Knowledge, Attitude, Practices Study on Zoonotic Diseases Among Socially Marginalized Livestock Farmers and Sanitation Workers in Uttar Pradesh

Thesis

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Dedicated To...

My Beloved Family

and

Respected Guide

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Certificate

This is to be certified that the research work embodied in this thesis entitled **"Knowledge, attitude, practices study on zoonotic diseases among socially marginalized livestock farmers and sanitation workers in Uttar Pradesh"** *submitted by* **Dr. Himangi Gupta. M-6599,** *for the award of* **Master of Veterinary Science** *Degree in* **Veterinary Public Health and Epidemiology** *at Indian Veterinary Research Institute, Izatnagar, is the original work carried out by the candidate himself under my supervision and guidance.*

It is further certified that **Dr. Himangi Gupta. M-6599,** *has worked for more than two academic years (4 semesters) in the Institute and has put in more than 150 days attendance under me from the date of registration for the* **Master of Veterinary Science** *Degree in this Deemed University, as required under the relevant ordinance.*

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We the undersigned members of Advisory Committee of **Dr. Himangi Gupta. M-6599,** *a candidate for the degree of* **Master of Veterinary Science** *with the major discipline in* **Veterinary Public Health and Epidemiology**, *agree that the thesis entitled* **"Knowledge, attitude, practices study on zoonotic diseases among socially marginalized livestock farmers and sanitation workers in Uttar Pradesh"** *may be submitted in partial fulfilment of the requirement for the degree.*

We have gone through the contents of the thesis and are fully satisfied with the work carried out by the candidate, which is being presented for the award of **Master of Veterinary Science** *Degree of this Institute.*

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Himangi

(Himangi Gupta)

ABBREVIATIONS

ANOVA	:	Analysis of Variance
CCHF	:	Crimean-Congo Hemorrhagic Fever
COVID	:	Coronavirus Disease
DM	:	Diabetes Mellitus
ELISA	:	Enzyme-Linked Immunosorbent Assay
IBM	:	International Business Machines (SPSS software)
ID	:	Identification
IDVET	:	Innovative Diagnostic Veterinary
INR	:	Indian Rupee
KAP	:	Knowledge, Attitude, and Practice
KFD	:	Kyasanur Forest Disease
OD	:	Optical Density
OR	:	Odds Ratio
PPE	:	Personal Protective Equipment
SC	:	Scheduled Caste
SD	:	Standard deviation
SE	:	Standard error
TB	:	Tuberculosis

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Introduction

1 INTRODUCTION

Zoonotic diseases pose significant public health challenge globally, particularly in developing countries like India. The World Health Organization (WHO, 1959) defines zoonoses as diseases and infections naturally transmitted between vertebrate animals and humans. Of the 1,415 pathogens known to infect humans, 61.3% (868) are zoonotic, while nearly 75% of emerging infectious diseases in humans originate from animals (Taylor *et al*., 2001; WHO, 2020). In simple words, six out of ten known human infectious diseases and three out of four emerging ones are zoonotic in nature, highlighting the critical role of animals in the epidemiology of human diseases. Besides the direct impact of zoonotic diseases on health, they significantly disrupt ecosystems, constrain livestock production systems and impose enormous economic losses globally (FAO, 2002; Gall and Leboucq, 2003).

In India, zoonoses such as rabies, brucellosis, tuberculosis and leptospirosis impose significant health and economic burdens. Rabies alone causes an estimated 20,000 deaths annually, making it one of the most fatal yet preventable zoonotic disease. Uttar Pradesh, one of India's most populous agrarian states, reported 2,18,379 dog bite incidents in the year 2023, ranking among the highest in the country (MOFHW, 2024). Brucellosis, another major zoonotic concern, exhibits a seroprevalence of 12.37% in dairy cattle in western Uttar Pradesh, with higher rates reported in organized farms (24.88%) compared to unorganized settings (4.08%) (Amitkumar *et al*., 2016). Further, seropositivity of coxiellosis (Q fever), a neglected zoonosis has also been recorded in cattle population of Uttar Pradesh (Dhaka *et al*., 2020).

Zoonotic diseases not only threaten human health but also hinder rural livelihoods, as livestock remains one of the most important assets for impoverished communities. Livestock movements, particularly in informal and unregulated markets, exacerbate the spread of zoonotic pathogens, such as brucellosis and leptospirosis (Shanko *et al*., 2015). This impact is particularly pronounced among socioeconomically marginalized populations, such as Scheduled Castes (SCs) in India. Limited access to healthcare, education and sanitation facilities further exacerbates their vulnerability to zoonotic diseases (National Sample Survey, 2017–18). SC farmers and sanitation workers often experience compounded risks due to their socio-economic status. These groups face systemic barriers to education and healthcare, resulting in limited awareness and understanding of zoonotic diseases. Economic constraints frequently force SC farmers to reside in close proximity to their livestock, increasing the likelihood of disease transmission. Similarly, sanitation workers, who play a pivotal role in maintaining public health, are occupationally exposed to zoonotic pathogens, such as leptospirosis and parasitic infections, through contact with contaminated materials. The lack of resources to implement biosecurity measures further elevates their susceptibility, perpetuating a cycle of health and economic disadvantages.

Livestock farmers, whose livelihoods depend on animals and sanitation workers, who safeguard community hygiene, stand at the frontline of zoonotic risks. Yet, the very nature of their occupations renders them highly vulnerable to these health threats, making it imperative to address zoonotic diseases not only as a medical concern but also as a socio-economic and occupational challenge. Addressing these challenges requires a comprehensive understanding of community-level knowledge, attitudes and practices (KAP) regarding zoonoses.

KAP surveys, originally introduced in the 1950s within family planning research, have evolved into valuable tools for public health investigations. These surveys provide critical insights into awareness, beliefs and behaviours, enabling the identification of gaps and misconceptions that contribute to public health risks (Bhuiyan *et al.,* 2020; Rao *et al.*, 2019). Conducting KAP surveys prior to intervention programs provides essential baseline data for designing targeted educational initiatives and evaluating program effectiveness. Such surveys not only guide the development of culturally relevant interventions but also help to monitor the impact of these programs over the period of time. By systematically assessing barriers and needs, KAP surveys contribute to the formulation of tailored public health strategies aimed at reducing the risk of zoonotic disease transmission in high-risk populations (Alemayehu *et al*., 2021).

