House conditions and the likelihood of domestic rodent infestations in an inner city area of Manchester

Dr R. Gai Murphy and Dr Peter A. Marshall
Research Institute for the Built and Human Environment, University of Salford, SALFORD, M6 6PU.
e-mail: r.g.murphy@salford.ac.uk
Tel No.: 0161 295 5574
Fax No.: 0161 295 2184

Rodent infestations are often associated with poor design and poor structural maintenance of dwellings. The English House Condition Survey (EHCS) reported only modest rates of mouse infestation within dwellings. This project examined the housing stock of an inner city area of Manchester, UK which was selected due to the high number of mouse infestations reported to local politicians by the residents. The area selected contained 254 domestic properties in both public and private ownership. The stock varied in age and property type, but was representative of an inner city area. Thorough internal and external constructional surveys of 117 dwellings were undertaken by a qualified surveyor to establish the general condition of the housing stock and to establish the factors which had contributed to the high levels of mouse infestations in the area. A fitness standard for each property was also recorded. Fifty percent of the properties were found to have mouse infestations. This was significantly higher than the rate of infestation reported in the EHCS. The paper examines the characteristics of the properties surveyed in this study which appeared to predispose them to mouse infestations and compares them with those reported in the EHCS. Infestations were significantly linked to indicators of poor constructional integrity within the housing stock and to general hygiene especially in the kitchen area. The findings of this study highlight the need to undertake detailed surveys of particular areas to complement the general house condition survey to enable a reliable snapshot of the nature and extent of domestic rodent infestations in the UK. The study explores residents' perceptions about rodent infestations and their views on approaches to controlling rodents and compares these with the approaches adopted by professional pest controllers.

INTRODUCTION

The house mouse (*Mus domesticus*) is a common commensal rodent in the UK. Its continued survival and proliferation owes much to its capacity to adapt to life in close association with people and its nocturnal habits enable foraging activities to go largely unnoticed (Rowe, 1973; Shenker, 1973). This species tends to live almost entirely inside buildings, increasing the opportunities for contact with people and poses a potential threat to public health through the diseases it may carry. Whilst urban house mice are known to transmit lymphocytic choriomeningitis (Buchmeier *et al.*, 1980), their vector status in the propagation of diseases such as salmonellosis, listeriosis and toxoplasmosis is less clear (Gratz, 1994, Healing, 1991;Konishi and Takahashi, 1987; LeDuc, 1987; Webster, 1996). Much of the previous research in the UK has focused on rodent populations within the agricultural setting (e.g. Webster, 1996; Quy *et al.,* 1999) and on the risks posed to workers who may come into contact with rodents during work activities (de Serres *et al.*, 1998). There has been little research into the threats posed within the domestic setting although Carrer *et al.* (2001) suggested that the presence of rodents in the home may contribute to increased levels of indoor allergens, causing allergic asthma and rhinoconjunctivitis.

Whilst the risk to human health is a sufficient reason for controlling domestic infestations, it would be naïve to assume that this is the sole justification. Just as the wastage of cereals and other crops has required the development of rodent control strategies in agricultural areas, so the damage done to the fabric of buildings and commodities in urban centres is not trivial. Rodents have been implicated in fires, floods and explosions as a result of their gnawing activities. Equally, it should not be forgotten that the fear of rodents is deeply rooted within European culture.

The impact of construction and hygiene on the biology and population dynamics of the house mouse is poorly understood. However, the 1996 English House Condition survey (EHCS) included, for the first time, details relating to rodent infestations and provided an important indication of the levels of rodent infestations associated with domestic properties. It reported modest infestation rates of 1.83% for mice living indoors (Langton *et al.,* 2001).

Previous research (Murphy and Oldbury, 2002) found that domestic mouse infestations were most likely to occur where there was poor structural maintenance, poor hygiene and ample internal harbourage. These results underline the importance of integrating population reduction measures with environmental management. Integrated Pest Management (IPM) was first developed to provide a means of protecting agricultural crops from pest damage and combines and integrates biological, chemical, physical and cultural control methods. Whilst it is important to try and reduce the numbers of rodents present (usually by the use of chemical rodenticides), if changes to the environment are not undertaken, numbers will quickly recover due to the increased breeding capacity of the rodents which have not been killed and from others moving into the area to exploit the vacated niches.

Colvin and Jackson (1999) emphasised the need to define the characteristics within a habitat that favour infestation and Childs *et al.* (1991) reported that socio-economic factors also influenced the ecology of commensal rodents.

