticide approvals should be reconsidered and, when possible, lessened. This will allow for the competitive possibility of registering more efficient and cheaper pesticides and pesticides that fulfil treatment niches. Approval fees should not be inflated to cover unrelated needs.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

In addition to international differences in requirements for approval of pesticides, the complexity and cost of pesticide approvals are rising continually. This prevents many companies from putting products on the market that could be more efficient and cheaper than existing ones and results in acceptable products of minor use being withdrawn from the market.

It is likely that future choices of the best available pesticide for a particular application will be severely reduced by the economics of the approvals process. Competition in the pesticides market will be skewed towards large international companies able to afford approvals.

As a result, the range of pesticides available will decrease, reducing the options for treatment, and treatments of pests that are of minor or new importance will not be carried out because it will be unprofitable to develop or obtain approval for pesticides for their control.

Pesticide applications

'Although regulations that cover the sale and use of pesticides exist throughout Europe and North America, a stricter differentiation between professional and amateur products should be established and enforced.

'Through scientifically based risk assessments and proper approval processes, pesticide applications and the pesticides used should not pose an unacceptable risk to consumers, operators or the environment. Proper risk assessments should be required and carried out before pesticides are put on the market.

'Hazardous pesticides should not be sold to consumers. Only WHO Category IV or equivalent category products formulated as ready-to-use products should be sold for consumer use.

'Sales of pesticide concentrates to consumers should be forbidden.'

(Excerpts from *Public health significance of urban pests*, WHO Regional Office for Europe)

Potent pesticide products are often available to and misused by private individuals due to a lack of knowledge or expertise. In this case, pesticides may be applied when unnecessary, in wrong formulations, at wrong concentrations and in wrong amounts. Even if used correctly, pesticides still hold a risk for both human and environmental health. They therefore require a technical risk-benefit analysis before being applied.

The way forward

Good pest control cannot be achieved through the sole use of chemicals. Integrated Pest Management is the key concept that supports sustainable pest management practices and should be enshrined in national regulations that deal with pest control.

IPM fosters the integration of various pest control methods so as to minimise reliance on individual environmentally damaging approaches and provide sustained management of pest populations.

IPM was developed for agriculture, where decisions are based on cost-benefit analyses. For vector-borne diseases, decisions are more appropriately based on cost-effectiveness or cost-efficiency analyses, so as to prevent the greatest number of possible human cases of disease at a given cost.

Many pests can only be effectively managed by combining as many different strategies, techniques and products as possible. This makes them ideal candidates for IPM, which includes inspection, identification, establishment of threshold levels, incorporation of two or more control measures and monitoring the effectiveness of controls.

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Of academic and research importance

Current research

'Governments, public health programmes and the general public would benefit from encouraging, supporting and promoting pest-related scientific research. This would lead to refined knowledge of the biology, ecology and behaviour of pests and of the epidemiology of pest-borne diseases, which is urgently needed, as are more efficient and specific tools and active ingredients for pest surveillance and control.'

(Excerpt from *Public health significance of urban pests*, WHO Regional Office for Europe)

While the biology and behaviour of urban pests has been well studied, the causes of the diseases they transmit, particularly in the case of newly emerging diseases, are poorly understood. Though the need for understanding exists, scientists specialised in medical zoology and medical entomology are becoming rare, as governments and universities progressively shift their limited financial resources to other fields.

Because of this shift in resources, not only is research in these disciplines being neglected, but the knowledge that underpins it is also disappearing, slowly and irreversibly. Moreover, public health professionals and physicians are often overly strained when confronted with pests and emerging pest-borne diseases.

The same is true of pest surveillance and pest control. Private pest management companies are becoming less and less (if at all) involved in research and development, and the pest management industry generally concentrates on products for which there are ready markets.

Future research needs

'How regulators will decide to interpret the results of probabilistic assessments is still open. These models demand the regulator to set the level of desired conservatism and in some cases determine the extent of protection of the population at risk.

'To our knowledge, no study has compared the risk of disease from exposure to urban pests with the risk of pesticide exposure. These risk-risk and risk-benefit analyses would benefit greatly from more studies on urban pest and pesticide exposure to human beings.

'To date, standardised testing in animal models has not been effective in predicting human responses to pesticide exposure that cause allergenic or neuropathic effects. Furthermore, the development of animal and computer models to detect and understand possible, if any, relationships between pesticide exposures and endocrine disruption is still in its infancy. Another area of uncertainty concerns the interaction of pesticides with inert ingredients in formulations. Currently these effects are quantified for acute exposures, but toxicity evaluations continue on inert ingredients.

'More research on pesticide use in residential settings should be conducted, and this research should better quantify environmental concentrations of pesticides in residential environments, to increase the level of certainty associated with residual pesticide exposure assessment and risk characterisation.'

(Excerpts from *Public health significance of urban pests*, WHO Regional Office for Europe)

Models have been designed to estimate human exposure to pesticides used in pest control activities. The science in this field is developing quickly.

One of the reasons for developing statistical models and replacing deterministic models with probabilistic models is the recognition that deterministic models, by nature, tend to be overly conservative. In fact, they tend to introduce several conservative assumptions in a serial way, and the resulting so-called point estimate reflects worst-case scenarios so extreme as to become clearly unrealistic.

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Asthma and allergies

'Asthma is a major urban disease and a substantial burden on both the quality of life for sufferers and the economics of health care. The global increase in the prevalence of asthma in the last 50 years has disproportionately affected urban communities in many countries.

'The evidence that relates asthma and domestic exposure to cockroaches, mice, and dust mites is clear. These pests are common in urban environments and play a significant role in the pathogenesis of urban asthma.

'Removing these pests is a logical tactic for preventing disease and reducing symptoms, but improved efficacy is needed. Studies suggest cautious expectations about the ease with which long-term clinically relevant allergen reductions can be accomplished. However, the burden of asthma in urban communities may be effectively reduced through more broadly defined interventions tailored to an individual's specific allergy, education about effective methods for sustained integrated pest management and general education.'

(Excerpt from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

In industrialised countries, asthma has emerged as one of the most common chronic diseases of childhood. Prevalence varies from less than one percent in rural Africa to 40 percent in some cities in the US and suburban Australia.

While mortality from asthma is low, the daily burden for sufferers is substantial and the economic cost to society high. As more countries develop urban centres and adopt western lifestyles and residential building methods, the importance of understanding the effect of these changes on urban pests and health will increase.

New sensitisations

Allergic sensitisation mainly occurs during the early years of life through the teenage years; however, adult exposure to new allergens can lead to the development of new sensitisations.

The prevalence of childhood asthma in an urban population could range from eight percent to 22 percent and that the prevalence of allergy among asthmatic children varies by community between 50 and 80 percent. Therefore, exposure to urban pets could affect between four and 17 percent of children living in urban areas.

A global epidemic

The global epidemic of asthma has been well-documented and appears to parallel changes in industrialised countries. The central question is, what has changed as a result of industrialisation to cause an increase in asthma?

Air pollution is known to be associated with exacerbation of asthma symptoms. Increased ozone has been associated with decreased lung function and exposure to diesel exhaust particulates is associated with increased allergic inflammation. However, the rising prevalence of asthma has not necessarily occurred in parallel with increased outdoor air pollution. Studies show an association between air pollution and bronchitis, but not asthma.

Changes in building practices have resulted in houses with less natural ventilation. This has led to an increase in indoor air humidity and a more stable climate for supporting dust mite growth. Increased use of carpets has also contributed to the increase in dust mites.

The hygiene hypothesis proposes that a cleaner home, with less exposure to viruses and bacteria, has led to a shift in the immune response to the more allergic T-helper cell 2. Decreased exposure to bacteria is thought to contribute to the increased prevalence of asthma. Although recent studies are compelling, the relevance of this hypothesis to the asthma epidemic is still not established scientifically.

Exposure to ozone and tobacco smoke in the home is associated with exacerbating asthma, as is psychosocial stress. There also may be dietary and physical activity components. Sedentary entertainment could affect both lack of exercise and longer exposure to indoor allergens.

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Allergens in the home

Exposure to an allergen is essential for the development of allergic asthma. However, the quantity of allergen necessary for sensitisation appears to depend on the allergen in question, concurrent exposure to other substances that stimulate the immune system, such as adjuvants (pharmacological or immunological agents that modify the effect of other agents) and the genetic predisposition of the individual.