According to the 2011 Census, Scheduled Caste (SC) community forms a significant portion of India's population, constituting 16.6% of the total population. Uttar Pradesh, as one of India's most populous states, also has the largest Scheduled Caste (SC) population, with 20.7% of the state's residents belonging to this community, making it a critical region for targeted studies. However, till date KAP studies on zoonoses focusing on sanitation workers and livestock farmers belonging to SC community has not been conducted in India. These groups are frequently exposed to zoonotic hazards due to their close interactions with animals, waste handling and poor living conditions, making them more vulnerable to zoonotic infections. Despite significant occupational and environmental risks, the absence of KAP studies represents a critical research gap in designing effective interventions that reduce zoonotic risks and improve the health and livelihoods of socioeconomically marginalized populations. Therefore, the present study has been designed with the following objectives:

1. **To assess the knowledge, attitude and practice (KAP) related to zoonotic diseases among livestock farmers of SC community in Uttar Pradesh**
2. **To assess the knowledge, attitude and practice (KAP) related to hygiene and zoonotic diseases among sanitation workers of SC community in Uttar Pradesh**
3. **To estimate the seropositivity of brucellosis and coxiellosis in dairy animals belonging to SC farmers of targeted areas**

Review of Literature

2 REVIEW OF LITERATURE

Knowledge, attitude and practice studies related to zoonoses among livestock farmers and sanitation workers of SC community

Zoonotic diseases, pose one of the greatest challenges to global health security. Tackling zoonotic diseases in marginalized communities requires a multifaceted approach that includes raising awareness, improving hygiene practices and building capacity for biosecurity measures. Knowledge, Attitude and Practice (KAP) studies serve as invaluable tools in this context, providing insights into community-level perceptions, beliefs and practices regarding zoonoses.

In rural areas of developing countries, livestock plays a vital role in sustaining livelihoods, providing income, food and social capital (Perry and Grace, 2009). However, the movement of domestic animal populations, especially in informal markets, often facilitates the spread of zoonotic diseases, such as brucellosis and tuberculosis, exacerbating the challenges for both human and animal health systems (Grace *et al.*, 2017).

Livestock farming is the backbone of Indian economy with 4.35% contribution to nation's GDP and employing around 54.6% of total workforce with a livestock population of approximately 535 million (DAHD, 2024). It directly supports around 20 million people and an additional 100 million are indirectly reliant on it, especially in rural areas (NDDB, 2021).

Uttar Pradesh state remains highly vulnerable for zoonotic diseases with 24 million livestock population and 70% of rural households engaged in livestock rearing (NSSO, 2018-19; Ali, 2007). The integrated livestock farming has been practiced by 68% of households

(Singh *et al*., 2021) which provides more conducive conditions and factors for zoonotic disease spread and transmission. These realities underline the importance of proactive interventions to safeguard vulnerable populations.

2.1 Impact of Zoonoses in India

India is a land of villages, with 65% of the country's population residing in rural areas and 47% dependent on agriculture for livelihood (Economic Survey 2022-23). With the world's largest human population, biodiversity hotspots and one of the world's greatest densities of tropical livestock, India has conducive environment for the transmission of novel diseases between animals and humans. Zoonotic diseases annually results in 2.5 billion cases of human illness and 2.7 million human fatalities worldwide (ILRI, 2012). Approximately 44% of the world's poor livestock keepers reside in India, making zoonotic diseases a critical challenge (ILRI, 2012). An estimated 3.4% of agricultural households from rural SC communities depend on livestock as their primary source of income in India (Sarkar, 2020). Endemic zoonoses are estimated to account for 20% of all human illnesses and fatalities in developing countries (Grace *et al*., 2011; Jones *et al*., 2011).

The major public health zoonotic diseases in India include rabies, brucellosis, Japanese encephalitis (JE), leptospirosis, scrub typhus, tuberculosis, cysticercosis, toxoplasmosis, plague, Nipah virus disease and Kyasanur Forest Disease (KFD) (Kumar *et al*., 2020). The Central Bureau of Health Intelligence (CBHI) reported 110 cases of rabies, 1,674 cases of JE, 14,971 cases of H1N1, 57,813 cases of chikungunya, 4,380 cases of kala-azar and 101,192 cases of dengue during 2018 (CBHI, 2018). Zoonotic diseases like avian influenza, Q fever and salmonellosis also pose a significant threat to human populations due to their considerable burden in animal populations. Endemic zoonotic infections such as leptospirosis, rabies, Japanese encephalitis, brucellosis and tuberculosis show a high positivity rate in both animals and humans (NCDC, 2023).

The impact of zoonotic diseases on human populations is frequently quantified using Disability-adjusted life years (DALYs) (WHO, 2020), a measure that captures the societal burden in terms of financial costs, morbidity and mortality (Torgerson and Macpherson, 2011).

Zoonoses account for approximately 26% of the total DALYs lost to infectious diseases worldwide (Grace *et al*., 2012), as highlighted in Global burden of disease (GBD) estimates (Lopez *et al*., 2006).

Leptospirosis is a globally prevalent disease, affecting over one million individuals annually and resulting in approximately 60,000 deaths each year. The infection imposes a significant public health burden, contributing to 2.90 million Disability-adjusted life years (DALYs) annually, exceeding that of other tropical diseases such as malaria, tuberculosis, filariasis, rabies and dengue. In southern India, leptospirosis remains endemic, with reported positivity rates of 11% in humans and 15% in animals (NCDC, 2023).

Japanese encephalitis (JE), a notifiable disease in India, affects thousands annually, with a mortality rate of 10-20%. In 2019, India had the highest estimated JE burden, reporting 22,219 cases and 8,081 deaths (Moore, 2021). The North-Eastern and Eastern regions exhibit high JE positivity due to larger pig populations, with 1,500-4,000 people affected annually. Among these, about 1 in 300 infections results in symptomatic illness, with nearly 30% of cases proving to be fatal (Kumar *et al*., 2012). Endemic districts in Bihar and Uttar Pradesh report a high burden of JE (NCDC, 2016).

Brucellosis is a significant concern in India, with a median annual economic loss of $3.4 billion in livestock (Singh *et al*., 2015). The disease causes ₹11,950 crores in losses due to productivity reductions, miscarriages and infertility in livestock (DAHD, 2024). Although specific DALY data for brucellosis is limited, it results in the loss of 30 million man-days annually (Bhatt, 2014). Seroprevalence studies indicate human infection rates between 0.9% and 18.1%, primarily affecting veterinarians, farm attendants, farmers, animal handlers and abattoir workers (Hossain *et al*., 2014; Palkhade *et al*., 2018).