Work by Humphries *et al.* (1992) confirmed that some urban mouse populations have become behaviourally resistant and the usual approaches to control fail to eradicate them.

Control in the UK

Effective control of rodents requires a holistic approach, drawing together an appreciation of their biology, behaviour and the factors affecting their population dynamics. In the UK a plethora of organisations are involved in controlling commensal rodents (Murphy and Oldbury, 2002). Local Authorities in the UK have powers to enforce statutory duties to protect public health, and although there is no statutory requirement for them to undertake treatments to control rodents in domestic premises, many Local Authorities do provide such a service. The way in which this service is operationalised varies across the UK with local political pressures and sensitivities determining decisions regarding whether charges are levied for the service. Charging is often related to historical (and often erroneous) views about rats and mice, with rats being classified as public health pests (and frequently treated free of charge in domestic premises) and mice as nuisance pests (with a charge levied against domestic treatments).

Local authorities that do undertake domestic infestation treatments are often hampered in their efforts to effectively control domestic mouse infestations. Whilst rigorous legislation relating to food premises exists which provide authorised officers of the Local Authority (usually Environmental Health Officers (EHOs) with powers of entry, the law relating to commercial non-food and domestic premises is relatively weak. The main piece of legislation used in these settings is the Prevention of Damage by Pests Act 1949 (PDPA). This legislation was introduced primarily to protect agricultural crops against rodent damage and its fundamental weakness is that it does not furnish EHOs with powers of entry. Whilst some local authorities have introduced local legislation to provide such powers of entry (for example the Greater Manchester Act 1981), many authorities do not have such legislation in place. Thus, if an infestation is confirmed within a terraced property, EHOs are often unable to gain access to all properties to treat the whole block if the owner refuses entry.

Whilst consideration of the impact of constructional features on the presence of rodent infestations is essential the need to understand and explore the perceptions of residents is an important and often neglected area of urban rodent control programmes. Only by establishing these factors can effective risk communication with the public be successfully undertaken. Previous attempts to involve local residents in control programmes have reported varying degrees of success (Colvin and Jackson, 1999; Lambropoulos *et al*., 1999; Margulis, 1977). However, if communities are not centrally involved by ensuring their beliefs and perceptions of urban rodents are integrated into control programmes, then they may believe that eradicating infestations is someone else's responsibility and that they have little to contribute to the long-term success of control programmes. Characteristics such as the audience's level of knowledge and education; their mental models, attitudes and beliefs about the issue at hand; their level of receptivity and openness to the ideas being communicated and their concerns about the issue will also affect the way in which risks are communicated (Bier, 2001).

Rowan (1991) identified five possible goals of risk communication: building trust in the communicator; raising awareness (e.g. of the potential disease hazard of rodents); educating; reaching agreement (e.g. on a particular strategy for ensuring long term control of rodent infestations) and motivating action (e.g. encouraging residents to adopt an integrated control strategy to reduce levels of infestation). Because of this multiplicity of purposes, different strategies of risk communication may be appropriate for different goals.

Different perceptions in the attitudes of the public to rodents may influence the way in which they implement their own control strategies and such actions may inadvertently facilitate the establishment of chronic infestations.

MATERIALS AND METHODS

The research area in Cheetham Hill, Manchester is a typical inner city residential area with a mixture of privately and publicly owned domestic properties ranging in age from pre-1919 terraces to post-1964 detached and semi-detached properties. The research area encompassed 253 residential properties. A qualified surveyor gained access to 117 properties and surveyed them internally and externally. Only two of the 253 properties in the area had evidence of rats inside the property, and only 4 of the 274 tracking plates placed externally throughout the study site showed evidence of rats outside the properties (see Taylor and Quy, 1973 for techniques used). The analysis presented in this paper is based on evidence of mouse activity inside the properties.

The surveyor inspected each property internally and externally and scored the general area with regard to four general aspects of the properties (described below). The surveys were undertaken between January – May 2002. Residents either volunteered or were recruited during contact with the research team and appointment times convenient to the resident were agreed. As the same surveyor undertook all of the surveys, consistency was assured. He did not attempt to estimate the extent or size of the infestation but recorded evidence (for example the presence of rodent droppings or damaged goods) of internal mouse infestations. In addition to searching for signs of rodent infestation, he also asked the resident whether he/she thought the property was infested and to show him any signs of infestation that they had seen. A survey report for each property was completed, and data were entered into a SPSS electronic database. Cross-tabulations were carried out against presence or absence of indoor mouse infestations, and where significant associations were found, the variables were screened and spurious results excluded. Variables which were significant and plausible were grouped into four categories (see Table 1 for details of the characteristics included):

General characteristics of the property;
External structure ;
General food hygiene within the kitchen area;
General environment external to the property.