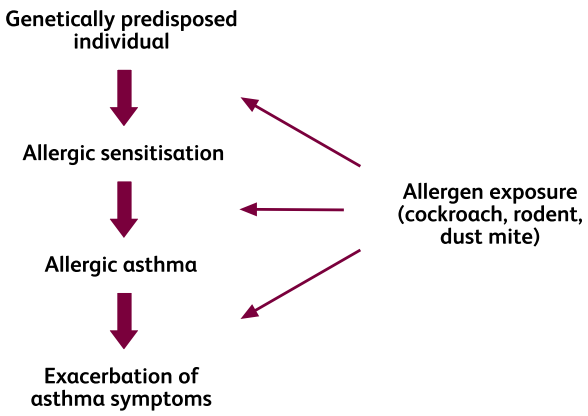
The level of allergens in homes necessary for allergic sensitisation is probably less than is necessary for precipitating asthma symptoms. For example, it is thought that sensitisation to dust mite allergens occurs at one-fifth the exposure threshold that precipitates asthma symptoms.

A US study found that for every dollar spent on asthma management, decreased visits to emergency departments resulted in a $3-4 saving. The long-term economic and quality-of-life benefits of decreasing missed school/work days are difficult to assess, but surely positive.

'A primary risk factor for developing asthma is allergic sensitisation'

(From *Public health significance of urban pests*)

Understanding allergic asthma – the atopic march



A primary risk factor for developing asthma is allergic sensitisation. Recent studies show a clear relationship between exposure to allergens from pests and an increased risk of allergic sensitisation and severe asthma.

'The atopic march' describes the process whereby an individual genetically predisposed to allergy is exposed to an antigen, becomes sensitised and develops an allergic disease.

A child with one atopic parent is twice as likely as a child with non-atopic parents to develop atopy. A child with two atopic parents is four times as likely. As with allergic sensitisation, a family history of asthma also contributes to the risk of becoming asthmatic.

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In the UK 39 percent of children and 30 percent of adults have been diagnosed with one or more allergies. The direct National Health Service cost for managing them is estimated at over £1 billion annually. For the US, the direct annual cost of asthma was estimated to be $9.4 billion and the indirect cost was estimated at $4.6 billion.

One study found that 77 percent of mild or moderate asthmatics aged 4-9 years were sensitised to at least one of the allergens tested, including a high prevalence of sensitisation to cockroach and mouse allergens. A similar study found that 80 percent of mild or moderate asthmatic children had a positive allergy skin test to at least one allergen, primarily from cockroaches and dust mites.

Recently a study found that about 15 percent of children as young as two years old were sensitised to mice, cockroaches or house dust mites.

House dust mites and asthma

House dust mites do not bite or transmit disease to people, nor are they a sign of poor hygiene. However, their faeces contains potent allergens known to trigger and possibly cause allergic disease such as perennial rhinitis, eczema and, most importantly, asthma.

The allergens HDMs produce are probably the most important allergens associated with asthma worldwide and are extremely persistent in the environment. Although the HDM has not historically been considered an urban pest, the increasing prevalence of these diseases justifies its consideration in this context.

Evidence that HDM allergens cause asthma is stronger than for any other inhaled allergen. Research has found children exposed to high levels of dust mite allergens at home during their first year were more likely to develop sensitisation and that those exposed to the highest levels were most likely to develop asthma.

Exposure to dust mite allergens most likely occurs in close contact with the reservoirs; allergen is probably inhaled when a person's head is close to bedding or when children are playing on carpets. Vacuum cleaning can also increase exposure. Generally, factors that lead to large dust mite populations will lead to high concentrations of allergen.

In homes, a resident or trained inspector can make visual assessment for cockroaches and mice, but not for microscopic dust mites. Although residents might report cockroaches or rodents in their homes inaccurately for a variety of reasons, studies suggest that residents are better informed than trained inspectors with regard to present and previous infestations.

'One study found that 77 percent of mild or moderate asthmatics aged 4-9 years were sensitised to at least one of the allergens tested, including a high prevalence of sensitisation to cockroach and mouse allergens'

(From *Public health significance of urban pests*)

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Cockroaches and asthma

Cockroaches typically rank as one of the most common and objectionable insect pests, especially in low-income housing. In a London study, more than 80 percent of residents from uninfested apartments felt cockroach infestations were worse than poor security, dampness, poor heating and poor repair. Only infestations of mice were considered worse. Only two percent of the respondents mentioned asthma or allergies as a potential health concern associated with cockroaches.

In recent years, studies have demonstrated the important role of cockroach faeces in human allergies and asthma. Cockroach allergen exposure, sensitisation and asthma are most strongly associated with bedrooms, where residents spend prolonged periods of time. Cockroach allergens can be extremely persistent in the environment. Studies have shown that cockroach allergen was still detectable in kitchen and bed dust samples, even though no cockroaches were detected.

Studies of inner-city asthmatic children in the US found that those who were sensitised to cockroaches and exposed to higher levels of cockroach allergen had more frequent asthma symptoms and hospital admissions than other asthmatic children. Evidence suggests that exposure and sensitisation to cockroach allergens is a stronger risk factor for asthma morbidity than to allergens produced by dust mites, cats or dogs.

Rodents and asthma

In the 1970s, five people working with laboratory animals developed asthma within two weeks to two years of starting work with mice and rats. Within a year of developing asthma, all experienced asthma symptoms after only a few minutes of exposure to the animals.

Research has found mouse and rat allergens might contribute to development and exacerbation of childhood allergic asthma. Sixty-one percent of inner-city children exposed to detectable levels of mouse allergen were skin prick positive.

A study of 499 children with asthma found 18 percent were allergic to mouse allergen. Allergy to rats was also prevalent (21 percent) amongst those tested, and those with sensitisation and exposure to rat allergens experienced more unscheduled medical visits, hospitalisations and days with diminished activity due to asthma.

Research suggests that even low levels of mouse allergen can pose a risk of developing allergic sensitisation. Unlike mouse allergens, rat allergens in house dust have not been positively associated with sensitisation. This could be because significant exposure might occur outside the home. Although this could be said for mouse allergen, it appears that significant exposure does arise from homes.

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House dust mites

Many householders can control house dust mite populations with simple behaviour changes. Public health campaigns should inform them how they can influence humidity levels in the home in order to harness natural seasonal culling of mites. Advice to allergic individuals should emphasise allergen-avoidance methods – for example, stringent cleaning and use of barrier covers.

Cleaning should be encouraged, especially in late autumn and spring. Fitted carpets should be discouraged, particularly in children's bedrooms, on solid ground floors and in basements.

More doctors should be able to conduct tests to identify patients whose asthma is caused or triggered by HDM or other allergens. Advice should be available from medical practitioners on allergen avoidance, control of HDMs and modification of the environment to prevent infestations.

More research is needed into individual control methods and the relationship between levels of airborne allergens and asthma. As with many pesticides, further work may need to be done to establish the long-term effects on human health of using pesticides to control HDMs.

(Summarised from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Less than a millimetre in size, house dust mites are found worldwide, primarily in human dwellings. The major component of their diet is scales from human skin, which is in plentiful supply in mattresses, bedding, carpets and upholstered furniture.

The trend towards warmer, drier, cleaner homes means there are now few other survivors in house dust apart from HDMs, which enjoy an assured source of food without hindrance from competitors or predators.

Mites are dependent on temperature and need high levels of relative humidity to survive.

Natural seasonal culling

Homes are more likely to be mite-positive in humid areas and less likely in areas with cold winters, where homes are heated. This is because, during winter, warm moist air from inside is continually exchanged with cooler air that contains less moisture. When this cooler, dryer air is heated, relative humidity inside falls. Once relative humidity falls below about 50 per cent, HDM populations start to dwindle.

Although a few mites may survive to take advantage of the favourable conditions of summer, if winter and spring are dry enough too few of them will survive to cause medical problems.

In regions with mild or warm winters seasonal culling is more likely to occur inland than by the coast, due to the additional moisture in sea air. It is most difficult to achieve in humid tropical and subtropical regions, which helps explain high mite concentrations and asthma prevalence in such cities as Sydney, Singapore and Caracas.

Scientists have suggested that exploiting natural seasonal culling might lead to permanent reductions in mite populations and even eradication. It has potential as a curative measure, for alleviating symptoms, and as a preventive measure, before sensitisation occurs.

Harnessing nature

Conditions unfavourable to mites can often be created inexpensively and without recourse to acaricides (agents that kill ticks and mites), by relatively minor adjustments to heating, ventilation or behaviour.