As per International Livestock Research Institute (ILRI), *Coxiella burnetii* is 'one of the most contagious diseases', as the infectious dose of the agent can be as low as a single bacterium (Jones *et al*., 2006; ILRI, 2012) In the Indian sub-continent, the pathogen is emerging, in humans and animals. It has increasingly been detected from foods of animal origin (including bulk milk, eggs and meat) as well as tick vectors in many parts of the world (Sahu *et al*., 2021).

Rabies is a fatal zoonotic disease with significant public health and economic burdens, causing thousands of human deaths annually, primarily in Asia and Africa. Globally, rabies accounts for 60,000 to 1,000,000 deaths annually, with Asia and Africa bearing the majority of the burden (Elelu *et al*., 2019). India contributes to one-third of global rabies cases, with an estimated 20,000 human deaths annually (Gill *et al*., 2019).

According to the World Health Organization's Global Tuberculosis Report (WHO, 2020), 10 million persons contracted TB disease in 2019, of whom 1.2 million died. An additional 208,000 fatalities were ascribed to the TB-HIV syndemic. It is anticipated that 140,000 of the 10 million individuals with new active TB are new instances of zoonotic TB (1.4%), of which 11,400 (8.1%) died (WHO, 2020). Around 21.8 million cattle in India are estimated to be affected with TB (Srinivasan *et al*., 2018). An estimated 26.9 lakh of the 100 lakh TB cases that are thought to occur worldwide each year are projected to occur in India, where they result in 4.21 lakh fatalities annually (Revised National TB Programme, 2019). In Asia, tuberculosis causes a 4–7% gross domestic product loss. In India, TB expenses exceed Rs 13,000 crore annually (Srinivasan *et al*., 2018).

Parasitic zoonoses also add to the disease burden, straining the livestock industry. Hydatidosis causes an annual economic loss of ₹1,147 crores, with 93.05% and 88.88% of losses attributed to the cattle and buffalo industries, respectively. A total of approximately ₹ 47.27 crore was lost economically as a result of hydatidosis (Singh *et al*., 2016). Neurocysticercosis-associated epilepsy leads to an annual economic loss of ₹1,200 crores, with ₹900 crores lost in northern India and ₹222 crores in the south (Singh *et al*., 2016). India also reports 70% of the global kala-azar cases, amounting to 58,200 annually (NCDC, 2016).

Emerging zoonoses like Nipah virus disease, Crimean-Congo hemorrhagic fever (CCHF), KFD and Zika virus disease have shown a marked increase between 2014 and 2023 compared to the 2009–2013 period (NCDC, 2023). Scrub typhus, in particular, has become a growing public health concern, with 2023 recording 29 outbreaks, the highest in a single year (NCDC, 2023). The disease is most prevalent in South India (55.5%), followed by North India (31.5%), affecting rural populations (81.7%) and agricultural laborers (53.3%) equally (Devasagayam *et al*., 2021).

2.2. Commonly reported zoonoses in India

The data on zoonotic disease outbreaks from the year 2009 to 2023, published under the Integrated Disease Surveillance Programme (IDSP) revealed significant variability in the proportion of different diseases in the zoonotic outbreaks in human population. The period from 2009 to 2013 saw a diverse distribution of zoonotic diseases, with Japanese Encephalitis emerging as the most prevalent with 37.1% of total zoonotic cases in humans. Other significant contributors included influenza A H1N1 (18.7%), scrub typhus (19.4%), and leptospirosis (15.9%). Less common but still notable diseases included kala-azar (4.8%), anthrax (3.0%), and Kyasanur forest disease (KFD) at 0.5%. Crimean-Congo Hemorrhagic Fever (CCHF) was recorded at a minimal of 0.6%, indicating limited outbreaks during this period. Between 2014 and 2018, the burden of Japanese Encephalitis cases increased to 43.1%, emphasizing its growing impact. Leptospirosis cases showed a marginal rise to 19.5%, while scrub typhus cases remained a significant concern at 16.2%. KFD cases exhibited a notable increase to 10.2%, suggesting heightened transmission. Anthrax cases also rose to 8.1%, indicating regional outbreaks. Additional diseases such as brucellosis (1.3%), CCHF (0.7%), Nipah (0.3%), and melioidosis (0.1%) were recorded, reflecting a broader spectrum of zoonotic threats.

The most recent period from the year 2019 to 2023, marked a dramatic surge in scrub typhus cases, accounting for 50.4% of all zoonotic disease cases reported to IDSP. This shift suggests either increased transmission or improved detection and reporting mechanisms. Japanese Encephalitis cases showed a decline to 13.6%, while Influenza A (H3N2) was recorded at 12.8%. Leptospirosis cases remained a persistent concern at 16.3%, though slightly lower than previous years. Rabies (1.6%) and Nipah (0.2%) continued to be detected at low levels. The emergence of Zika Virus (0.4%) and West Nile Fever (0.6%) highlighted the evolving nature of zoonotic threats. Additionally, 0.1% cases of dog bites were reported. The number of anthrax decreased to 1.3%, and brucellosis to 0.6%, while KFD cases dropped to 0.9%, signalling potential improvements in control measures (NCDC, 2023).

The surveillance of targeted zoonotic diseases in human and animal populations, conducted by the National One Health Programme for Prevention and Control of Zoonoses (NOHPPCZ) between 2019 - 2023, revealed significant variability in positivity rates. The overall positivity for leptospirosis in humans and animals was 11% and 15%, respectively. The endemicity of brucellosis was observed in all the regions with 10% positivity rate in humans and 7% in animal populations. Japanese Encephalitis positivity was recorded at 6% in humans and 28% in animals with high positivity rate in north east and eastern regions of country. Besides Japanese encephalitis, higher positivity rates (>30%) of bovine tuberculosis and rabies were detected in animal populations emphasizing the need for sustained monitoring and control measures.

2.3. Prevalence/Incidence of major zoonotic diseases among animals in Uttar Pradesh, India

The literature has been reviewed to know the status of commonly reported zoonotic diseases in India with special reference to Uttar Pradesh.