To investigate the perceptions of residents to rodent infestations, questionnaires were delivered to all properties within the area. In addition to asking householders

about current and previous infestations they were also asked about their approaches to control.

In order to encourage community participation, several community events before, during and after the fieldwork were organised to keep residents informed of the aims and objectives of the project. Regular newsletters (in English and Urdu) were delivered to all households to keep them updated with progress.

Results

Fifty percent of the properties surveyed were found to be infested with mice indoors. This is significantly higher than the levels of indoor mouse infestations reported in the EHCS ($\chi^2 = 933$; $p < 0.001$). Whilst the sample size in Cheetham Hill is modest, this difference may highlight a potential problem with the way in which the EHCS data were collected and weighted. Meyer and Drummond (1980) reported the effects of clumping in mouse infestations, and the EHCS, whilst giving a good indicator of infestations across the UK, may miss the clumping effect, particularly in urban areas with a high proportion of older terraced properties.

The relationship between specific variables and the presence of mouse infestations was explored using a chi-square analysis (Table 1). These results confirm the complexity of the factors which determine mouse infestations within a particular area and underline the importance of an holistic approach to control.

In addition to the information collected by the surveyor, residents were asked, via a questionnaire about their opinions on rodents and their control. Questionnaires were delivered to all dwellings within the study area and 224 responses were received (88.5% response rate).

The residents were asked how they knew they had a mouse infestation (n = 156). Eighty one percent of residents had seen mice, 70% had seen droppings, 56% had heard them, 43% had noticed chewed items, 23% smelt them and 3% sited other reasons for concluding that they had a mouse infestation.

The residents were asked to indicate where they had seen mice within their property (n = 152). Eighty four percent reported seeing mice in the kitchen, 60% in the lounge, 44% in the bedrooms, 25% in the bathroom and 12% in the loft space. These findings confirmed that mice tended to be found around food storage, preparation and eating areas and underlined the importance of examining features in the kitchen that were likely to facilitate the persistence of mouse infestations.

Respondents were asked how they thought the mice had got into their property (n = 132). The largest proportion (48%) stated that they did not know. Other reasons included: via floorboards (15%), via outside doors (11%), via general holes (7%) and via the cavity walls (5%). Residents were also asked where they thought the mice were coming from (n = 149). The largest proportion thought that mice were coming from the garden or outside (34%). Thirty two percent thought mice were coming from next door and 20% stated that they did not know where the mice were coming from.

Analysis of the approaches adopted by those in the study area to control mouse infestations was undertaken. Of the 154 respondents who had experienced

infestations either currently or previously, 77% had attempted to get rid of the mice themselves. Respondents were given four options (use of live traps, snap traps, poisons and 'other' methods) and asked to indicate all the methods they had used. Results are presented in Table 2. Poisons were used by 62% of the respondents, traps (either live or snap) by 56% of respondents and other methods by 13%. Only two respondents mentioned the need for improved hygiene and maintaining the fabric of the building. Twenty three per cent of respondents reported that they had not attempted to control the infestation in any way. It is unclear what influenced their decisions not to undertake treatments themselves. These results provide important information about approaches to control.

Residents were asked to indicate their levels of agreement with 6 statements about mouse infestations (see Table 2). Results demonstrated that the majority of residents (96%) were aware that mice could carry diseases that were transmissible to man. Almost a third of respondents thought that it was easy to get rid of mice, despite the history of chronic infestations within the area. The vast majority (93%) of respondents acknowledged the impact of construction in agreeing that mice were able to invade from neighbouring properties. There was divergence in the responses related to the relationship between infestation and hygiene, with 48% disagreeing with the statement that mice were more likely to live in dirty houses. A large proportion of respondents (65%) believed that using poisons was the best way to get rid of mouse infestations. These responses suggest that residents are not clear about the need for integrated control measures and prefer to rely on the use of rodenticides to control infestations. Thirty-five percent of respondents also believed that leaving poisons down even when there was no active infestation. Poisons will decline in efficacy over time and it is also likely that continual access to anticoagulant poisons is likely to encourage the establishment of resistant populations.

Discussion and conclusion

The survival of urban rodent populations is predicated on their abilities to exploit the niches provided by human activities. However, it remains difficult to provide a realistic estimation of the risks posed by mice in the urban environment within domestic dwellings. Previous research has demonstrated that urban mice can act as vectors of diseases that could cause substantial morbidity and possibly mortality within human populations. It is also clear that the general environment and the constructional features of urban buildings influence population dynamics and the opportunities for contact with people. Variation in the approaches to the control of rodents and little attempt to rigorously evaluate treatment regimes means that a piecemeal approach to their control persists.

