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Rodent Infestation in Khayelitsha Site C: Differences between the experiences of households in formal and informal settlements.

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Rodent Infestation in Khayelitsha Site C: Differences between the experiences of households in formal and informal settlements.

Abstract

This paper explores the experiences with rodent infestation of people living in Site C, Khayelitsha. The objective is to see if there are any appreciable differences between those living in shacks or formal houses. It draws on quantitative and qualitative data from the Khayelitsha Rodent Study (KRS) to show that rodents cause appreciable damage, especially in shack areas. Controlling for area type, rodent entry points in the floor and through the walls was statistically significantly associated with rodent damage.

1. Introduction

Since the mid-2010s, Cape Town appears to have been experiencing an upsurge in pest rodents, particularly rats (Nattrass et al., 2018). This is especially a problem in densely-populated lower-income shack settlements, placing children at an elevated risk of suffering rodent bites (De Klerk et al., 2016) and posing threats to household food stores and possessions.

This paper considers the experiences with rodent infestation of people living in Site C, Khayelitsha. The objective is to see if there are any appreciable differences between those living in shacks or formal (brick) houses in this mixed settlement area (see Figure 1). Khayelitsha is a township located on the Cape Flats in Cape Town, South Africa. The name means “New home” in IsiXhosa. The township was built during the apartheid regime and is now the second largest township after Soweto in Johannesburg (Beyond Our Borders, n.d.). Khayelitsha is split into 22 sections or areas consisting of old formal areas with newer, mostly informal shack settlements around them. Key areas include: Site B, Site C, Green Point, Litha Park, Mandela Park, Makaza and Harare. Deeply entrenched in Khayelitsha are persistent socioeconomic problems:

unemployment is at a staggering 73%, with 70% of the population living in shacks and 89% of households considered moderately to severely food insecure (Beyond Our Borders, n.d.). Given that rodent infestation is correlated with poor socio-economic conditions and dense, poor-quality housing, we expected study participants in the area to confirm a rodent problem.

The analysis draws on qualitative data from the Khayelitsha Rodent Study (KRS) to provide a flavor of what it means to live in rodent infested homes. Rodent infestation here is measured by damage caused by rodents to household and frequency of rodent sightings in the home. This paper includes a multiple linear regression of rodent damage with area type, rodent entry points into home and kitchen risk factors as regressors. The analysis finds that only rodent entry points and area are statistically significant predictors of whether households experienced any rodent damage.

The KRS was conducted by the University of Cape Town Centre for Social Science Research (CSSR). The study was a two-stage, stratified random sample conducted in Site C (also known as Ikwezi Park), Khayelitsha, South Africa, between the period 08-08-2017 and 26-11-2017. It is to the best of my knowledge the first representative survey of rodent infestation and control in Cape Town. The sample comprised 221 households (formal and informal) drawn from 11 Small Areas as defined in the 2011 South African census (Nattrass et al., 2018). The sample rule aimed for a 12.5% sample from each Small Area. As of December 2017, an average of 10% had been interviewed. The sampling design allows for representative conclusions to be made about people living in Site C on issues including the experience of rodent infestation, rubbish management, socio-economic status, attitudes to rodent control etc. (Nattrass et al., 2018).

The questionnaire research was conducted by me (Fezeka Lephaila) and Thobani Ncapai, in Xhosa. In addition to posing pre-coded questions (for data capture) on rodent presence, rodent control strategies, socio-economic status, personal characteristics, etc., we made extensive notes recording anecdotes and additional information volunteered by respondents. This rich combination of quantitative and qualitative data allows for a mixed methods approach to understanding potential socio-economic determinants of rodent infestation (and related damage) as well as the meanings attached to it. Promkerd et al. (2008) used a similar approach in drawing on both statistical analysis and more ethnographic observations. The key question explored in this paper is whether there are statistically significant differences between informal and formal parts

of Site C with respect to rodent infestation. We expected rodent infestation to be more of a problem in informal settlement areas within Site C.

2. Rodents and the risks they pose to humans

Rodents make up nearly half of living species of mammals (de Masi et al., 2009). They have upper and lower pairs of ever-growing rootless narrow-edged teeth (Musser, 2017b), which accounts for their gnawing behaviour. This can result in structural damage to homes and the destruction of household objects (Mughini Gras et al., 2012; Musser, 2017a).

Only 50 out of 2050 rodent species are known to cause damage to agriculture or public health (ibid). This small subgroup of pest rodents is directly responsible for the transmission of more than 60 diseases to both human beings and domestic animals (World Health Organization [WHO] 1992). Rodents are carriers of zoonic pathogens, including but not limited to Leptospira interrogans, Rickettsia typhi, Yersinia pestis and Streptobacillus monilliformis (Roomaney et al., 2012; De Klerk et al., 2016; Puckett et al., 2016.), with children under the age of 5 being most susceptible.