2.3.1. Rabies

Rabies has been documented from India in various animal species, including canines, cattle, buffaloes, ovines and equines while reported annual deaths among these species were 68 (2016), 383 (2017), 383 (2018), 196 (2019) and 14 (2020), respectively (MoFAHD, 2022). Over the past six years, the prevalence of rabies among stray dogs remained at 66%. However, in 2023, the positivity rate among infected stray dogs in Pune decreased to 40% (Hindustan Times, 2024). In Punjab, the incidence of rabies in stray and pet dogs was reported as 2.03 and 2.71 per 10,000 dog years, respectively, while for cattle and buffaloes, the incidence was 0.23 and 0.19 per 10,000 cattle and buffalo years, respectively (Gill *et al.*, 2019). Notably, there have been no confirmed reports of bat rabies in India (WHO, 2024).

Perusal of literature revealed no published data on the prevalence or incidence of rabies in animal population of Uttar Pradesh. However, sporadic cases of rabies in cattle, buffalo and dogs have been reported from Hathras, Sharanpur, Fatehpur, Unnao and Shamli districts of Uttar Pradesh (AICRP- ADMAS, 2017, 2018).

2.3.2. Brucellosis

Brucellosis is a highly contagious bacterial zoonotic disease and is considered one of the most common neglected bacterial zoonoses (Schaeffer *et al.*, 2021). A meta-analysis estimated the overall prevalence of brucellosis in bovines in India at 15.1%, with species-specific rates of 16.6% in cattle and 14.2% in buffaloes (Jaismon *et al.*, 2023). The highest prevalence was recorded in Punjab, where 23.51% of cattle and 10.2% of buffaloes were affected (Holt *et al.*, 2021). A meta-analysis on brucellosis seroprevalence in India reported seroprevalence of 14% in cattle, 8% in buffaloes, 8% in sheep, 8% in goats, 16% in yaks and 26% in mithun (Lalrinzuala *et al.*, 2023).

A serological study conducted in western Uttar Pradesh reported an overall seropositivity of 12.37% in dairy cattle and buffaloes (Kumar *et al.*, 2016). It revealed that seropositivity was significantly higher in organized farms (24.88%) compared to unorganized farms (4.08%). Age-related differences were also observed, with young calves exhibiting a lower seropositivity rate (9.17%) than sexually mature adults (12.71%). District-wise variation in seropositivity was evident, with the highest prevalence among cattle recorded in Bareilly (22.22%) and Bijnor (12.50%), while buffaloes showed the highest rates in Baghpat (16.67%) and Hardoi (16.67%), followed closely by Bijnor (14.29%) (Kumar *et al.*, 2016). The overall seroprevalence in small ruminants was 12.05% with 36.93% in sheep and 5.27% in goats (Mere, 2014).

2.3.3. Japanese Encephalitis (JE)

Japanese encephalitis (JE) is a mosquito-borne viral zoonotic disease and a major cause of viral encephalitis. The seroprevalence of JE in pigs across various Indian states ranged from 7.0% to 61.5%, with an average of 34.25%, influenced by agro-climatic conditions

(Kumar *et al*., 2020). A study reported JE virus (JEV) seroprevalence of 20.3% using IgM ELISA and 16.6% using IgG ELISA, with an overall seroprevalence of 17.7% (Mote *et al*., 2024). Among studied states, the highest seroprevalence was observed in Assam (30.2%), followed by Maharashtra (17.2%), Uttarakhand (13.4%) and Uttar Pradesh (11%) (Mote *et al*., 2024). In equines, regional variation in seropositivity was noted, with the highest prevalence in the West zone (30.02%), followed by the North (17.81%), Northeast (9.30%) and East (5%) zones of India (Kapdi *et al*., 2022).

A study spanning ten districts of eastern Uttar Pradesh recorded mean seroprevalence rates of 14% for IgG (2013–2022) and 10.98% for IgM (2017–2022) in pigs (Dhanze *et al*., 2024). Whereas, a study conducted in the year 2022 estimated the overall prevalence of JEV in swine at 39.25% based on molecular and serological assays in western Uttar Pradesh (Kumar *et al*., 2023).

2.3.4. Leptospirosis

Leptospirosis is a globally prevalent zoonotic disease that affects domestic animals, wildlife and humans (Grippi *et al*., 2023). A meta-analysis reported the highest prevalence in buffaloes (45.75%), followed by rodents (40%), dogs (26%), cows (24.26%), goats (19.42%) and pigs (15.8%) (Choudhary *et al*., 2023). Among Indian states, the highest prevalence was recorded in Andhra Pradesh (64.71%), Kerala (60.5%), Chhattisgarh (54.7%) and Odisha (52.26%), while the lowest was reported in Assam (0.9%) and Haryana (1.4%) (Choudhary *et al*., 2023).

Seropositivity of 8 per cent was reported in bovine population of Rohilkhand region of Uttar Pradesh (Sachan *et al*., 2012). The overall seropositivity of 23.81% was recorded in pig population of western Uttar Pradesh with Icterohaemorrhagia as leading serovar (Kumar *et al*., 2021)

2.3.5. Q Fever

Q fever (coxiellosis) is a neglected zoonotic disease and one of the 13 “global priority zoonoses” due to its high transmissibility (Grace *et al*., 2019). Infected animals serve as key reservoirs, posing a significant risk to farmers and other vulnerable groups (Grace *et al*., 2019). Serological studies using ELISA have reported higher seropositivity in cattle (17.7%) compared to buffaloes (8.3%) (Dhaka *et al*., 2020). A study conducted in a Gaushala (cattle shelter) detected *Coxiella burnetii* seropositivity in 9.56% of cattle (Yadav *et al*., 2021).

In Uttar Pradesh, PCR and ELISA testing for coxiellosis in cattle from organized dairy farms revealed prevalence rates of 12.03% and 16.2%, respectively, whereas small livestock farms reported a lower seropositivity of 5.13% (Dhaka *et al*., 2020; Vinod *et al*., 2021).

2.3.6. Tuberculosis (TB)

India has the highest global prevalence of bovine tuberculosis (bTB), with an estimated prevalence of 7.3%, affecting around 21.8 million cattle (Srinivasan *et al*., 2018). The disease presents significant zoonotic and reverse zoonotic risks. A meta-analysis revealed a higher prevalence in cows (6.3%) compared to buffaloes (4.3%) (Srinivasan *et al*., 2018).

In Eastern Uttar Pradesh, out of 108 faecal samples, 23.14% tested positive for acid-fast bacilli using Ziehl–Neelsen staining, while 12.03% and 12.96% were positive by culture and direct IS900 PCR, respectively. (Singh *et al*., 2016). Screening 541 cows using the Single Intradermal Tuberculin Test (SITT) found 13.12% positive for bovine tuberculosis. (Thakur *et al*., 2016).

