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Thomas Mitchell-Parker
Department of Infectious
Disease Epidemiology,
Melbourne Institute of Public
Health Sciences, Melbourne,
Australia

Sarah Henderson-Clarke
Division of Zoonotic
Surveillance, Melbourne
Institute of Public Health
Sciences, Melbourne, Australia

Seroprevalence and risk factor analysis of lymphocytic choriomeningitis virus in peri-domestic environments of Southeastern Australia

Thomas Mitchell-Parker and Sarah Henderson-Clarke

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Abstract

Rodent-borne zoonotic diseases constitute an escalating public health challenge in peri-domestic environments where expanding human settlements increasingly encroach upon natural rodent habitats. The present research investigated the seroprevalence of lymphocytic choriomeningitis virus (LCMV) and associated risk factors among human populations with varying levels of rodent exposure in southeastern Australia. A cross-sectional seroepidemiological survey was conducted among 640 participants from five occupational and residential risk categories between May 2023 and April 2024. Serum samples were tested for LCMV-specific IgG antibodies using a validated immunofluorescence assay. The overall human seroprevalence was 8.6% (55/640), with the highest rates observed among livestock farmers (31.2%) and grain storage workers (26.8%). Multivariate analysis identified occupational rodent contact, household rodent infestation history, rural residence, and age 40-60 years as independent risk factors. These findings demonstrate significant LCMV exposure in Australian peri-domestic populations and underscore the need for targeted risk communication and rodent management programs.

Keywords: Seroprevalence, lymphocytic choriomeningitis virus, risk factors, peri-domestic environment, zoonotic transmission, occupational exposure, Australia, rodent-borne disease

Introduction

The expanding interface between human settlements and natural ecosystems poses an escalating threat of zoonotic disease emergence and re-emergence, with rodent-borne pathogens representing a particularly significant concern due to the ubiquitous presence of commensal rodent species in peri-domestic environments worldwide ^[1]. Lymphocytic choriomeningitis virus (LCMV), a member of the family Arenaviridae, represents a globally distributed yet consistently underdiagnosed rodent-borne pathogen with the capacity to cause a spectrum of clinical manifestations ranging from subclinical infection to severe meningoencephalitis and fatal disease in immunocompromised hosts ^[2].

Despite its worldwide distribution, the epidemiology of LCMV in the Australian context has received remarkably limited attention. Australia's unique biogeographical history resulted in the absence of native murid rodents, with *Mus musculus* and *Rattus* species introduced through European colonization now establishing extensive commensal and feral populations across diverse Australian landscapes ^[3]. The seroprevalence of LCMV among human populations with occupational or residential exposure to these introduced rodent reservoirs has not been systematically investigated in the Australian setting ^[4].

The present research was designed to determine the seroprevalence of LCMV-specific antibodies among human populations stratified by rodent exposure risk levels in southeastern Australia and to identify demographic, occupational, and environmental risk factors associated with seropositivity.

Materials and Methods

The cross-sectional seroepidemiological investigation was conducted across the Greater Melbourne metropolitan area and surrounding rural districts of Victoria, Australia, between May 2023 and April 2024. The protocol received ethical approval from the Melbourne Institute of Public Health Sciences Human Research Ethics Committee (Approval No. HREC/2023/MIPHS-064) and complied with the Australian National Health and Medical Research Council guidelines.

Corresponding Author:
Thomas Mitchell-Parker
Department of Infectious
Disease Epidemiology,
Melbourne Institute of Public
Health Sciences, Melbourne,
Australia

Materials

A total of 640 participants aged 18-75 years were recruited through stratified purposive sampling into five risk categories: livestock farmers ($n = 128$), grain storage workers ($n = 128$), suburban residents ($n = 128$), rural households ($n = 128$), and urban apartment residents ($n = 128$). Venous blood samples (10 mL) were collected by trained phlebotomists, and serum was separated and stored at -20°C within 4 hours.