The house mouse (*Mus musculus*), black rat (*Rattus rattus*/roof rat/house rat) and brown rat (*Rattus norvegicus*) are commensal rodents that thrive in human-dominated environments and are ubiquitous in urban areas (Langton, 2001; Puckett et al., 2016; Himsworth et al., 2014). The magnitude of rodent infestations is largely linked to poor-socio economic and environmental factors (Langton, 2001). Poor sanitation and open drains; inadequate storage of food and poor waste disposal combined with deteriorating and high-density housing provide food, water and shelter for rats (Mughini Gras et al., 2012; Jassat et al., 2013; De Klerk, 2016).

Jassat et al. (2013), identified the use of communal taps, pit latrines, storage of water (instead of reticulated water) and the absence of a waste bins as encouraging factors for rat prevalence in Johannesburg households. Additionally, leaking roofs and damp floors were positively associated with rodent infestation, while owning a cat reduced rat infestations by 60% in homes (ibid). In South Africa, to curb the scourge of rodent infestations, poor South African communities turn to highly toxic illegal pesticides to manage rodents (Rother, 2010; Nattrass et al., 2018). Street pesticides, such as aldicarb – an agricultural pesticide, are very dangerous. A 60 mg sachet has the potency and potential to kill 6 children (Roomaney et. al., 2012). Unprotected exposure to illegal pesticides can result in acute health consequences ranging from asthma,

cancer, reproductive complications and birth defects to neurological limitations and sometimes even death (*ibid*). It appears then that the use of poison, while intended to rectify the problem of rodent infestations and its associated dangers, inadvertently adds another layer of risk.

3. Living with rodents: some descriptive statistics

Site C comprises both formal and informal residential areas, with the informal areas comprising mostly stand-alone shacks (96.1%) and the formal area mostly brick houses (70.8%). Shacks are built primarily out of zinc, and formal houses out of brick and concrete blocks. Concrete flooring predominates across formal and informal areas, suggesting that variation in floor type is unlikely to be a robust predictor of rodent infestation.

Table 1 compares the basic demographics for households in the formal area and the informal area. The average household size is smaller in the informal area than in the formal area (3.3 and 4.6 people respectively), a difference that is statistically significant at the 1% level. Formal households also have more adults, more employed adults (statistically significant at the 5% level) more children (including of school-going age) and are much more likely to have pensioners.

The wealth difference between the formal and informal area is measured using the asset price index constructed by taking the average price of common household items, including but not limited to items such as a television, electric stove, car, lounge suite and basic tools such as hammers and pliers. On average, formal area homes have an average asset price index of R30,191.66 vs R16,159.87 in informal areas (a difference that is statistically significant at the 1% level). Wealth distribution in the formal area is more varied relative to informal area as shown by the standard error of R2,048.29 vs R952.30 respectively. At the aggregate level across both areas, the average household wealth amounts to R21,493.22. This average is above the modal value of R19,711.25 and this is indicated by a skewness of 1.55. There are some influential outliers inflating the mean. This is indicated by a high Kurtosis of 4.95, with outliers as large as R68,469.58.

Table 1. Summary statistics for formal area relative to informal area:

		Formal	Informal	Total	Pr (|T|>|t|)	T statistic#
Household size	Mean	4.59	3.25	3.76	0.000***	4.817
	Standard error	0.25	0.15	0.14		
	N	84	137	221		
Adults	Mean	2.52	2.07	2.24	0.002***	3.146
	Standard error	0.12	0.08	0.07		
	N	84	137	221		
Employed	Mean	1.28	1.06	1.15	0.041**	2.052
	Standard error	0.09	0.06	0.05		
	N	84	136	220		
Pensioners	Mean	0.30	0.06	0.16	0.000***	4.417
	Standard error	0.05	0.02	0.02		
	N	84	136	220		
Asset price index	Mean	R30,191.66	R16,159.87	R21,493.22	0.000***	6.975
	Standard error	R2,048.29	R952.30	R1,077.05		
	N	84	137	221		
School goers	Mean	1.43	0.85	1.07	0.000***	3.609
	Standard error	0.15	0.08	0.08		
	N	84	137	221		
Children	Mean	0.64	0.34	0.45	0.002***	3.158
	Standard error	0.09	0.05	0.05		
	N	84	137	221		

Two-sample t-test of the difference between the means of formal and informal area dwellings. Pr (|T| > |t|) is the two-tailed p-value computed using the t distribution. It is the probability of observing a greater absolute value of t under the null hypothesis. If the p-value is less than 0.1 (*) or 0.05 (**) or less than 0.01 (***), we conclude that the difference is statistically significant. N = number of observations.