In regions with cold or dry winters, public health campaigns should make householders more aware that heating and ventilation can suppress HDM populations. Special training should be given to health professionals that make home visits to provide advice about how to environmentally control HDMs, as well as other mite control measures.

It is vital that insulation standards are improved in conjunction with measures that enable and encourage householders to achieve good ventilation. Some windows do not allow sufficient flexibility or range of opening positions. Trickle vents, such as those in window frames, can improve the situation.

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The spread of moisture vapour can be restricted by keeping kitchen and bathroom doors closed and by drying clothes only in rooms that can be closed and well ventilated, if not outside or in a tumble drier.

The impact of poverty

Indoor relative humidity tends to be high in low-income households due to a low level of ventilation being maintained to preserve heat, but indoor temperatures tend to be low. If they are low enough for long enough, this is likely to prevent mites from proliferating, regardless of humidity. With wider access to affordable warmth, indoor temperatures in low-income housing can be expected to rise. Unless moisture production is curtailed simultaneously, near ideal conditions for mite proliferation could be created.

Integrated Pest Management

The public carry out the majority of HDM control measures. It is therefore essential that they know how to integrate the available control methods to best effect.

Although rigorous household cleaning, with the exception of steam cleaning, will not eliminate or significantly reduce HDM populations, it will remove allergens. Cleaning also reduces the amount of food available to HDMs, potentially reducing the size of future populations.

Dusting, particularly damp dusting, and regular vacuuming both reduce the quantity of dust and therefore allergens. Vacuuming can also decrease the number of mites present. The concentration of airborne allergens has been found to increase significantly after using a standard vacuum cleaner. This can be minimised by fitting vacuum cleaners with high efficiency filters.

HDM allergens are extremely soluble in water. Washing bedding and clothing at 55°C kills all mites. Washing at 50°C kills only half of them. At low temperatures, it is possible to add products to the wash to kill the mites.

Carpet cleaning and autoclaving can effectively kill mites and remove allergens, but autoclaving is practical in hospitals, not homes.

Exposing carpets to direct sunlight kills all mites within three hours. Freezing using liquid nitrogen or a freezer can also kill mites. These techniques do not remove allergens and should be combined with washing and/or vacuuming.

Electric blankets, bed heaters, barrier fabrics, high efficiency particulate air filters, anti-allergy sprays and dehumidifiers are other IPM options.

Habitat modifcation

Fitted carpets, together with increased indoor temperatures and decreased ventilation, are among the changes that have increased the prevalence and severity of asthma. Carpets tend to be cooler and damper than the rest of the room, particularly where laid directly on to a concrete and screed ground floor.

When properly fitted, hard flooring such as wood, tile and laminate can reduce the number of HDMs. Hard floors are more readily cleaned than soft floors, but because dust may become easily airborne it is essential that they be cleaned regularly.

Leather and vinyl furniture is less likely to be colonised by HDMs than conventional soft furnishing and can also be cleaned more easily.

Pesticides

While biological control options are limited, acaricides are extrememly effective in killing mites, although they generally have little effect on allergens. In Europe and elsewhere, there is a shift away from the use of insecticides, particularly in homes. Many other control methods can be used instead. If acaricides are used, it is essential to minimise direct contact with people during and after treatment.

'In regions with cold or dry winters, public health campaigns should make householders more aware that heating and ventilation can suppress HDM populations'

(From *Public health significance of urban pests*)

Recently, there has been a revived interest in the use of fungicides to control HDMs. Antimicrobial treatments are thought to retard HDM growth by preventing fungal development on skin scales, thus reducing the nutritional value of their food.

The knowledge gap

The association between HDM allergens and disease has prompted considerable research over the past several decades. Much is now known about HDMs, but there is still much to learn, including how temperature and humidity affect HDM life processes. The need for continuing research is urgent.

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Cockroaches

'Cockroaches are one of the most significant and objectionable pests found in apartments, homes, food-handling establishments, hospitals and health care facilities worldwide. Indoor species, especially the German cockroach, exploit conditions associated with high-density human populations and impoverished living conditions.

'Poor sanitation, disrepair and clutter contribute to large populations of cockroaches. In these situations, their medical importance requires the implementation of aggressive Integrated Pest Management programmes. To minimise the likelihood of insecticide resistance in cockroach populations and human exposure to insecticides, strategies that include baiting and built-in pest control should be adopted.

'Cockroach species that are found outdoors require IPM programmes that focus on altering and removing suitable habitats and that use baits and possibly even biological control options.'

(Excerpt from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Of the 3,500-4,000 species of cockroaches, only about 50 have been reported as pests of human structures and dwellings worldwide. All of the major domestic pest species in North America and Europe have relied on human activities, commerce and the urban environment to spread throughout the world.

In addition to the direct health problems associated with cockroaches, improper applications of insecticides and a heavy reliance on aerosols and liquid sprays may create potential human exposure problems, especially by untrained people in the home and in sensitive areas such as schools and health care facilities.

Even though numerous studies have demonstrated the ability of cockroaches to pick up and later excrete or transfer pathogens including *Salmonella*, *Campylobacter* and *Listeria*, definitive evidence that cockroaches are vectors for human disease is still lacking. However, the prevalence of cockroaches near human and animal wastes, human food and human environments creates sufficient concern about their role as vectors.

The cost of the problem

Children allergic to cockroach allergen and exposed to high levels had a 3.4 times higher rate of hospitalisation for asthma than other asthmatic children. This group also had 78 percent more unscheduled visits to health care providers because of asthma and missed significantly more days of school than other children.

In 2006 the cost of treating a cockroach-infested apartment in the US was about $150, buildings typically cost $1,200 or more and commercial premises such as restaurants typically cost $250 a month.

The impact of poverty

Physical and sanitary conditions greatly affect the likelihood of cockroach infestation. In New York City, the frequency of cockroach sightings and allergens is related directly to housing problems and disrepair including holes in ceilings or walls, peeling paint, water damage, leaking pipes and lack of gas or electricity.

In a study of asthmatics from Connecticut and Massachusetts, poverty and minority status were associated with a high likelihood of cockroach allergens in house dust. Elevated cockroach allergen levels increased as the number of families living together increased.

Inner-city children are exposed to heavy applications of regulated pesticides. The use of illegal pesticides such as aldicarb, Chinese chalk and methyl parathion is another problem encountered in impoverished neighbourhoods.

'Built-in' control

Hollow wall voids, drop ceilings and voids under cabinets, attics and built-in appliances provide suitable harbourage for cockroaches. Elimination of these harbourages is the primary goal of so-called built-in pest control or insect proofing.

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One important advantage of built-in treatments is that dusts are applied in areas not readily accessible to people and pets. Repellent dusts such as silica aerogel are typically applied at the time of construction to prevent cockroaches from establishing themselves. Non-repellent dusts such as boric acid are applied to existing infestations.

Integrated Pest Management

IPM programmes must be economically and aesthetically acceptable and must address the specific attitudes of the target audience.

Research indicates that baiting consistently provided excellent reductions and combination treatments that targeted different habitats were especially effective.

The development of baits has revolutionised cockroach control. A common misconception is that the use of baits alone is IPM. Nothing could be farther from the truth. Effective IPM involves a systematic approach and process.

Indoors, baiting and other less pervasive methods have largely replaced the use of spot, baseboard and surface sprays. Nevertheless, perimeter and spot treatments have a place in IPM.

The incorporation of natural predators has been a long-term goal of IPM. Biological control is especially attractive in sensitive situations such as animal rearing facilities, zoos, sewers, and greenhouses.

Working together

IPM programmes must be designed for the pest species and each situation. No two programmes will be identical.

It is essential to identify the pest species and locations where indoor and outdoor infestations are breeding or gaining access to structures. The use of commercial traps is an important first step in determining the extent and severity of the problem. Traps have never been shown to be effective in controlling cockroaches, but can provide information upon which to base treatments and evaluate success.

A community action plan is necessary, so that tenants, landlords and proprietors actively participate in the IPM programme. Tenants' assistance in removing clutter, food and water sources and permitting access to their flats is essential. Landlords or caretakers have responsibility for maintaining and repairing the structure and surrounding property.

In treating large blocks of flats or entire buildings, failure to treat all units will leave potential refuges for reinfestation. Unsuccessful results are discouraging and encourage future noncompliance by tenants and landlords.

Control strategies should involve built-in pest control, elimination of potential pest harbourages such as clutter, cracks, crevices and voids and prevention of cockroach movement across common pipes and conduits. Application of non-repellent dusts to voids should be repeated when flats are refurbished between occupancies.