Mouse control in the UK relies heavily on a reactive approach to control. This approach will continue to hamper the long term and effective control of mice. The results of this study highlight the need for a coherent, strategic approach to control which addresses building maintenance, external and internal hygiene, provision of explicit advice and where appropriate, legal action to ensure that improvements are undertaken. Whilst the initial costs of undertaking block treatments may be substantial, once infestations have been reduced or eradicated by the systematic treatment of all premises within the block, the long term costs of maintaining pest free dwellings should be reduced significantly.

Following collection of this information a treatment regime was established. All properties with evidence of infestations were treated. Properties which were either attached to infested properties or within a block which contained infested properties were also treated to ensure mice could not migrate to other areas and avoid treatments. Residents were given advice on hygiene and proofing and each household was given 5 free snap traps. Follow up surveys have confirmed that this area remains free of mouse infestations

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Table 1: Variables related to four general aspects of the properties surveyed with χ^2 statistics, significance levels and % mouse infestation for each variable

GENERAL CHARACTERISTICS		
Tenure of the property (χ^2 = 9.04, 2df, p = 0.011)		
Variable	**n**	**% infested**
Privately owned	84	48%
Privately rented	23	71%
LA rented	10	20%
Date of construction (χ^2 = 42.14, 3 df, p = <0.001)		
Pre 1919	60	77%
1919-1939	6	67%
1940 – 1964	3	67%
Post 1964	48	15%
Dwelling type (χ^2 = 31.7, 1 df, p = <0.001)		
Detached/semi detached	43	16%
Terraced/flats	74	70%
Fitness (χ^2 = 47.1, 3 df, p = <0.001)		
Unfit	11	91%
Defective	19	84%
Acceptable	51	61%
Satisfactory	36	6%
EXTERNAL STRUCTURE		
Damp proof course (front and back) (χ^2 = 25.58, 1 df, p = <0.001)		
Satisfactory	72	32%
Unsatisfactory	45	80%
External front and back overall assessment (χ^2 =5.4, 1 df, p = 0.02)		
Satisfactory	100	46%
Unsatisfactory	17	76%
Gaps on external door thresholds (χ^2 = 14.11, 1 df, p = <0.001)		
Gaps present	30	80%
No gaps	87	40%
Airbricks (χ^2 = 11.86, 1 df, p = 0.001)		
No Airbrick present	50	32%
Airbrick present	67	64%

KITCHEN		
Kitchen food storage (χ^2 = 15.85, 2 df, p = <0.001)		
Variable	**n**	**% infested**
Good	34	23%
Satisfactory	69	58%
Poor	14	79%
Kitchen refuse storage (χ^2 = 20.52, 2 df, p = <0.001)		
Good	34	23%
Satisfactory	69	55%
Poor	14	93%
Kitchen under cupboard access (χ^2 = 9.77, 1 df, p = 0.002)		
Yes	73	62%
No	44	32%
Kitchen overall hygiene (χ^2 = 14.35, 2 df, p = 0.001)		
Good	34	23%
Satisfactory	64	59%
Poor	19	68%
GENERAL ENVIRONMENT		
Vacant properties (χ^2 = 19.09, 1 df, p = <0.001)		
Little problem	51	27%
Substantial problem	66	68%
Industrial waste/rubbish (χ^2 = 19.09, 1 df, p = <0.001)		
Little problem	**51**	**27%**
Substantial problem	66	68%
Domestic waste/rubbish (χ^2 = 19.09, 1 df, p = <0.001)		
Little problem	51	27%
Substantial problem	66	68%
Evidence of residents feeding pigeons (χ^2 = 17.57, 1 df, p = <0.001)		
Little problem	50	28%
Substantial problem	67	67%

Table 2: Levels of agreement (%) with 6 statements associated with mouse infestations

Statement	**CA***	**A**	**D**	**CD**	**n**
People can catch diseases from mice	66	30	3	1	206
It is easy to get rid of mice	7	20	49	24	203
If my neighbour has mice I will get mice too	48	45	6	0	205
Mice are more likely to live in dirty houses	25	27	38	10	201
Using poisons are the best way to get rid of mice	25	40	28	7	195
You should always leave poisons down, even if you don't have mice at the moment	14	21	39	26	189

* CA: Completely agree; A: Agree; D: Disagree; CD: Completely disagree