Table 2 shows that there are statistically significant differences (at the 1% level) with regard to the frequency of rat and mice sightings (whether in the home or in the area) between formal and informal settlements. The indicator of rodent presence refers to how often in the past month respondents had seen rodents (either rats or mice) in their homes or in their area. The index takes a score of 1 for ‘never’, 2 for ‘a few times’, 3 for ‘many times’ and 4 for ‘just about every day’. On average households in the informal area report higher sightings of rats in the area (a mean of 3.4, which roughly translates to many times), relative to the formal area (a mean of 2.4, roughly translating to seeing rats in the area a few times in the past month). Informal areas also report higher levels of rat sightings in the home (a mean of 2.3 compared to 1.5, significant at the 1% level.)

Table 2. Summary statistics for formal area houses relative to informal: Rodent presence

Index of rodent presence: How often have you seen rats/mice/rodents in your area and home in the past month (1=never, 2=a few times, 3=many times, 4=just about every day)		Formal	Informal	Total	Pr (|T|>|t|)	T-statistic#
Rat sightings in area	Mean	2.39	3.36	3.01	0.000***	-6.360
	Standard error	0.13	0.08	0.07		
	N	68	122	190		
Rat sightings in home	Mean	1.5	2.26	1.98	0.000***	-5.139
	Standard error	0.09	0.09	0.07		
	N	68	122	190		
Mice sightings in area	Mean	2.55	3.05	2.87	0.001***	-3.194
	Standard error	0.11	0.09	0.07		
	N	70	121	191		
Mice sightings in home	Mean	2.08	2.86	2.58	0.000***	-5.621
	Standard error	0.11	0.07	0.07		
	N	0 69	121	190		

Two-sample t-test of the difference between the means of formal and informal area dwellings. Pr (|T| > |t|) is the two-tailed p-value computed using the t distribution. It is the probability of observing a greater absolute value of t under the null hypothesis. If the p-value is less than 0.1 (*) or 0.05 (**) or less than 0.01 (***) we conclude that the difference is statistically significant. N = number of observations.

3.1 KRS qualitative data on living with rodents

This section draws on the qualitative data (obtained from comments recorded on the questionnaires) from the KRS study to provide a flavour of what it means to live in a rodent infested environment. The quotes below speak to the fear and irritation associated with living with rats and mice.

> ‘I see them every day, all the time. They're always here. I mean if you were to go outside now you'd see them. Sometimes they chase each other inside the house. They come into the house all the time at night, during the day all the time. Especially at night, during the day not so much, but at night it's scary sometimes you feel one landing on your bed like it fell from the ceiling. Sometimes you hear it chewing the base of your bed, sounds like someone is using a chainsaw on your bed.’

‘There is one in the house as we speak. They come in during the day and sit in corners and under the bed the whole day and you hear it at night walking between walls. There is no getting used to them[rats], rather the small ones[mice] you can always scare away. I worry for myself and the kids. There is no sleeping once it starts moving between walls: it’s heavy; has quite a strong presence and not in a good way. There's no way you'd be happy living with a wild animal only slightly smaller than a cat.’

‘I only hear them at night when we're asleep. They're probably sleeping during the day. When they're inside you know they're inside; you don't see them - you hear them. As soon as you turn on the lights, they run. I'm used to them now they live with me.’

‘They're really scary and big, as big as cats - some look like they can't walk because they're so heavy and full, I guess. We don't have them in my house, but I saw one by Island [an area within Site C]. I mean those things are huge - they could eat a person.’

‘I see them at night. I don't see them, but I hear them at night. Especially when it’s hot or I've cooked, they all come camp here. I work during the day, so I don't really see them, but I hear them at night. I think that’s their mating season [summer] that’s when you see tiny hairless ones.’

‘When I get to the kitchen I find a whole lot of them on the floor, they send me back running to my room. They're different sizes; there are small ones, there are long ones as well - you'd think they're snakes. Our mice are big - I'm not even talking about rats, I'm talking about mice.’

‘Unlike other people I see them live, not hear them at night. We'll be sitting here having dinner and say a grain of rice drops to the floor you'll see one swooping in to eat it before you sweep it away. They're the sizes of kittens. There's no way you wouldn't be scared, they're heavy. They're so big they could scoop us out of our homes. I don't sleep peacefully.’

‘It becomes a part of our life, we greet them now. Yes, even know these rats and know which one is yours. They've become a part of the family. You'll be sitting in the living room and see it walking by and

no one says anything – we watch it. We even name them; they have markers. I sleep really late and that's when they decide to come out so I see them.'