Cleaning and sanitation can be important in removing harbourage sites and sources of food and water. This is especially important in multi-family dwellings, where cockroaches can rapidly spread and the tenants do not feel directly responsible for the problem.

When necessary, applications of insecticidal sprays, dusts and gel baits should be applied to cracks, crevices and voids which harbour cockroaches. Non-repellent insecticides should be used to avoid scattering cockroaches and slow-acting baits might be used indoors whenever possible. Containerised baits are preferable, especially in extremely sensitive situations, such as schools and health care facilities. Applications should minimise potential exposure to people and pets. Insecticides should only be applied where warranted.

Post-treatment evaluations are essential and need to be shared with tenants and landlords to ensure continued co-operation and support.

'All of the major domestic pest species in North America and Europe have relied on human activities, commerce and the urban environment to spread throughout the world'

(From *Public health significance of urban pests*)

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Commensal rodents

'Rats and mice present a great risk to human health, especially to people whose health is already compromised. In addition to being reservoirs for zoonotic diseases (diseases that are passed from animals to humans), commensal rodents are also linked to medical problems associated with asthma and indoor allergic reactions.

'Various aspects of the behaviour and biology of commensal rodents, such as enormous reproductive potential, trap avoidance and feeding behaviour, contribute to the failure of many rodent control programmes. To achieve acceptable results, all aspects of the biology and behaviour of commensal rodents should be understood and taken into account.

'Also, a legal framework is necessary to support measures that secure effective practices for the control and prevention of commensal rodents that are urban pests and simultaneously safeguard the health and safety of practitioners. Legislation that supports efficient rodent control programmes while providing regulatory powers for overseeing these programmes, such as use of rodenticides, is of paramount importance.'

(Excerpt from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Rats and mice share dwellings with humans and, metaphorically speaking, eat from the same table. Fear and loathing of these commensal rodents (rodents that live with humans) is embedded in many cultures. For rats, this may be due to their association with Plague, which still causes illness and death in many parts of the world today. Although not closely associated with plague, the house mouse is an unwelcome pest and carries with it social stigma, as well as human pathogens.

Rats and mice can be infected with a large variety of parasites and zoonootic agents, which elevates their status from mere nuisances to public health pests. Typically, when compared to rats, mice have been seen as a nuisance because of the spoilage of foodstuffs and the damage they cause in homes. Mice do, however, carry several zoonotic agents and should be treated as a potential threat to public health.

Rodents in housing

Urban sewers are the perfect man-made rat habitat. They minimise temperature fluctuations, provide food and greatly reduce or eliminate predation. Breeding continues year-round, and heavily infested sewers and drains can act as reservoirs of rats, restocking surface areas following control efforts. Rats prefer the dry parts of the network, disused pipes and excavations next to cracks or bad joints in pipes.

Rats are often found in substandard dwellings where building density is very high and construction design denies them outdoor burrowing opportunities. In these situations, they colonise basements and kitchens and attempt to coexist with human occupants, which makes rat bites increasingly likely. According to one study, the typical rat-bite victim is an impoverished child, less than five years old, living in substandard housing.

Vandalism, dishevelled gardens, vacant buildings, poor maintenance, poor hygiene and ample internal harbourage have been related to rodent infestations in homes. Litter, carelessly discarded food waste and inadequate sewer baiting encourage above-ground rat infestations.

Public health risks

Schistosomiasis, one of about 40 diseases carried by rats, has infected as many as 200 million people worldwide. Rats can also spread Murine typhus, Salmonellosis, Leptospirosis, Trichinellosis and Rat-bite fever.

Research shows brown rats in the UK were infected with 13 different parasites and human disease agents. Of 510 brown rats samples, all carried fleas, 67 per cent carried mites and 38 percent carried lice. None carried ticks.

Rodent parasites act as vectors for serious diseases, for example the primary vector fo the Bubonic plague is the Asiatic rat flea. Rat bites can also spread infection.

Mice carry parasites on their bodies and zoonotic agents. They help to spread Toxoplasmosis, Murine typhus and Rickettsial pox. Recent studies have

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found that house mice carry the mouse mammary tumour virus, which may be linked to breast cancer.

Rats and mice can be a source of anxiety for occupants, which can affect mental health.

Pro-active control

Too often, control strategies are limited to responding to complaints, with the assumption that a lack of complaints indicates an absence of rodents. But where there are defects in the sewage system, rats may move regularly between sewers and the surface unnoticed.

Residents in some urban areas are more tolerant of rats than others. Little attention has been paid to deciding what level of infestation, if any, represents satisfactory control. However, it has been suggested that where the infestation rate is one percent or less, it is not worthwhile adopting a structured approach. This implies, however, that the local authority has adequate information on which to make that assessment.

Planning poisoning

When a population of sewer-dwelling rats has been reduced via rodenticide treatment, numbers can recover at rates of up to 20 percent a week. Perfunctory, unplanned poisoning merely kills some of the population, leaving rat numbers to recover quickly. Two treatments have been shown to reduce a sewer population to a small fraction of its original size. When surface infestations were dealt with at the same time, recovery of the population was slow.

Pulse baiting accommodates the hierarchical feeding common to rats, allowing older, dominant rats to die before replacing the bait for less dominant rats. Three baiting pulses can remove almost an entire population.

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In England and Wales, local authorities now charge for pest treatments in homes and in many cases complaints have declined. Any charging regime should be assessed for its potential impact on the rodent population and the control strategy and be supported with free information about what householders can do to prevent infestations.

Rodenticides are an essential means of effective control in sewers coupled with maintenance and repair of sewerage infrastructure. In many countries, rodenticides are seen as an immediate, economical and easy answer to urban infestations, which has led to an over-reliance on this approach. The whole community should address rodent problems, which should be seen as a symptom of a vulnerable and more often than not degraded urban environment.

The cost of the problem

Substantial rodent infestations lead to ill health and stress, which have a negative impact on individual and national economies.

Rats damage buildings and installations, creating a significant risk of fire and electrocution as the result of damage to cables. Burrowing rats can cause landslides or the collapse of banks of canals and ditches, leading to flooding. The annual cost associated with this damage in the US is now close to US$19 billion. Damage to infrastructure by rats costs the British economy between £61.9 million and £209 million per year.

Infestations are a reflection of poor environmental quality and can make an area unattractive to investment. Dealing only with rodent problems may merely be treating a symptom, rather than taking a long-term, sustainable approach to improving the urban environment and reducing economic disadvantage.

Moving forward

States should consider more effective surveillance for identifying the contribution of commensal rodents to the spread of disease.

Addressing the need for environmental change will have positive economic and health benefits. The emphasis must be on effective waste management, improved inspection, repair of buildings, sewers and drains and reduced harbourage through landscape management.

The legal framework should reflect the need for an integrated approach, regulation of rodenticides and environmental change. Public authorities should have the necessary powers to intervene where voluntary action is inadequate.

The level of management within public authorities, as well as a properly trained and equipped workforce, should be adequate. Staff should have adequate time to carry out thorough surveys and address infestations properly. An integrated programme of control for all urban areas must be rigorously and consistently monitored.

'Commensal rodents, such as the brown rat, the roof rat and the house mouse, present a great risk to human health, especially to people whose health is already compromised. Studies show that rats and mice can be infected with a large variety of parasites and zoonotic agents, which elevates their status from mere nuisances to public health pests'

(From *Public health significance of urban pests*)

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Mosquitoes

'Except for a few examples, such as West Nile fever and Saint Louis encephalitis virus, mosquito-borne infections are still exceptional in Europe and North America. However, concern is rising as international travel and trade increasingly introduce both vectors and pathogens.

'Of mosquito species, the Asian tiger is the most famous because of its recent geographical spread. It is a vector of at least 22 viruses, including those that cause dengue fever and chikungunya fever. Mosquitoes can also transmit malaria parasites and dirofilarial worms in Europe and North America. Though still uncommon, incidences of locally acquired infections appear to be increasing.

'Pest management is important at personal and public levels. In the urban environment, proper sanitation and water management are key factors. This includes ensuring there are no potential breeding places in the immediate surroundings of dwellings and housing estates.

'Mosquito management should consider the health hazards of pesticides and aim to promote environmental changes detrimental to the development of mosquitoes, rather than treating mosquitoes with pesticides.'