2.3.7. Scrub typhus

A research study conducted in Madurai investigated the role of rodents and shrews in the transmission of scrub typhus. To identify the chigger vectors responsible, four rodent species including *Rattus rattus, Rattus norvegicus, Mus musculus* and one shrew species, *Suncus murinus*, were collected from the region. The prevalence of chiggers was recorded at 40% (Candasamy *et al*., 2024). In a study conducted across Tamil Nadu and Puducherry, a total of 181 animals, including four rodent species and one shrew species, were examined. The chigger index for *Leptotrombidium deliense* was calculated as 41.1 per animal (Candasamy *et al*., 2016). Among 50 animals screened for *Orientia tsutsugamushi*, 28 tested positive for agglutination against OX-K in the Weil-Felix test, confirming the presence of antibodies

(Candasamy *et al*., 2016). Another study from Vellore District, Tamil Nadu, identified five different species of rodents and shrews carrying 17 species of trombiculid mites. A total of 940 chigger mites (94.76%) were predominantly found on rats and shrews, with a recorded chigger index of 16.79 (Paulraj *et al*., 2022). In Northeast India, a serosurvey conducted in Mizoram examined household rodents across 41 villages in all 11 districts. The study reported an overall seropositivity of 66.26% among the captured rodents (Pautu *et al*., 2023).

A study conducted in Gorakhpur district, Uttar Pradesh, investigated the prevalence of *Orientia tsutsugamushi* antibodies in rodents and shrews using the Weil-Felix test. Among the 401 serum samples analyzed, 273 (68%) tested positive for antibodies against the OX-K antigen. The highest seropositivity was observed in *Suncus murinus* (79.9%), followed by *Rattus* species (8.4%). Seasonal variations in seropositivity were noted, ranging from 31.4% in May to a peak of 91.8% in August, with higher detection rates recorded between July and November. In vector surveillance, a total of 5,526 mite tissue samples were pooled into 352 vials for molecular screening. Four pools of *Leptotrombidium deliense* tested positive for *O. tsutsugamushi*, confirming the presence of the pathogen in the chigger vector.(Sadanandane *et al*., 2021)

2.3.8. Toxoplasmosis

Toxoplasmosis prevalence in animals across various regions of India has been extensively studied. A study assessed the seroprevalence of *Toxoplasma gondii*-specific antibodies in small ruminants and cattle. Among the tested sheep, 50% (30 out of 60) from West Bengal were found to be seropositive (Singh *et al*., 2015). PCR-based detection methods revealed the presence of *T. gondii* zoites in 1.69% of sheep and 1.34% of goat samples, while *T. gondii* DNA was detected in 3.67% of sheep and 3.50% of goats in South India (Satbige *et al*., 2016). In Punjab, a low seroprevalence of 2.4% in cattle, 2.9% in buffaloes, and 3.76% in sheep was reported (Sharma *et al*., 2008). Additionally, a molecular prevalence study reported less than 2% *T. gondii* presence in slaughtered sheep and goats (Kalambhe *et al*., 2017). In Jharkhand, *T. gondii*-specific IgG antibodies were detected in 42.47% of goat samples using rSAG1-based indirect ELISA (Bachan *et al*., 2018). Research on bovines in

India has highlighted the scarcity of data on toxoplasmosis in farm animals, with existing reports focusing mainly on small ruminants, emphasizing the need for more comprehensive research. A study on slaughtered pigs detected *T. gondii* DNA in 6.7% (54/810) of the tested samples, with the highest prevalence observed in Punjab (8.2%), followed by Chandigarh (5.3%) and Uttarakhand (4.8%) (Thakur *et al*., 2019). In Kerala, a seroprevalence study found that 185 out of 258 cattle tested positive for *T. gondii*-specific IgG antibodies, resulting in a prevalence rate of 71.8% among the tested cattle population (Sudan *et al*., 2015).

A study found that *Toxoplasma gondii*-specific antibodies were present in 41.26% (26 out of 63) of goat sera samples from Makhdoom. Similarly, 64.44% (29 out of 45) of cattle sera samples from Bareilly tested positive, indicating a significant prevalence of toxoplasmosis in these regions (Singh *et al*., 2015). A study conducted in the Mathura district of Uttar Pradesh found that only 19% of participants were aware that cats serve as reservoirs for the *Toxoplasma* parasite, while the remaining majority were unaware of this fact (Singh *et al* 2024).

2.4. Prevalence/Incidence of major zoonotic diseases among humans in Uttar Pradesh, India

The literature has been reviewed to know the status of commonly reported zoonotic diseases in India with special reference to Uttar Pradesh.

2.4.1. Rabies

Rabies ranks as the tenth leading cause of infectious disease-related mortality globally, with India bearing the highest burden of rabies-related deaths. Dog bites are responsible for 95–97% of these fatalities each year (Baxter, 2012; IDSP, 2021). Annually, estimated 18,000 to 20,000 human rabies cases occur in India, primarily attributed to approximately 17.4 million dog bites (Kole *et al*., 2014). Children are particularly susceptible, constituting 40% of dog bite victims in rabies-endemic regions. The estimated annual incidence of dog bites is 5.6 per 1,000 individuals (Thangaraj *et al*., 2025). Over the years, the incidence of animal bites in India has shown a significant upward trend. According to Integrated Disease Surveillance

Project report (IDSP, 2021) animal bite cases increased from 4.2 million in 2012 to 7.2 million in 2020, involving bites from dogs, cats, monkeys and other animals. Dog bite cases alone exhibited a 26.5% year-over-year increase, rising from 2.18 million in 2022 to 2.75 million in 2023 (MOHFW, 2023).

The state ranks fifth in terms of dog bite cases, reporting 2,18,379 incidents in the year 2023 while in the year 2022, 19 confirmed deaths due to rabies were reported from the state (MOFHW, 2022).

2.4.2. Brucellosis

In India, the reported seroprevalence of brucellosis varies between 0.8% and 26%, with lower prevalence observed in the general population presenting with pyrexia of unknown origin and higher prevalence among individuals with occupational exposure (Appannanavar *et al*., 2012). Studies suggest that human brucellosis remains relatively common, with a prevalence of 2.24% in the general population. In occupational settings, the prevalence among dairy farm workers is estimated at 6.60% (Mangtani *et al*., 2020).