4. Exploring external risk factors for rodent infestation

This section explores potential external risk factors for rodent infestation pertaining to the outside yard (Table 3) and potential rodent entry points (Table 4).

Table 3: Potential yard risk factors

Yard risk factor binary (0=No, 1=Yes)		Formal	Informal	Total	Pr (|T|>|t|)	T-statistic#
Outside carpets	Mean	0.22	0.67	0.50	0.000***	-7.240
	Standard error	0.04	0.04	0.03		
	N	84	137	221		
Outside carpets	Mean	0.06	0.06	0.06	0.841	-0.200
	Standard error	0.02	0.02	0.01		
	N	83	134	217		
Vegetable garden	Mean	0.01	0.01	0.01	0.727	0.349
	Standard error	0.01	0.01	0.01		
	N	84	137	221		
Garden	Mean	0.08	0.06	0.07	0.635	0.474
	Standard error	0.03	0.02	0.01		
	N	84	136	220		
Livestock	Mean	0.01	0.00	0.00	0.202	1.278
	Standard error	0.01	0.00	0.00		
	N	84	137	221		

Two-sample t-test of the difference between the means of formal and informal area dwellings. Pr (|T| > |t|) is the two-tailed p-value computed using the t distribution. It is the probability of observing a greater absolute value of t under the null hypothesis. If the p-value is less than 0.1 (*) or 0.05 (**) or less than 0.01 (***), we conclude that the difference is statistically significant. N=number of observations.

Table 3 explores whether differences in the immediate external environment between formal and informal areas were significantly associated with rodent presence in the house or not. Yard risk factors assessed in the KRS questionnaire included the presence of carpets covering the ground outside (which could potentially provide places for rats and mice to nest under); piles of rubbish within 5 metres of the house (further potential nesting sites); a vegetable garden; a garden (flower garden) and livestock kept on the property (all of which

potentially provide food and places to shelter). Of these risk factors, only carpets on the ground outside was statistically significant (68% of houses in informal areas had carpets on the ground outside compared to 22% in the formal area). All other differences were not statistically significant.

Table 4: Rodent entry points into home

Entry point binary (0=No, 1=Yes). Entry Points (non-binary but an index: 0=None; 1=One; 2=Two; 3=Three, 4=Four)		Formal	Informal	Total	Pr (|T|>|t|)	T-statistic#
Enter door	Mean	0.41	0.37	0.39	0.583	0.549
	Standard error	0.05	0.04	0.03		
	N	83	137	220		
Enter floor	Mean	0.03	0.14	0.10	0.009***	-2.609
	Standard error	0.02	0.03	0.02		
	N	83	137	220		
Enter wall	Mean	0.03	0.13	0.09	0.019**	-2.348
	Standard error	0.02	0.02	0.01		
	N	83	137	220		
Enter gaps	Mean	0.09	0.49	0.34	0.000***	-6.592
	Standard error	0.03	0.04	0.03		
	N	83	137	220		
Enter clueless	Mean	0.13	0.07	0.09	0.146	1.457
	Standard error	0.03	0.02	0.01		
	N	83	137	220		
Enter never	Mean	0.23	0.04	0.11	0.000***	4.277
	Standard error	0.04	0.01	0.02		
	N	78	134	212		
Entry points	Mean	0.57	1.14	0.93	0.000***	-6.171
	Standard error	0.06	0.06	0.04		
	N	83	137	220		

Two-sample t-test of the difference between the means of formal and informal area dwellings. Pr (|T| > |t|) is the two-tailed p-value computed using the t distribution. It is the probability of observing a greater absolute value of t under the null hypothesis. If the p-value is less than 0.1 (*) or 0.05 (**) or less than 0.01 (***) we conclude that the difference is statistically significant. N = number of observations.

The KRS questionnaire asked respondents where they thought rodents might be accessing their homes. The questionnaire included four distinct entry points, allowing us to construct binary variables for whether they thought rodents were entering through the front door; through holes in the floor; holes in the wall and through gaps in the wall. Entry through gaps between the floor and the wall can be regarded as a proxy for dilapidation.