(Excerpt from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Unlike many tropical and subtropical regions of the world, in Europe and North America mosquitoes are more important as pest nuisances than as vectors of disease. Mosquitoes receptive to pathogens are indigenous to Europe and the USA, but because the pathogens have either been absent or rarely become apparent, they have mostly been neglected.

Explosive increases in international travel and trade now allow accidental importation of mosquito vectors and hosts, and as our climate and environment change, mosquitoes can spread unnoticed to new areas, bringing emerging and resurging vector-borne diseases.

Mosquitoes may change their behaviour and adapt to new breeding habitats including slurry pits, liquid manure pits and rainwater pools in used tyres. Climate and environmental changes should be observed carefully, as mosquito seasons may be extended and mosquito habitats and densities may increase.

Seasonal mass reproduction of mosquitoes may occur when large areas of land are flooded. This is not a modern phenomenon, but what is relatively new are the large human populations that live near flooded areas.

New disease vectors

The Asian tiger mosquito was introduced from South-East Asia by the used tyre trade and, after a period of adaptation, began to spread. It is an efficient vector of numerous arboviruses, including dengue, chikungunya and probably West Nile viruses.

The rock pool mosquito, a vector of Eastern equine encephalitis virus in the US, has been introduced to southern Europe by used tyres from North America.

The Asian bush mosquito, a vector of the Japanese encephalitis virus, has been found infected with WNV. It has invaded Europe and the US from Asia.

There are about 100 species of mosquitoes recorded in Europe and over 160 in Canada and the US. States in the US are far more up to date than most European countries and can react more quickly and efficiently to emergencies.

The emerging importance of WNV

About 20 percent of human cases of West Nile virus result in symptoms being evident. These symptoms may range from inflamation of the membranes surrounding the brain to complete paralysis. In cases where the nervous system has been affected, there is long-term disability or death.

Migrating birds regularly transport the virus from sub-Saharan Africa to Europe. European birds seem to have adapted to most of the circulating virus variants and may contribute to virus elimination.

The US was WNV-free, but between 1999 and 2003 the virus spread rapidly from the east coast to the west coast, most likely introduced by illegally imported birds. There were 19,655 human infections by 2005, including 782 fatalities. Birds were also affected badly.

More than 15 mosquito species in Europe and at least 60 species in the US are

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suspected WNV vectors. Most important among them are species that feed on different types of hosts, particularly in urban areas where they breed in small, man-made water containers and serve as bridge vectors between birds and mammals, including human beings.

Other serious diseases

Dengue fever, the most important human viral disease transmitted by mosquitoes, is endemic in tropical and subtropical Africa, Asia, Australia and South America but only imported cases are found in Europe and the US. This was not always the case, and the potential for the return of active transmission still exists, as global Dengue virus transmission increases rapidly, especially in Central and South America.

The advent of the Asian tiger mosquito – an efficient Dengue virus vector – in Europe and North America and the proximity of the US to the southern dengue endemic countries have caused uncertainty about the potential return of Dengue fever. Preventing the further spread of this mosquito is imperative.

Recently, epidemics of Chikungunya fever have occurred on islands in the Indian Ocean and in India and Malaysia. In Réunion, the outbreak affected over a quarter of the population and brought about extraordinarily severe cases and 155 deaths. The virus vector in the Indian Ocean is the Asian tiger mosquito, so there is great concern that the virus will be imported to and established in Europe.

Sporadic cases of locally acquired Malaria in central and southern Europe and the US result mainly from bites of mosquitoes infected by feeding on malarial tourists, immigrants or seasonal workers. Local transmissions near airports may occur during summer, particularly during hot years. Disinfection of aircrafts can minimise the risk of such cases.

In 2003, 1,278 cases of Malaria were reported in the US, 1,268 of them imported. For the same year, 11,573 imported cases of Malaria and 166 travel-related cases of Dengue fever were documented in Europe. Recently, over 160 cases of Chikungunya disease were imported to Europe in less than a year from Indian Ocean islands.

The number of imported cases of mosquito-related infections is sufficient to expect sporadic local transmission by indigenous mosquitoes. In Europe and the US, mosquitoes capable of transmitting malaria are still widely distributed. The primary Dengue virus vector, the Yellow fever mosquito, has been eradicated from Europe, but not the US. Unlike Dengue, vaccination keeps the number of imported cases of Yellow fever, which is endemic in sub-Saharan Africa and South America, quite low.

In the US, 77 cases of Dengue fever were identified in 37 states and the District of Columbia from 2001 to 2004. However, as Dengue fever is not a nationally notifiable disease in the US, the true figure is probably higher.

Human dirofilariasis is caused by filarial worms. Possible vectors include the Asian tiger mosquito. Until the middle of the last century it was considered exceptional, and from its first demonstration in 1864 until 1995, a total of only 181 human cases had been reported for Italy. However, between 1995 and 2000, 117 more cases were registered in Italy.

The cost of the problem

From June 2002 to February 2003 the Louisiana WNV epidemic cost about $4.4 million in medical costs, $6.5 million in indirect, nonmedical costs and $9.2 million for the public health response. Evidence of WNV transmission by transfusion prompted mandatory screening of US blood supplies and routine screening of blood donations. A prospective cost analysis, on the basis of two million transfusions, was calculated at US$7-19 million.

'Mosquitoes may change their behaviour and adapt to new breeding habitats including slurry pits, liquid manure pits and rainwater pools in used tyres'

(From *Public health significance of urban pests*)

Efforts are in progress to develop a vaccine against WNV. However universal vaccination would only be cost-effective when the incidence of disease increased substantially or the costs of vaccination fell below US$12 per person.

Mosquitoes can affect livelihoods and property values. In Germany's Upper Rhine Valley the economic loss expected in the absence of mosquito control is €7.5 million, mainly due to losses in the food and leisure sectors and spending on mosquito control. Thanks to mosquito control, property values have increased in this region.

Control methods

Source reduction is the only long-term solution to mosquito infestation, especially in urban areas. Some natural habitats could be modified to reduce the production of mosquitoes by stabilising the water level. Preventing or at least identifying stagnant waters is crucial in artificial areas. This can be accomplished by avoiding stagnation

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in sewers, draining stagnant water from subfloor crawl spaces, closing air gaps with mosquito nets, covering tyre stocks or storing tyres in warehouses and removing containers that hold water or regularly replacing the water.

The golden rule of control is to get to the root of the problem by controlling larval development. Biochemicals and growth regulators have the advantage of being more specific, whereas chemicals are less expensive and easier to use, especially for very large habitats.

Treating adult mosquitoes can reinforce control. Due to its low specificity and to risks such as allergies or damage to vehicle paintwork, such applications are often restricted to critical situations.

The WHO has supported research on about 40 biocontrol agents including bacteria, fungi, viruses, insects, snails and plants. The topminnow and decorative fish such as goldfish and guppies have successfully been introduced as biological control agents.

Passive methods of protection including clothing, screens, nets and repellents can limit the impact of a mosquito problem.

Areas that have insufficient water management or experience floods need mosquito control programmes. However, appropriate facilities for controlling mosquito outbreaks are not commonly available. Strategy should be based on an integrated pest management philosophy. Physical, biological, biochemical and chemical approaches should be combined, and applications of pesticides should be minimised. Educating the public on how to prevent unintentional provision of breeding sites in urban areas is fundamental.

Moving forward

It is very important to provide international rules for adequate tyre storage and tyre traceability, aircraft and ship disinfection and more efficient control of animal transport.

Governments would benefit from establishing a network of centres in each country to gather information and take action.

To avoid forming mosquito breeding sites by city management or landscaping, such as through the restoration of large tracts of land along rivers to a natural state, building authorities must collaborate with biologists who understand local mosquito populations.

Harmonising control

There is no EU-wide policy on mosquito control. It is necessary to intensify international and European collaboration at legislative and executive levels. In Europe, notification systems should be standardised and notifications reported to a central agency.

Harmonising mosquito control practices will reduce harm to the environment. EU guidelines for insecticides should be harmonised between member states. Formation of an insecticide panel to facilitate effective control of nuisance and vector mosquitoes must be guaranteed for the future. Possible health hazards caused by control activities must not exceed those of the pests they are intended to control.

'It is essential to re-intensify research in medical entomology and train medical entomologists to deal with vector-borne diseases and their control'

(From *Public health significance of urban pests*)

Better research

It is essential to re-intensify research in medical entomology and train medical entomologists to deal with vector-borne diseases and their control. Epidemiological data about mosquito-borne virus activity in Europe are urgently needed.