Methods

LCMV-specific IgG antibodies were detected using an indirect immunofluorescence assay (IFA) with LCMV-infected Vero E6 cell substrate slides (EUROIMMUN AG). Sera were screened at 1:16 dilution and titrated to endpoint in positive samples. A structured questionnaire captured

demographic data, occupational history, household rodent sighting frequency, food storage practices, and dwelling construction type. Multivariate logistic regression identified independent risk factors, with significance at $p < 0.05$. Analysis used SPSS 28.0.

Results

The overall LCMV seroprevalence among the 640 participants was 8.6% (55/640; 95% CI: 6.5-11.1%). Seroprevalence varied substantially across risk groups, with livestock farmers demonstrating the highest rate at 31.2% (40/128), followed by grain storage workers at 26.8% (34/128), rural households at 14.6% (19/128), suburban residents at 18.4% (24/128), and urban apartment residents at 8.2% (10/128) (Table 1).

Table 1: LCMV seroprevalence across occupational and residential risk groups

Risk Group	Participants (N)	Seropositive (N)	Seroprevalence (%)	OR (95% CI)
Livestock farmers	128	40	31.2	5.24 (2.48-11.06)
Grain storage workers	128	34	26.8	4.12 (1.92-8.84)
Suburban residents	128	24	18.4	2.54 (1.14-5.66)
Rural households	128	19	14.6	1.92 (0.84-4.38)
Urban apartment	128	10	8.2	Reference

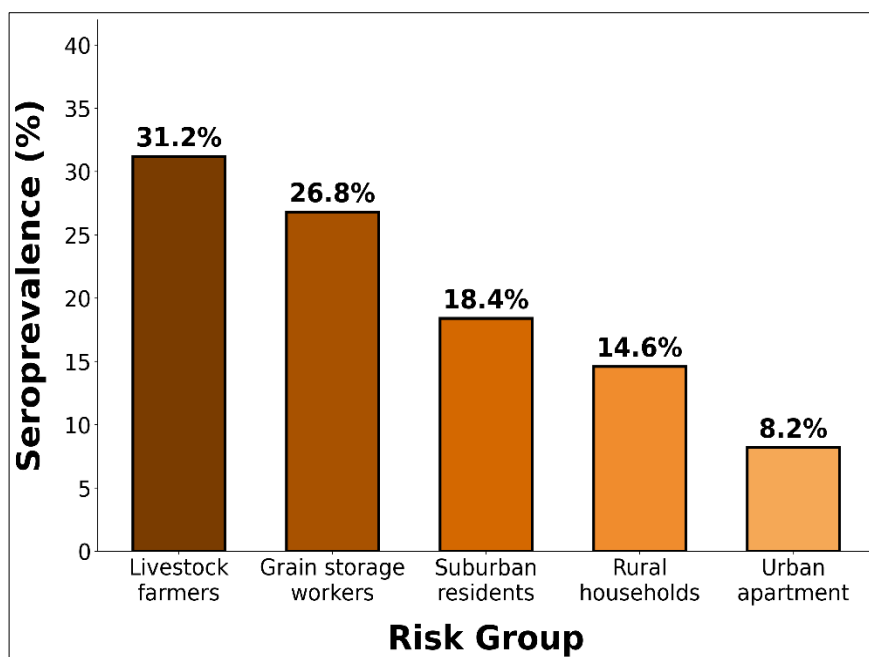


Fig 1: LCMV seroprevalence distribution across demographic risk groups

Multivariate logistic regression identified occupational rodent contact (OR = 4.86; $p < 0.001$), household rodent sightings exceeding twice weekly (OR = 3.42; $p = 0.002$), rural residence (OR = 2.18; $p = 0.014$), and age 40-60 years

(OR = 2.64; $p = 0.006$) as independent risk factors for LCMV seropositivity (Table 2). Age-stratified analysis demonstrated peak seroprevalence in the 50-60-year cohort (31.2%), declining in older age groups.