Table 4 shows that there was no statistically significant difference across informal and informal areas with regard to whether rodents were perceived as entering through the front door. Entry through floor and gaps between the floor and wall, however were statistically significant at the 1% level and so can serve as possible explanatory variables for the variation in rodent infestation between formal and informal area homes. This difference is to be expected given that the majority of houses in the formal areas have cement walls and therefore are more structurally sound than informal area homes with predominantly zinc wall structures which are more likely to have more gaps between the floor and wall. The dominant floor type in both formal area and informal area homes is carpets on concrete. Even so, households in the informal area were statistically significantly more likely to report rodents coming through holes in the floor than in the formal areas (14.6% as opposed to 3.6%). There was also a statistically significant (at the 5% level) difference in reports between formal and informal areas of rodents entering the home through the walls. On average, informal area households report higher levels or rodent home invasion through penetrating the walls relative to formal area homes (13.1% and 3.6% respectively). Again this is expected, due to structural differences: informal area homes largely have cement walls while formal area homes have zinc walls.

Some households reported awareness of rodent presence in home but ignorance as to their points of entry into the home. For such homes a variable labelled "enter clueless" was created but proved to be statistically insignificant at 10% level, thus offering little information about potential sources of variation in rodent presence in households across area type. Some households report that rodents never enter their home. As expected, this report is more common in the formal area than informal area and the finding is statistically significant at the 1% level. An entry points index was then created which is the summation of the four identifiable entry points where net score 0= zero entry points; 1= one entry point; 2= two entry points; 3= three entry points and 4= four entry points. On average households in the informal area reported more rodent entry points into household as indicated by the mean entry score of 1.2 compared to the formal area mean score of 0.6 (a clearly statistically significant difference at the 1% level).

4.1 KRS qualitative data on how rodents enter homes

This section includes quotes from the KRS qualitative data to provide additional information on residents' thoughts and observations of how it is that rodents get into their homes:

> 'They don't come straight through the door. They burrow through walls and small holes between the small openings in zinc roofs.'

> 'I do not have any rat or mice holes so I think those that make noise on the ceiling come in through the roof.'

> 'They rush in when the door is open. Even through the cement they create holes from underneath. I don't know how but they get through. They dig holes through the ground and travel underground into the house. You seem shocked we're not safe here from rats. They get through everything. It's that river that's the problem.'

> 'They travel underground - you can feel them under your tiles. They have their own routes and holes underneath. They go underground and then come out of a hole somewhere into your home. They're always in groups - never alone - about 3 or 4 and if you shout at them then they come back with anger and cause more damage. I don't know - they're like evil spirits; they understand what we say.'

> 'They burrow through cement floors and into the house. We no longer have mice only rats - I think the big ones eat them. They love clothes. It's remarkable they get through anything. We have a washing machine in the other house When I take out my load I always find one in there. I don't know how they get in as it works just fine, there are no holes but they get in there and from in there they eat my clothes.'

5. Exploring internal risk factors for rodent infestation

This section explores potential internal risk factors for rodent infestation pertaining to general household hygiene (Table 5). To assess whether there were differences in internal household cleanliness that might increase the risk of

rodent infestation, the interviewers were asked to assess house cleanliness by a cursory inspection; especially looking for dirty dishes and exposed food. Binary variables were then created for these factors namely 'House dirty', 'Dirty dishes' and 'Exposed food', for each answer in the affirmative the value one was assigned and zero for negative. The responses to the three variables were then tallied up to create a variable, 'kitchen risk'. The following labels were assigned for each level of kitchen risk: 0= none, 1=low, 2=moderate and 3=high.

On average informal area homes have a higher kitchen risk relative to formal area homes as indicated by the mean score of 0.6 compared to the formal area value of 0.4 (a statistically significant difference at the 10% level). Although the difference is statistically significant it is worth noting that both risk factors on average range between zero and low. Individually 'House dirty' and 'Exposed food' of the three variables are the only statistically significant variables. On average informal area homes are dirtier than formal area homes and have poor food storage, leaving food readily available to rodents.

Table 5: Internal hygiene

House dirty, dirty dishes and exposed food (binary 0=no, 1=yes)//Kitchen risk index (0=none; 1=low; Moderate=2 and 3=high)		Formal	Informal	Total	Pr (|T|>|t|)	T-statistic#
House dirty	Mean	0.16	0.27	0.23	0.056*	-1.919
	Standard error	0.04	0.02	0.02		
	N	84	136	220		
Dirty dishes	Mean	0.19	0.2	0.19	0.863	-0.171
	Standard error	0.04	0.03	0.02		
	N	84	135	219		
Exposed food	Mean	0.07	0.15	0.12	0.071*	-1.808
	Standard error	0.02	0.03	0.02		
	N	84	137	221		
Kitchen risk	Mean	0.42	0.61	0.54	0.097*	-1.667
	Standard error	0.07	0.07	0.05		
	N	84	134	218		

Two-sample t-test of the difference between the means of formal and informal area dwellings. Pr (|T| > |t|) is the two-tailed p-value computed using the t distribution. It is the probability of observing a greater absolute value of t under the null hypothesis. If the p-value is less than 0.1 (*) or 0.05 (**) or less than 0.01 (***), we conclude that the difference is statistically significant. N = number of observations.