Cases of mosquito-borne diseases and the distribution and abundance of mosquitoes must be monitored regularly by specialised, government-authorised institutions.

In Europe, an institution equivalent to the CDC, the European Centre for Dissease Control, is presently being set up in Sweden. Another organisation, the European Mosquito Control Assocation, focuses on mosquitoes and mosquito-borne diseases. It consists of institutions from 22 European countries.

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Birds

Monitoring diseases associated with birds in urban areas is the first essential step in controlling these diseases. Although most remain relatively infrequent, vigilance is necessary as their incidence might be significantly underreported and undiagnosed.

The majority of public health problems caused by wild birds are associated with feral pigeons, gulls, blackbirds, grackles, starlings, crows and house sparrows. At least 800 transmissions of a pathogen from feral pigeons to people have been reported. This is probably the tip of the iceberg.

The extent and significance of the hazard varies enormously according to local conditions. It can be determined by first establishing whether a human bird-borne infection occurs at a particular urban setting and if it does, how often. The final step involves a decision about the level at which public funds should be spent on prevention and control.

(Summarised from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Urban free-living birds could be called companion animals, especially for children, the elderly and lonely people. They are often watched or fed with pleasure. However some urban bird species congregate at too high population densities and can produce droppings that harm buildings and cars, be extremely noisy, harm urban vegetation or cause pollution problems with their droppings.

In urban areas, nests of feral pigeons in lofts can result in invasions of soft ticks into high density flats and apartments. Their bites often lead to allergic reactions. Other parasites that live on pigeons and can occasionally attack humans include the chicken mite, which may produce allergic reactions, especially in children and susceptible adults.

Wild birds and human diseases

Wild birds, including those living in towns and cities, can harbour pathogens and spread them to people.

- West Nile virus infected at least 19,655 people and killed 782 in US cities in 1999-2006 and affected hundreds in Bucharest in 1996-1997 and Volgograd in 1999-2000
- At least 500 cases of Ornithosis acquired from feral pigeons have been reported worldwide since 1966
- There have been epidemics of mosquito-borne Saint Louis encephalitis virus in North American cities
- Blackbirds in urban parks are carriers of infected ticks and are amplifying hosts of the agent of Lyme disease
- Hundreds of human cases of Histoplasmosis have been acquired near communal roosts of blackbirds and starlings in North American city parks

Other bird-related pathogens which cause human disease include *Campylobacter*, E.Coli and *Salmonella*.

The risk of infection

Bird-related pathogens can be spread by the air, ingestion, direct contact with birds or blood-feeding insects like mosquitoes and ticks. The ability of some pathogenic fungi and bacteria to grow in bird faeces and nests could pose a public health hazard in mass communal roosts or large nesting colonies at urban or suburban sites.

Bird species that have high population densities, nest in colonies, roost gregariously or congregate at water and food sources or in other places in urban areas are important due to frequent contacts that enable effective transmission of disease agents.

Aquatic birds, even in urban situations, attract higher numbers of blood-feeding insects such as mosquitoes than do terrestrial birds, while woodland, ground-foraging birds are parasitised by ticks. Bird mobility and migratory habits are other crucial factors; they make the transport and spread of agents more effective.

Overpopulation of infected urban birds and insect vectors and intimate contact between people and infected urban birds or their habitats all increase the risk of bird-borne infections.

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Monitoring and surveillance

Public health surveillance should involve monitoring based on reports of disease, surveys of urban birds and city dwellers, examination of blood-feeding insect vectors and avian hosts and investigations of habitats as sources of disease.

Control methods

The control of wild bird populations in urban and suburban areas is difficult and sometimes ineffective. However, a few 'public friendly' methods are available.

In circumstances of established risk, feeding the birds can be restricted at public sites and scavenging birds can be controlled on landfill sites and at harbours and airports.

Proactive and reactive control measures include dispersing birds, for example by acoustic or light signal methods, predation or water-mist sprayers. Habitats can be modified, for example by thinning or clearing vegetation or by preventing birds from breeding on buildings, by blocking loft spaces and perch sites using netting, spikes, repellent gels or electroshock deterrents.

Other control methods include collecting and inactivating eggs and trapping and killing or sterilising birds, if permitted.

Controlling and sanitising large communal roosts of birds may be necessary in city parks.

These activities should be carried out as part of an integrated approach, which includes educational and legal components. Individual steps alone do not produce success. Inspection and control measures must be performed or supervised by veterinary public health agencies. Ornithologists, wildlife managers and citizens should be involved in implementing control measures. A risk-benefit analysis should also be performed.

'Bird-related pathogens can be spread by the air, ingestion, direct contact with birds or blood-feeding insects like mosquitoes and ticks'

(From *Public health significance of urban pests*)

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Ticks

'Ticks transmit the most common vector-borne diseases in Europe and North America, Lyme Disease being the most highly prevalent.

'The incidence of tick-bourne diseases seems likely to increase, partly due to man-made environmental changes. Some approaches to urban planning can provide new ecosystems suitable for tick infestations.

'Incidence of tick-borne diseases can be lowered by active public education campaigns, targeted at the times and places of greatest potential for encounter between humans and infected ticks. Similarly, vaccines are most effective when made available to people at greatest risk, and for high-prevalence diseases such as Lyme disease.

'Development and design of human residential and recreational areas should routinely consider TBDs as part of the planning effort. Public health experts should be consulted early in the planning process.'

(Excerpt from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Important disease vectors to people and domestic animals, ticks dwell predominantly in woodlands and meadows, in association with animal hosts including deer, rodents and birds. Some ticks are associated with pigs, sheep and cattle and can be found in stables and houses that incorporate stables. The brown dog tick can persist in long-term infestations of homes with dogs and the European pigeon tick can occur in dwellings with pigeon infestations.

Some hard ticks can directly cause adverse effects, such as tick paralysis, a systemic poisoning due to toxic salivary proteins. Similarly, soft ticks can provoke severe allergenic bite reactions in people.

The changing urban environment

Most ticks that are important to human health are rare in highly urbanised environments, but with increasing frequency ticks are occurring in domestic settings when a moist microhabitat is provided by high grass, gardens and rough forest edges. Foliage, decomposing organic matter and litter can give shelter to ticks and the small mammals that act as their hosts.

Increasing suburbanisation has resulted in substantial contact between people and ticks. This 'border effect' is more pronounced in North America than in Europe, but the European landscape is beginning to change. The increase in Lyme disease is apparently related to urban sprawl. This often results in invasion of residential areas by deer and mice, which can bring tick-bourne pathogens and ticks.

Pathogens can be transmitted to people by a bridge vector, such as the castor bean tick or sheep tick, which frequently feeds on hedgehogs. The widespread recommendation to encourage hedgehogs to live in gardens by preparing piles of leaf litter may therefore contribute to urbanisation of TBDs.

Tick-borne diseases

Regional studies show that tick abundance is increasing and TBDs are emerging and spreading. Milder winter temperatures in particular have important effects on tick distribution and can foster shifts into higher latitudes and altitudes.

Among European TBDs, only TBE is a widely notifiable disease, despite the fact that the most frequent TBD in Europe is Lyme disease, with possibly hundreds of thousands of clinical cases a year.

Lyme disease

According to studies conducted in north-eastern Germany, Lyme disease is most often acquired in city parks and gardens near forests. It can cause arthritis, chronic skin disease and, rarely, chronic Lyme meningoencephalitis, where sporadic fatalities have been reported.

Prevalence varies considerably among European countries, with estimated average rates between 0.3 cases per 100,000 population in the UK and up to 130 cases per 100,000 population in parts of Austria. Lyme disease tends to be focal, with defined hot spots within countries, so mapping hot spots is an important tool for disease prevention. Over 23,000 cases

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were reported to the US Center for Disease Control in 2002, but it has been estimated that this is roughly 10 percent of the actual total number of cases in the US.

The cost of Lyme disease

An economic impact of between several €100 million and €1 billion a year is plausible for Europe. In the US, estimated costs are about US$150 million, but if the number of cases reported is only about 10 percent of the total number of cases, actual costs are in billions. Indirect costs would greatly increase these very rough estimates and prevention activities such as landscaping and pesticide applications contribute further to the economic impact.

Tick-borne encephalitis

TBE is the most frequent viral TBD in central Europe. Thousands of clinical cases a year occur, mainly in the Russian Federation, the Czech Republic and Latvia. In 1997, 10,208 clinical cases of TBE, with 121 fatalities, were reported in Europe. In 2005, there was an increase of 50 percent or more in notified clinical cases in Switzerland and Germany.