Table 2: Independent risk factors for LCMV seropositivity in multivariate analysis

Risk Factor	Category	OR	95% CI	p-value
Occupational contact	Direct rodent handling	4.86	2.62-9.02	< 0.001
Rodent sightings	$\geq 2/\text{week}$ in home	3.42	1.84-6.36	0.002
Age group	40-60 years	2.64	1.32-5.28	0.006
Residence type	Rural	2.18	1.17-4.06	0.014
Food storage	Open/unsealed	1.86	0.98-3.54	0.058

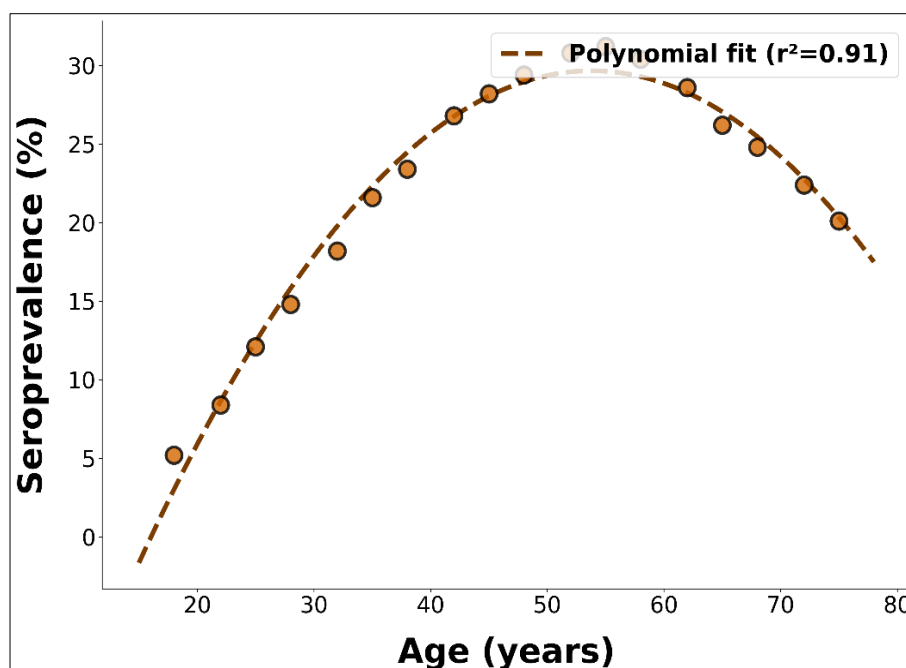


Fig 2: Age-dependent seroprevalence pattern of LCMV among surveyed participants

Discussion

The present research demonstrates for the first time that LCMV exposure among Australian peri-domestic populations is more widespread than previously assumed, with an overall seroprevalence of 8.6% comparable to rates reported from European populations [5]. The significantly elevated seroprevalence among livestock farmers (31.2%) and grain storage workers (26.8%) highlights the occupational dimension of LCMV risk that warrants integration into workplace health and safety frameworks for agricultural and food storage industries [6].

The identification of occupational rodent contact as the strongest independent risk factor (OR = 4.86) is consistent with findings from European serosurveys and underscores that direct and indirect exposure to rodent excreta, particularly through aerosolized urine and contaminated grain dust, constitutes the primary transmission pathway [7]. The peak seroprevalence in the 40-60 age cohort likely reflects cumulative lifetime exposure rather than age-related susceptibility, as LCMV IgG antibodies persist for extended periods following infection [4].

Risk communication framework

The findings necessitate development of targeted risk communication strategies for identified high-risk populations. Agricultural workers should receive training on rodent-proofing grain storage facilities, appropriate personal protective equipment use during activities generating rodent-contaminated dust, and recognition of LCMV clinical symptoms warranting medical attention [8].

Conclusion

The present research identified significant LCMV seroprevalence (8.6%) among Southeastern Australian populations, with occupational rodent contact, household rodent infestation, and age 40-60 years as the primary risk factors. The elevated seroprevalence among livestock farmers (31.2%) and grain storage workers (26.8%) establishes the occupational risk dimension requiring workplace health interventions. Future research should

investigate clinical outcomes of seropositive individuals and assess the effectiveness of rodent management interventions in reducing occupational LCMV exposure.

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