5.1 Measuring rodent damage

Table 6 reports on the differences between households in the formal and informal areas regarding the experience of rodent damage in the past year. The damage types are presented as binary variables, 1=yes and 0=no. The responses for each damage type are then tallied to give a damage score which is then coded into a damage Likert scale with 0=none, 1=mild, 2=moderate, 3=severe and 4=very severe.

Table 6: Rodent damage

Evidence of food eaten, possessions damaged, rubbish infiltrated and have been bitten by rodents are binary variables (0=no, 1=yes)// damage Likert (0=none, 1=mild, 2=moderate, 3=severe, 4=very severe)		Formal	Informal	Total	Pr (|T|>|t|)	T-statistic #
Food eaten	Mean	0.64	0.89	0.79	0.000 ***	-4.730
	Standard error	0.05	0.02	0.02		
	N	84	134	218		
Possessions damaged	Mean	0.5	0.76	0.66	0.000 ***	-4.095
	Standard error	0.05	0.03	0.03		
	N	84	134	218		
Rubbish infiltrated	Mean	0.17	0.53	0.39	0.000 ***	-5.483
	Standard error	0.04	0.04	0.03		
	N	84	132	216		
Rodent bites	Mean	0.09	0.12	0.11	0.568	-0.571
	Standard error	0.03	0.02	0.02		
	N	84	134	218		
Damage score	Mean	1.41	2.31	1.96	0.000 ***	-6.116
	Standard error	0.12	0.08	0.07		
	N	84	132	216		

Two-sample t-test of the difference between the means of formal and informal area dwellings. Pr (|T| > |t|) is the two-tailed p-value computed using the t distribution. It is the probability of observing a greater absolute value of t under the null hypothesis. If the p-value is less than 0.1 (*) or 0.05 (**) or less than 0.01 (***), we conclude that the difference is statistically significant. N = number of observations.

Statistically significant at the 1% level, informal area households relative to formal area households are more likely to experience food damage by rodents. This is evidenced by the higher mean value to the binary question, ‘Have you seen evidence that mice or rats were eating your food?’ The closer the mean value is to the value 1, indicates an answer in the affirmative is common in the area. More specifically, 90% of households in the informal area reported seeing rodent-related damage to food in the past year compared to 64.3% in the formal

areas. The difference in response to the question 'Have you seen evidence that mice or rats were chewing your possessions or damaging your home?', represented here as 'Possessions damaged', is also statistically significant at the 1% level with informal area households reporting possessions damaged more frequently relative to formal area households. The same is true for 'infiltrated rubbish'. The response to 'Have you been bitten by rodents?' (Rodent bites), however, is not statistically significant.