A study conducted in the Lucknow district of Uttar Pradesh reported human brucellosis seroprevalence of 19% using IgM ELISA and 23% using IgG ELISA (Renu *et al*., 2022). Whereas, an investigation conducted across peri-urban areas of four districts in the Braj region Mathura, Agra, Hathras and Kasganj estimated the seroprevalence of human brucellosis at 4.31% using the Standard tube agglutination test (STAT) and 3.73% using indirect Enzyme-linked immunosorbent assay (Mishra *et al*., 2024).

2.4.3. Japanese Encephalitis

Japanese encephalitis (JE) is a notifiable disease in India, with thousands of human cases reported annually and an associated mortality rate ranging from 10% to 20% (Moore *et al*., 2021). The national incidence rate of JE was estimated at 1.08 cases per 1,000,000 populations between 2013 and 2021, based on secondary public health surveillance data (Tandale *et al*., 2023). According to a study conducted by the National vector borne disease control programme (NVBDCP), the number of reported JE cases increased by 19% in 2022 compared to 2021, with the case fatality rate rising from 8.9% to 12.4%. Between 2023 and 2024, JEV related fatalities increased from 65 to 93, while morbidity rose from 1,107 to 1,328 cases (NCVBDC, 2024).

Uttar Pradesh, an agriculturally driven state, experiences significant regional and seasonal variations in weather. Eastern Uttar Pradesh, particularly the districts of Siddharth Nagar, Sant Kabir Nagar, Kushinagar and Gorakhpur, is highly prone to Japanese encephalitis (JE) due to recurrent annual flooding (Patel *et al*., 2021). Between 2011 and 2018, four districts of the Gorakhpur division (Gorakhpur, Maharajganj, Deoria and Kushinagar) and three districts of the Basti division (Basti, Sant Kabir Nagar and Siddharth Nagar) accounted for 86% of the total acute encephalitis syndrome (AES) cases in the state. The Lucknow division, comprising Hardoi, Lakhimpur Kheri, Lucknow, Raebareli, Sitapur and Unnao, contributed 6% of AES cases, while the Devipatan division (Bahraich, Balrampur, Shravasti and Gonda) accounted for 4%. The Faizabad and Azamgarh divisions reported 2% and 1% of AES cases, respectively (Singh *et al*., 2020).

2.4.4. Leptospirosis

Leptospirosis, a re-emerging zoonosis, is widely distributed across the globe due to the variety of wild and domestic animals that act as either natural or accidental hosts. Leptospirosis is considered endemic in several regions of India, including Gujarat, Maharashtra, Kerala, Tamil Nadu, Karnataka and the Andaman & Nicobar Islands. In India, the frequency of leptospirosis outbreaks has been increasing over the past three decades. The highest positivity rate is observed in the southern part of the country (25.6%), followed by northern (8.3%), western (3.5%), eastern (3.1%) and central India (3.3%) (RSTMH, 2021).

In Uttar Pradesh, a study reported an overall leptospirosis prevalence of 26.6% in the eastern and central regions (Shukla *et al*., 2022). A study encompassing 26 districts in eastern and central Uttar Pradesh found that all positive cases were confined to 14 districts. The highest seropositivity was recorded in Lucknow (23.7%), followed by Barabanki (10.5%). Other districts with notable seropositivity included Bahraich, Ayodhya (Faizabad), Basti, Sultanpur and Gorakhpur, each reporting 7.9%. Lower seroprevalence rates were observed in Unnao, Sitapur, Raebareli and Gonda (5.3%), while Sant Kabir Nagar, Ambedkar Nagar and Maharajganj each exhibited a seropositivity of 2.6% (Shukla *et al*., 2022).

2.4.5. Tuberculosis

India carries a substantial burden of TB, accounting for 26% of global prevalence and 34% of TB-related deaths in humans in 2020 (Global Tuberculosis Report, 2021). While bovine TB has been nearly eradicated in developed countries, zoonotic TB remains a major public health issue in many regions. Human TB, second only to AIDS as a leading cause of death worldwide, is often linked to *M. bovis*, which is responsible for 5–10% of all human TB cases, with children accounting for 25% of these cases. Extra-pulmonary TB, commonly affecting organs other than the lungs, is the predominant manifestation in approximately 53% of cases, with transmission primarily occurring through aerosol droplets or consumption of unpasteurized, contaminated milk. Agricultural workers, veterinarians, abattoir employees and individuals living in close proximity to infected animals are at heightened risk. The differentiation between *M. tuberculosis* and *M. bovis* remains a diagnostic challenge due to limitations in routine testing and inadequate laboratory infrastructure, which can lead to missed zoonotic TB (WHO, 2017).

Perusal of literature revealed no published reports on zoonotic TB prevalence/incidence in human population of Uttar Pradesh.

2.4.6. Q Fever

Coxiellosis, commonly known as Q fever, is a significant public health concern, particularly in developing countries like India. A review of international databases revealed only 25 studies conducted in India over the past 60 years on Q fever in humans and animals, underscoring a substantial knowledge gap (Kumar *et al*., 2017). This gap highlights the urgent need for further research to evaluate occupational risks and inform effective public health strategies

Recent research reported 2.1/ % (6/282) seroprevalence of *Coxiella burnetii* in AES cases of children admitted in BRD medical college, Gorakhpur (Gulafshan *et al*., 2024).

Another study reported seropositivity of 84.21% in workers of cattle farms in Bareilly (Dhaka *et al*., 2020).

2.4.7. Scrub typhus

Over the past decade, a total of 18,781 confirmed cases of scrub typhus have been documented through 138 hospital-based studies and two community-based studies. The majority of these cases (89%) were confirmed using IgM ELISA, which was employed in 122 studies. Among studies investigating acute undifferentiated febrile illness (AUFI), scrub typhus was identified in 25.3% of cases, while the community seroprevalence was reported at 34.2% (Devasagayam *et al*., 2021). Occupational data, provided by 32 studies, revealed that 53.3% of laboratory-confirmed cases were agricultural laborers or unskilled workers. Residential area data, available in 34 studies, indicated that the majority of cases (81.7%) lived in rural areas near shrubs and bushes, while 18.3% resided in urban areas (Devasagayam *et al*., 2021). The highest prevalence of scrub typhus cases was observed in Tamil Nadu (37.6% of cases), followed by Himachal Pradesh (11%), Karnataka (8.8%) and Uttarakhand (8.5%) (Devasagayam *et al*., 2021)

Scrub typhus has emerged as a significant contributor to the high prevalence of acute encephalitis syndrome (AES) in Uttar Pradesh, particularly in Gorakhpur and its neighboring districts. Each year, approximately 1,500–2,000 AES cases are reported in this region during the monsoon season (July-October), with a fatality rate of 20–25% (Murhekar *et al*., 2016; Mittal *et al*., 2017). High seroprevalence (70.8%) of *Orientia tsutsugamushi* was recorded during AES epidemic period as compared to that of lean AES period (IgG: 50.6%) in Gorakhpur region (Kamble *et al*., 2020).