Symptoms may include fever, anorexia, headache, muscle aches, nausea and vomiting, meningitis and encephalitis and a residual slight or partial motor paralysis. Case fatality rates are generally below five percent in Europe, but up to 50 percent in some outbreaks of Asian subtypes. Treatment often requires hospitalisation and intensive care.

Vaccination, prevention of infective tick-bites and pasteurisation of contaminated goat's, sheep and cow's milk constitute the first line of defence in preventing TBE. In some cases, up to 76 percent of human TBE infections can result from consumption of raw TBE-infected milk, as reported in Belarus.

Emerging TBDs

The 1944/1945 epidemic of Crimean-Congo haemorrhagic fever resulted in more than 200 human cases, 10 percent of them fatal. Now CCHF is re-emerging, with an estimated annual incidence far greater than 100 cases. It is probably underreported worldwide.

A haemorrhagic fever with severe typhoid-like symptoms, it kills 8-30 percent of sufferers and up to 60 percent of those who contract the disease from another person. Treatment requires barrier nursing and special hygienic care to prevent secondary infection, but seems promising during the early stages of the disease. No licensed, safe vaccine is currently available.

CCHF is the most severe TBD in Europe and has the potential to spread quickly from person to person. Bulgaria, the southern part of the Russian Federation and Ukraine are among the most highly affected areas. Cases have also been reported from Albania, Bosnia and Herzegovina, Greece, Hungary, Montenegro, the Republic of Moldova, Serbia, and the former Yugoslav Republic of Macedonia. The virus has been detected in almost all south-eastern districts of the Russian Federation, resulting in an additional regional budget of Rub2.5 million (US$ 872,000) for treatment and prevention.

Other emerging tick-borne diseases of concern include Tick-borne rickettsioses, and Babesiosis.

Protection from ticks

Avoiding fields, forests and other tick-infested habitats or using clearly defined paths, especially in known disease hotspots, can help prevent contact with tick-infested vegetation. Bites of soft ticks can be prevented by avoiding old campsites, animal and poultry stables and infested cabins and by taking appropriate precautions when coming in contact with animals potentially infested with ticks.

'Increasing suburbanisation has resulted in substantial contact between people and ticks'

(From *Public health significance of urban pests*)

Effective repellents are available for clothing or skin. Tucking trousers into boots or socks and shirts into trousers is advised. Light-coloured clothing aids detection of dark-coloured ticks, which can be collected or removed with commercial tape. A major advance in the protection of high-risk personnel, such as outdoor workers, hunters and soldiers, has been the development of residual insecticides that can impregnate clothing, tents and netting.

Most TBDs require a period of attachment – often several hours – before the pathogen is transmitted, so thorough body examination and prompt removal of attached ticks is essential in known disease hotspots.

Hard ticks should be removed by grasping the tick where the mouthparts are attached to the skin and then pulling it out slowly, but steadily, preferably using pointed forceps. The bite site should be cleansed with antiseptic before and after removal.

Soft ticks withdraw their mouthparts when touched with a hot needle tip or dabbed with chloroform, ether, alcohol or other anaesthetics.

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Of tick-borne diseases endemic in Europe and North America, only TBE can be prevented by the use of a vaccine. TBE vaccination is widely neglected as a public health tool, apart from in Austria. There is no effective vaccine available for Lyme disease.

Urban habitat manipulation

In the past, TBDs have rarely been considered in urban or suburban design. Medical entomologists and natural resource experts should be consulted during the planning process.

Maintaining short-clipped lawns, establishing barriers to prevent access to woodland and conservation areas and constructing pathways through natural sites can minimise human exposure to ticks.

'Avoiding fields, forests and other tick-infested habitats or using clearly defined paths, especially in known disease hotspots, can help prevent contact with tick-infested vegetation'

(From *Public health significance of urban pests*)

Host-centred methods

Domestic animals and pets can be vaccinated to minimise tick attachment or protect them against TBDs. Vaccination of wild reservoir species of animals could theoretically be another tool in the box. Manipulation of host populations of wild animals, for example deer, can lower tick populations.

Biological control

Ticks have numerous natural predators, parasites and pathogens. With additional research and development widespread release of wasps of the genus *Ixodiphagus*, which parasitise only ticks, might eventually be an effective control method in North America.

At present, one of the best candidates for tick biocontrol is the entomopathogenic fungus, *Metarhizium anisopliae*. Preliminary field trials have had modest results but improved formulations may provide effective control.

Pesticide applications

Broadcast pesticide applications can rapidly lower tick numbers, but can have substantial effects on non-target species. Pesticides can be targeted at host animals by attracting the hosts to bait boxes, permethrin-treated cotton balls and so-called four-poster devices, which coat the heads and necks of animals with a pesticide, allowing far lower amounts to be applied than in broadcast applications.

These methods can be important tools in integrated pest management programmes, especially when combined with other management techniques appropriate for local conditions.

Permanent infestations in houses and stables require professional use of pesticides, as well as treatment of dog hosts or construction modifications of infested houses and stables to prevent further infestations of pigeons, the natural hosts of pigeon ticks.

Moving forward

In Europe, national reporting strategies differ among countries, and little has been done to routinely implement measures that protect individuals against tick bites or TBDs. Some notable exceptions are vaccination against TBE and the use of skin repellents in some areas.

Fabrics impregnated with acaricides (agents that kill ticks and mites) are widely unknown and difficult to procure, even for people exposed to tick-infested areas of endemic TBDs at work. So far, few research efforts have been initiated to reduce tick populations by ecological changes, biological control or IPM.

Accurate, practical information should be made readily and widely available to health professionals, pest management professionals and the public. Specific programmes should be provided for people with occupational and recreational exposure to ticks and TBDs.

Research can lead to innovative and improved methods to lower the incidence of these diseases. Improved surveillance programmes can allow better-targeted management efforts.

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Bedbugs

After the Second World War bedbugs became so rare that just collecting specimens became a difficult task. However, they are enjoying a definite resurgence.

Steps should be taken to make accurate information on bedbug biology, behaviour, control and prevention available to pest management professionals, health professionals and the public. Government agencies should try to address problems related to low incomes in dealing with bedbugs and housing or building quality.

Research should determine the susceptibility of bedbugs to the insecticides most frequently used to control them and whether or not they transmit human pathogens, especially those that cause new or emerging diseases. More research is needed to clarify aspects of bedbug physiology and behaviour, with the goal of developing techniques to survey even small populations. New ways of controlling bedbugs are also needed, as is an assessment of the effectiveness and practical use of extreme temperatures, especially heat, to eliminate bedbugs. New studies should aim to characterise the nature and treatment of unusual, extreme or very persistent bedbug bites.

(Summarised from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

Bedbugs have been persistent pests throughout history. Feeding only on blood, they are nocturnal, transient and elusive.

The common bedbug can be found in all the temperate areas of the world. It thrives in conditions of temperature and humidity comfortable for people, and people provide it with blood meals and somewhere to live.

Once bitten…

Common bedbugs have been found to naturally contain 28 human pathogens, but have never been proven to transmit them. Studies of the hepatitis B virus seem to support the possibility of mechanical transmission by contaminated faeces or when bugs are crushed while feeding on the skin.

Numerous routine bedbug bites can contribute to anaemia and may even make a person more susceptible to common diseases. Some people develop a general malaise from numerous bites that, along with loss of sleep and extreme itching, can make them listless and almost constantly uncomfortable. Others develop so-called sensitivity syndrome, which may include nervousness, jumpiness and sleeplessness. In such cases, relocating the person or removing the bedbugs has caused the syndrome to disappear over time.

Besides the effects of direct bites, airborne common bedbug allergens may produce bronchial asthma.

Although their bite is often nearly undetectable, bedbug saliva contains active proteins that may cause an immunogenic and allergenic reaction to repeated biting.

Symptoms from bedbug bites may include serious local redness and intense itching, boil-like eruptions on the skin leading to further reactions of the blood system and even anaphylaxis. Such reactions are often misdiagnosed as a blocked coronary artery.

Currently, there is no requirement to report bedbug infestations to any public health or other government agency.

Identifying bedbugs

Common bedbugs are up to 7mm long, oval, flat and brown, with three-segmented beaks. They have antennae and the remains of wings and are covered with short, golden hairs. They are nocturnal, but feed in daylight when hungry. Like fleas, they often produce a series of bites in a row.