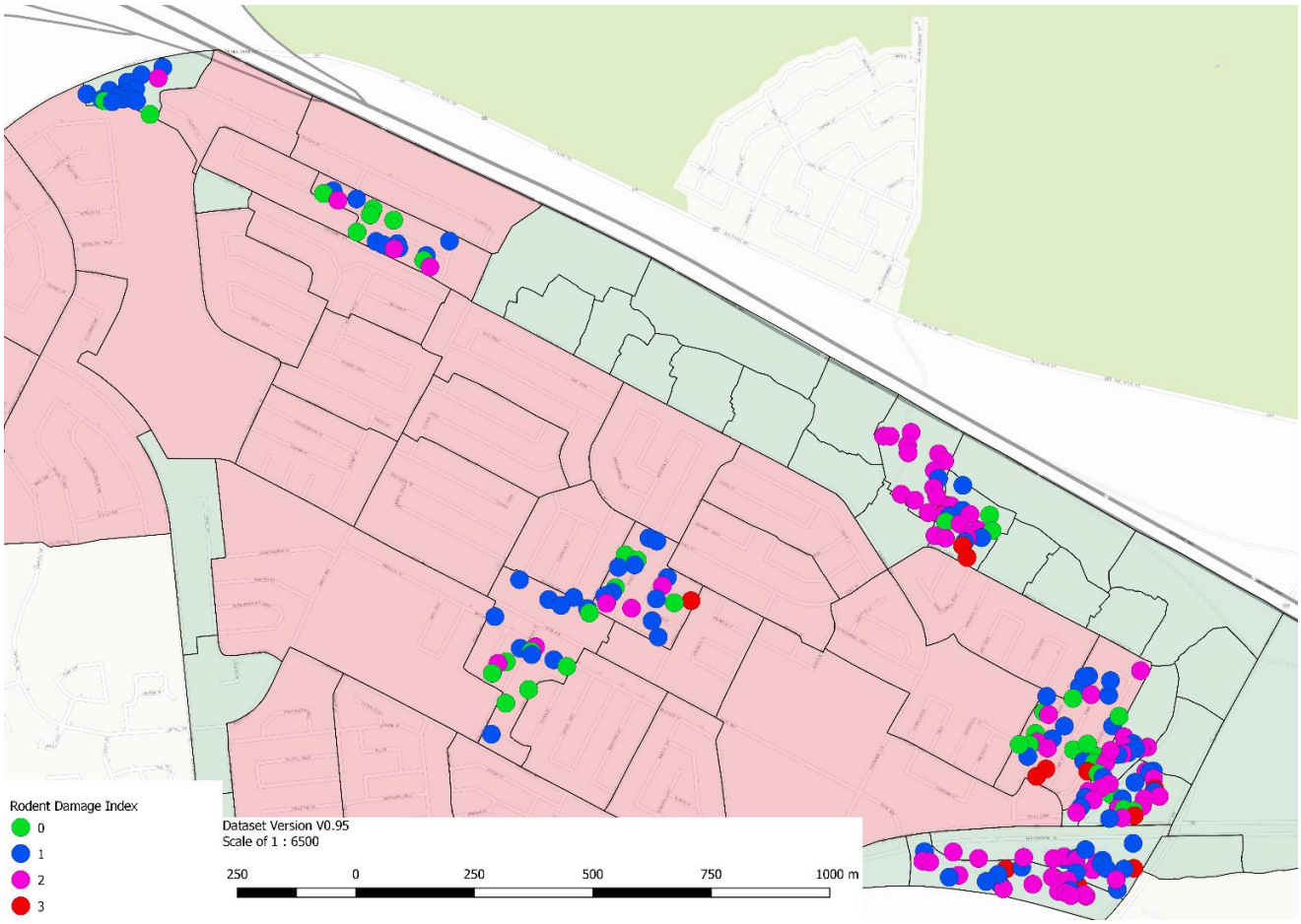

Figure 1: Spatial distribution of rodent damage in Site C study area where the blue-green area is the informal area and the pink the formal area [Map provided by Jed Stephens].

The rankings in the damage index between the two areas are statistically significantly different (at the 1% level). Informal area households reported a greater combination of rodent damage as evidenced by the larger mean score of 2.3 which, when truncated, roughly translates to moderate damage. The mean for formal area households was 1.4 which, when truncated, translates into mild

damage. It is expected that formal area households have lower damage index scores as there are on average fewer entry points and rodent sightings in the home relative to informal area homes. Figure 1 shows how the rodent damage index varies spatially and in line with the distinction between formal and informal housing areas in Site C.

5.2 KRS qualitative data on the nature and extent of rodent damage

When asked for richer descriptions of the nature and extent of rodent damage in their homes, people had the following to say:

> ‘They chewed my cardigan. I showed it to some friends. They then asked if I shouted/cursed them because apparently they chew your clothes in rebellion when you curse them.’

> ‘Where your food is exposed they're there. I sell vegetables, so they go for that; they have a fondness for potatoes.’

> ‘I don't know how they get into my cupboards, but they do. When I have bread there, they get to it. They chew through my food buckets creating holes for easy access. I swear when rats come into my house - it’s like there's a ghost coming into my house knocking everything in its path.’

> ‘You have to make sure to do the dishes before you sleep and throw away any leftover food else they'll eat it and you can't leave out your food buckets.’

> ‘They'd just poop everywhere. When you leave your food open on the table, they probably eat and poop on it.’

> ‘Sometimes they look like they're in a trance - not seeing you, not searching for food, just standing still, turning its head listening to conversations.’

> ‘I don't give them easy access to food because you'll find mice when you maybe cook and leave food in the open or crumbs on the floor then you'll have rats. I don't do that, I clean up after I cook and leave

nothing in the open. They don't chew clothes and cupboards - they ruin the house itself, they dig holes and chew through walls. When I have an inside plastic bag, I don't get any sleep to the point that I have to take it outside.'

'The worst part is that they destroy groceries and bite us at night.'

'Of cause they're dangerous. I mean they'll bite children in their sleep infecting them with all the poison they've been eating from all the homes.'

'There's a child who got bitten on her finger. She had to get an operation. I mean I sleep with the lights on. I think they won't bite me with the light on.'

[What is your worst rodent experience?] 'Having nightmares when they climb on top of you, you think you're having a bad dream. When you wake up you can't sleep again. They make a noise when they are trying to break into your house, so you get no sleep when they're here. Now that we have pigs, they know they're prey. But you see them across the road because the pigs can't cross over. It's not normal, they have an emotional response to being shouted at - they get angry. When you have visitors, they stand on their hind legs, look you in the eye with their ears standing at attention, listening to your conversation. It's not a normal animal.'