2.4.8. Toxoplasmosis

A nationwide survey reported a seroprevalence rate of 24.3% among the Indian population (Dhumne *et al*., 2007). A study conducted in Uttarakhand reported an overall seropositivity rate of 36.88%, with higher rates in hilly regions (50%) compared to plains (40.3%). Factors such as age (40–50 years and above), rural residence, and existing comorbidities were associated with increased seropositivity (Deka *et al*., 2021). Research in Chandigarh found a seroprevalence of 20% among the population (Dhumne *et al* 2007). A study focusing on veterinary personnel in Punjab observed a seroprevalence of 15%. The research highlighted that factors such as keeping cats as pets and consuming sheep meat, were significantly associated with Toxoplasma seropositivity (Thakur *et al* 2022). Another study focusing on pregnant women found an overall seroprevalence of 22.4%, with regional variations South India: 37.3%, North India (Delhi NCR): 19.7%, East India (Assam): 21.2%, West India (Gujarat): 8.8% (Singh *et al*., 2014).

Research in Lucknow indicated a seroprevalence of 58.83% for IgG antibodies and 5% for IgM antibodies among the studied population (Khan *et al* 2017). A study in Aligarh found a seroprevalence of 35.44% in the sampled individuals (Siddique *et al*., 2014).

2. 5. Hygiene and Sanitation Challenges in Marginalized Communities

In India, marginalized communities, particularly the Scheduled Castes (SCs), face disproportionate vulnerability to zoonotic diseases. According to the 2011 Census, 16.6% of India's population, over 20 crore people belong to the SC community. A substantial proportion of them reside in Uttar Pradesh, where over 20% of the population is classified as SC, with districts such as Sitapur, Sonbhadra and Kaushambi being home to the highest concentrations.

Many SC farmers have been engaged in high-risk occupations, particularly animal husbandry and sanitation work, placing them at a risk of zoonotic infections. The socio-economic disadvantage, compounded by limited access to healthcare education and sanitation, increase their vulnerability. According to national sample survey (2017–18), small farmers many of whom are SCs struggle with inferior resource-endowment, which further diminishes their access to public health services (Krishna *et al*., 2019).

Among women from these marginalized communities, barriers to healthcare access are 1.37 times higher than those faced by women from the general category. The inequality report (2021) underlines these disparities, with infant mortality rates 13.1% higher in SC communities and stunting rates also showing a significant increase. While two-thirds of general categories households have access to non-shared sanitation facilities, this is not the case for SC households, with a 28.5% gap in coverage. Furthermore, only 13.15% of SC/ST households have access to treated tap water, compared to 25.14% of non-SC/ST households. These gaps in basic sanitation and healthcare underline the heightened risk of zoonotic diseases for marginalized communities (NSS, 2017-18; Ghosh *et al*., 2023).

A significant factor exacerbating the public health crisis is the occupational health risk faced by sanitation workers, who are often drawn from SC communities. These workers are directly exposed to animal and human waste, significantly increasing their vulnerability to zoonotic diseases. Among sanitation workers, inadequate hygiene resources and lack of infection control training heighten occupational health risks. Leptospirosis, Hepatitis E and parasitic infections such as Cryptosporidium and Giardia are prevalent among sanitation workers, with studies indicating that nearly 18% suffer from gastrointestinal infections due to inadequate protective measures (ICMR, 2021; WHO, 2021). Systematic reviews highlight that sanitation workers remain disproportionately exposed to gastroenteritis and respiratory conditions due to insufficient occupational health policies (Diakos *et al*., 2022). However, studies indicate that consistent glove use can significantly reduce cryptosporidiosis risk from 29.08% to 4.82% (Rimoldi *et al*., 2020). This underscores the urgent need for improvements in hygiene protocols, personal protective equipment, health monitoring and occupational health education.

As these challenges unfold, it becomes clear that marginalized communities, particularly the SC/ST group, require urgent attention. The solutions to these issues are not just about healthcare; they are about realizing the United Nations' Sustainable Development Goals (SDGs), specifically SDG 3, which aims to "ensure healthy lives and promote well-being for all," and SDG 10, which advocates for "reducing inequality among social groups" (UN, SDG, 2015).

The problem is especially pressing in a nation as diverse and ecologically rich as India, where systemic barriers and socio-economic factors hinder progress. The economic burden of zoonotic diseases is further magnified by inadequate veterinary infrastructure and limited awareness of preventive measures. The lack of robust healthcare and veterinary systems, combined with economic deprivation, keeps these communities locked in a cycle of vulnerability

(Chaudhary *et al*., 2020). But there is a hope. Global studies have shown that awareness campaigns and capacity-building efforts are critical in reducing zoonotic risks. The United Nations Environment Programme (2021) stresses that "stakeholder awareness" should be prioritized to control zoonotic diseases. This underscores the importance of involving marginalized communities in policy-making and program implementation. Without their inclusion, sustainable progress toward equitable health outcomes remains elusive.

In recent years, several government interventions have successfully targeted these issues. For instance, in July 2021, the National Centre for Disease Control (NCDC) launched an Information, Education and Communication (IEC) program focused on seven zoonotic diseases: Rabies, Scrub Typhus, Brucellosis, Anthrax, CCHF, Nipah and Kyasanur Forest Disease. Through a variety of communication mediums print, audio and video these initiatives have played a vital role in raising awareness and controlling zoonotic outbreaks (NCDC, 2021).