Females attach their eggs to surfaces, often in crevices, where they may hide in loose clusters.

A definite resurgence

With widespread use of synthetic insecticides soon after the Second World War, bedbugs became very rare pests in many industrialised countries. But during the past eight years, a definite resurgence has been reported in the US and parts of Europe, Africa, Australia and Canada.

This has been credited to increased travel, use of previously owned furnishings, loss of pest control products and changes in control practices.

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One national company in the US reported a 300 percent increase in bedbug control calls from 2000 to 2001 and 70 percent increases in both 2002 and 2003.

Observational reports from Germany and the UK claim a sharp increase in the frequency of infestations during the last decade. In Berlin, the number of reported infestations has risen from five in 1992 to 76 in 2004.

The cost of the problem

On top of the practical costs to the hospitality industry, lawsuit judgements have ranged from US$382,000 to US$20,000 plus expenses. In 2006, damages of US$20m were sought from one hotel.

Because the general public lacks knowledge of bedbug feeding activity, victims nearly always seek medical attention, incurring costs for diagnosis as well as treatment.

Bedbugs and poverty

Crowded, cluttered and poorly maintained homes offer bedbugs places to hide. Deteriorating structures with warped woodwork or floors, loose tiles or wallpaper and large cracks may be nearly impossible to seal or treat effectively.

The cost of controlling infestations professionally is usually more than such building owners or occupants can afford. They often try themselves and are seldom very effective, which further depletes already limited resources.

Bedbugs readily move through wall voids and along utility lines, heating ducts, lift shafts and laundry and mail chutes. Once they become established, any control effort that does not include checking the whole building at nearly the same time, along with a co-ordinated occupant education and treatment effort, will usually fail.

Effective management

Where local regulations allow, fumigation of furniture, clothing or other personal items can kill all stages of bedbugs present. Fumigation of a whole building should be equally effective but would seldom be needed, practical or affordable.

Heating infested rooms or buildings to temperatures of at least 45°C, the thermal death point of common bedbugs, has been used to control bedbugs since the early 1900s. Cold and carbon dioxide gas treatments have also been proved effective.

These treatments, however, would not prevent re-infestation.

Dust formulations should be used in electrical outlet boxes and other places where it is desirable to use a minimum-risk, long-lasting insecticide.

Integrated Pest Management

Because they are small, nocturnal and can detect and avoid many chemicals, bedbugs are often hard to control. A properly labelled and licensed insecticide, in combination with the IPM principle, is often the quickest, most practical and possibly the only affordable or viable option.

'Besides the effects of direct bites, airborne common bedbug allergens that are always released during infestations may produce bronchial asthma'

(From *Public health significance of urban pests*)

Interior sprays or dusts are usually applied to cracks and crevices and the surfaces bedbugs crawl over to reach the host.

Educating occupants is essential to ensure they actively co-operate in any control programme. Good communication between homeowners, housing managers and relevant government agencies should be maintained throughout.

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Flies

'At present, a few flies in a home may not constitute a serious health risk, but this may not be the case in the future.

'Proper sanitation is the key to fly control. Deny flies access to places to lay their eggs. Fly management in urban areas may involve surveillance at and management of potential fly-producing sites outside the urban perimeter.

'If people experience fly problems, particularly if associated with illness, health authorities should be contacted immediately. Health authorities with entomological expertise should have properly trained personnel to identify flies and assess the extent of the problem. Should their assistance be needed, health authorities should have contacts with outside entomologists.

'Public awareness and educational programmes are essential to minimise transmission of pathogens by flies, especially in times of disaster. Communities should develop fly management guidelines that indicate action thresholds for adult populations and that suggest corrective measures to be taken when thresholds have been exceeded. Corrective measures may include legal action to be taken against individuals or companies that fail to control flies where necessary.'

(Excerpts from *Public health significance of urban pests*, 2008, WHO Regional Office for Europe)

More than a nuisance

Some 120,000 species of flies inhabit almost all ecosystems. Many, collectively called filth flies because of their association with waste, faeces and carrion, easily become disease vectors. They receive pathogens as they walk and feed on contaminated material, and flies such as houseflies regurgitate digestive juices and defecate where they feed or rest.

The impact of climate change

Over the past 100 years, the global average temperature has increased by about 0.6°C. This trend may show a fast rise in the future. Warmer conditions could promote transmission of diseases and increase local disease-vector populations. A simulated climate change model predicted a potential increase in fly populations of 244 per cent by 2080.

Flies and human health

Filth flies can carry over 100 human pathogens including Salmonella, E. coli O157, *Campylobacter* and *Helicobacter*. Houseflies can maintain E. coli O157 for up to 30 days. A single fly could deliver a lethal dose, for example by falling into a child's drink.

There is strong evidence that flies play an important role in bacterial infections including the severe diarrhoeal diseases salmonellosis shigellosis and cholera. Flies ecologically associated with humans may carry bacteria resistant to antibiotics.

Flies carry parasites such as *Cryptosporidium* and viral pathogens including Poliovirus, Coxsackievirus and Enteroviruses. They can transfer the eggs and cysts of various cestodes and nematodes, particularly hookworms and ascarids. There are also presumptions that biting flies are involved in transmitting Lyme disease.

Some people have allergic reactions to the bite of the stable fly, the major biting fly in urban areas, some of which can be life-threatening.

The danger of Myiasis

The larvae of more than 50 fly species including the ubiquitous housefly can cause Enteric (intestinal) myiasis when ingested, leading to malaise, vomiting, pain and bloody diarrhoea.

Flesh flies, houseflies, latrine flies, false stable flies and blow flies can also cause myiasis by infesting living human tissue with larvae or eggs. Species incapable of reproducing without a living host such as blow flies, flesh flies and bot flies can cause Dermal creeping myiasis.

The cost of the problem

In 2003, 63,044 cases of Salmonellosis were reported in Germany. Each year, an estimated 600 people die from Salmonellosis. In the US, *Campylobacter* causes an estimated 2.45 million cases of Bacterial diarrhoea and 124 deaths annually.

A supermarket chain with 20 stores pays between $38,400 and $54,000 a year for pest management. State-funded aerial spray programmes such as Florida's stable fly management scheme operate annual budgets of up to $50,000.

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Compost and flies

Some cities and countries encourage composting, but at temperatures below 50°C flies, particularly stable flies, can use compost, straw or other stall bedding to develop their immature stages.

The WHO does not recommend biological control for urban settings because most available options work best against flies' immature stages while the adults cause the problems. If immature stages are found in temporary urban habitats, these can usually be eliminated quickly by nonbiological means. The exception might be in compost.

WHO pest control conclusions

- **Monitor urban fly populations regularly, with special focus on hospitals. Devise a system to better estimate when disease outbreaks are related to flies**

  Long-term surveillance, including evaluation of flies' pathogen load and the percentage of infected flies, may reveal identifiable trends that can be used to protect people.

- **Restrict pesticide usage to outbreak scenarios**

  Pesticides are not widely used for controlling flies in urban areas except during large-scale disasters. After Hurricane Katrina in 2005, millions of flies could have facilitated disease transmission had control methods not been implemented. During such situations, aerial pesticide applications should result in minimal public exposure in urban areas.

  Around structures, pesticides are only applied to outdoor walls where flies rest. Unless reapplied regularly, they may increase pesticide resistance.

  In homes, commercial aerosol pesticides should give adequate protection against small numbers of flies.

- **Improve trap designs and exclusion devices and develop effective perimeter control techniques without pesticides**

  Exclusion fans on doors and ceiling fans, sometimes used in conjunction with ultraviolet light traps, can keep flies out of food preparation and serving areas. Business doors should open outwards, with self-closing devices. Air-conditioning should have positive air pressure inside, so air blows out when customers enter. Exhaust vents should be screened. Odours must be vented away from doors and lighting should minimise attracting flies.

  Traps including ultraviolet light traps, sticky traps, jar or bag traps and window traps are pesticide-free. Perimeter treatments using vaporised or liquid repellents or pesticides are in development.

- **Develop improved attractants for traps and baits**

  Trapping flies outdoors is a good way to manage fly populations in built-up areas, using an attractant in water to attract and capture flies. Attractants are desperately needed for urban areas. Agricultural housefly attractants are often too odoriferous for indoors.

'Filth flies can carry over 100 human pathogens including Salmonella, E. coli O157, Campylobacter and Helicobacter. Houseflies can maintain E. coli O157 for up to 30 days'

(From *Public health significance of urban pests*)

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