5.3. Exploring the determinants of rodent damage using multi-variate regression

The following section builds a predictive model for rodent damage in Site C. The regression is as follows:

Rodent damage =
$\beta 0 + \beta 1$ Formal + $\beta 2$ Enter floor + $\beta 3$ Enter gaps + $\beta 4$ Kitchen risk +u

Rodent damage here is taken as a proxy/measure of rodent infestation. The questionnaire asked about actual rodent sightings, but this information was deemed unreliable and not used here. Rodent sightings are not a reliable measure of rodent infestation as it is highly subjective, will vary between

members of the household and there is not an easy way to count the number of rodents one sees a day. Furthermore, there is no way of knowing the extent of rodent infestation without catching, marking and releasing the rodents (so called catch and recapture studies) because you would not know if you are seeing the same rodent multiple times, or different rodents each time. Furthermore, some people do not see rodents but hear them or see evidence of their damage and so the index of rodent damage (see Table 6) then becomes a more suitable proxy for the invasion of a home by rodents.

Given the exploratory analysis presented earlier, we hypothesize that living in a formal area will decrease rodent damage, and that identifiable rodent entry points increase rodent damage. The regression thus includes binary variables for formal/informal and for whether rodents are understood to be entering through the floor or through gaps between the floor and the wall (as an indicator of general dilapidation). Kitchen risks features as a binary for, and is expected to increase, rodent damage as dirt and exposed food draw rodents into the home.

Table 7: rodent damage regression

	(1)	(2)	(3): Main	(4)
VARIABLES		With entry	With kitchen risk	With yard risk and poor sanitation score
formal = 1	-0.962***	-0.626**	-0.611**	-0.580**
	(0.177)	(0.216)	(0.203)	(0.180)
enter_floor = 1		0.606***	0.567***	0.537***
		(0.148)	(0.141)	(0.131)
enter_gaps = 1		0.678**	0.661***	0.539***
		(0.214)	(0.180)	(0.154)
kitchen_risk_dummy = 1			0.230	0.201
			(0.165)	(0.173)
Poor sanitation score				0.097
				(0.063)
Yard risk				0.039
				(0.05)
Constant	2.350***	1.944***	1.857***	1.670***
	(0.134)	(0.183)	(0.195)	(0.214)
Observations	216	215	213	207
R-squared	0.174	0.237	0.245	0.245
Prob > F	0.0004	0.0013	0.0017	0.0202
Average of 5 Crossfold Root Mean Squared Error (RMSE) estimates	1.052	1.002	1.009	1.002

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7 presents 4 regressions. All regression F-tests reject the null hypothesis that all the coefficients are equal to zero. As we add variables to the regression each additional variable increases the percentage of variation in rodent damage explained by the independent variables. This is indicated by the increasing R-squared with each successive regression. The adjusted R-squared (which takes into account the impact of simply adding variables on the R-squared) is not available when using the svy: reg command in Stata (i.e. the command that accounts for the survey design effects). We thus used crossfold to provide an average of five root mean squared errors, with a lower score indicating a lower out of sample predictive error (and thus a better model). As seen from the table, adding entry points (regression 2) results in a stronger model compared to regression 1. Regression 3 (the main regression) adds kitchen risk. The coefficient is not statistically significant and adding it weakens the model slightly (as indicated by the rising probability for the F-test and the higher crossfold mean squared error). Finally, we include a further specification, regression 4, which adds yard risk and an indicator of sanitation quality[1]. Neither were statistically significant and did not improve the model. Being in a formal area remains the strongest predictor of rodent damage in all regressions.

4. Conclusion

The paper provides a preliminary investigation into possible determinants of rodent damage in Site C, Khayelitsha. We found that formal area households experienced less rodent damage than informal area households. Homes reporting more identifiable rodent entry points in the floor or walls reported higher levels of rodent damage. Rodent entry through gaps between the wall and the floor was taken as a proxy for structural dilapidation, indicating poor housing quality. Kitchen uncleanliness and exposed food, coded here as kitchen risk, were not statistically significant determinants of rodent damage – and neither was external conditions (yard risk). From anecdotal accounts the rodent problem in Site C has imposed economic costs on residents as rodents are reportedly destroying housing structures, possession and groceries. People are also clearly stressed by the presence of rodents and several raised concerns about the health consequences of poison use.

[1] The sanitation score is a composite indicator based on toilet system (ranging from shared outside toilets to flush toilets inside) and water system (ranging from communal taps to piped water in the house).

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