2.6 Knowledge, Attitude and Practice studies: An Overview

Knowledge, attitude and practice (KAP) surveys originated in the 1950s within the fields of family planning and population research (Green, 2001) and have since become widely accepted tools for investigating health-related behaviors and health-seeking practices (Bhuiyan *et al*., 2020). These surveys are relatively easy to design, conduct, analyse and interpret, making them valuable for public health research (WHO, 2008). Designed to be representative of a target population, KAP surveys aim to assess what is known (knowledge), believed (attitudes) and practiced (behaviour) regarding a particular health issue (Siddiqui *et al*., 2021). KAP studies are integral to public health and medical research, providing critical insights into community awareness, perceptions and behaviours related to health concerns. Through the analysis of these factors, researchers can identify existing knowledge gaps, misconception and behavioural patterns that contribute to public health risks (Siddiqui *et al*., 2021). The findings from KAP surveys are instrumental in the development of targeted interventions, educational programs and policies that address specific health needs while promoting evidence-based health practices (Choudhury *et al*., 2019). Given their utility in informing resource allocation, strategic planning and program implementation, KAP surveys have become essential tools in public health research and intervention planning. Ideally KAP survey should precede an awareness or intervention program, as it provides baseline data that inform the design of effective health initiatives (Bhuiyan *et al*., 2020). These surveys offer a structured framework for identifying existing knowledge deficits, misconceptions and high-risk behaviours within specific populations, enabling the development of culturally and contextually relevant interventions (Monde *et al*., 2011). By evaluating barriers and needs within target populations, KAP surveys facilitate the formulation and implementation of evidence-based public health strategies. Furthermore, they serve as a critical evaluation tool, measuring changes in knowledge, attitudes and practices over time, thereby ensuring the effectiveness of interventions aimed at mitigating health risks.

A major strength of KAP surveys lies in their systematic methodology, which involves survey design, representative sampling, structured data collection and statistical analysis to generate empirical evidence. These studies play a pivotal role in disease prevention by assessing public awareness and attitudes toward health threats, including infectious diseases, chronic conditions and emerging health crises. During the COVID-19 pandemic, KAP surveys were extensively utilized to assess public knowledge regarding viral transmission, preventive measures and vaccine acceptance (Akalu *et al*., 2020). Findings from these studies informed the development of culturally appropriate public health campaigns, ensuring effective messaging and increasing adherence to preventive guidelines (Wang *et al*., 2015).

In the context of zoonotic diseases, understanding community awareness and behavioural practices is crucial for designing targeted interventions that address specific vulnerabilities. KAP surveys contribute to reducing the burden of zoonotic diseases by informing the development of intervention programs aimed at enhancing occupational safety and promoting public health within at-risk communities (Andrade *et al*., 2020). By providing a scientific foundation for program planning and evaluation, KAP studies remain indispensable in public health efforts to mitigate disease risks and improve overall health outcomes.

2.6.1 Knowledge of zoonotic diseases

Research worldwide indicates that livestock farmers generally have poor knowledge of zoonotic pathogens, placing them at high risk of infection. In Tajikistan, 85% of respondents were unaware of brucellosis, with lower knowledge levels correlating to higher infection risks (Lindahl *et al*., 2015). Similarly, only 2% of livestock farmers in Turkey had sufficient knowledge of zoonotic diseases (Cakmur *et al*., 2015). In Jordan, while all livestock keepers were aware of brucellosis, most did not understand its transmission (Musallam *et al*., 2015).

In Ethiopia, 82.7% of farmers recognized raw meat and 79.9% identified raw milk as zoonotic transmission sources, yet many lacked awareness of specific diseases like bovine tuberculosis (61.3%), brucellosis (74.7%) and taeniasis (71%) (Abuna *et al*., 2024). Informal discussions were the primary information sources, with minimal reliance on formal education or veterinary guidance. Similarly, in Bangladesh, only 11.55% of farmers demonstrated good knowledge, while 57.60% had poor understanding. A majority (82%) were unaware of airborne zoonotic transmission, 52% did not know animals could transmit diseases to humans and 53% were unaware of raw milk-related risks, though biosecurity training significantly improved knowledge (Ahmed *et al*., 2025).

In Nepal, awareness was high for avian influenza (95.8%) and rabies (90.7%), but low for brucellosis and bovine tuberculosis (Bagale *et al*., 2023). Livestock farmers of Uganda showed moderate knowledge of brucellosis (Kansiime *et al*., 2014), while farmers of Zimbabwe had varied awareness of rabies (9%), anthrax (72%) and brucellosis (21%) (Chikerema *et al*., 2013). Globally, farmers are often aware of common zoonoses like rabies and brucellosis but lack knowledge of transmission routes. Countries like Tajikistan, Turkey and Bangladesh showed extremely low overall knowledge, while Ethiopia, Uganda and Zimbabwe had disease-specific awareness gaps. These findings highlight the need for targeted education programs, stronger veterinary-medical collaboration and biosecurity training.

A similar trend is seen in India. A study in Andhra Pradesh found that 68% of farmers were unaware of brucellosis, with only 23% recognizing it as zoonotic. Rabies awareness was highest (100%), followed by bird flu (25.89%) and swine flu (18.58%), while knowledge of anthrax, leptospirosis and tuberculosis was low. Awareness of transmission via milk (14.10%) and meat consumption (18.58%) was also poor (Babu *et al*., 2015). In Punjab, while 80% had heard of "zoonoses," specific knowledge was limited, only 40% knew tuberculosis was zoonotic, 31% were aware of Japanese encephalitis and 25% recognized taeniasis. Rabies knowledge was high (92%), but awareness of hydatidosis, toxoplasmosis and brucellosis was minimal (Singh *et al*., 2019). Many farmers were unaware that livestock species such as cattle, sheep, goats, pigs and poultry could spread zoonoses, increasing exposure risks.

To enhance zoonotic disease awareness among sanitation workers and marginalized livestock farmers, participatory education, peer-to-peer training and community-based health promotion are essential. Models like the Swachh Bharat Mission in India demonstrate the effectiveness of engaging local stakeholders in hygiene and sanitation initiatives (Ministry of Jal Shakti, 2021). Integrating such approaches into public health strategies can significantly improve awareness, leading to better disease prevention practices.

2.6.2 Attitudes towards zoonotic disease prevention

Globally, studies have highlighted significant variations in farmers attitudes toward zoonotic disease prevention, influenced by factors such as awareness, cultural beliefs and access to education. In Ethiopia, only 43.3% of farmers exhibited a positive attitude, while 56.7% displayed negative perceptions. However, despite limited knowledge, 75.2% reported avoiding the consumption of meat, milk and other products from sick or dead animals, indicating some level of awareness of zoonotic risks (Abuna *et al*., 2024). In contrast, a study in Bangladesh found a much higher level of proactive attitudes, with 86.32% of farmers demonstrating preventive behaviours. Among them, 98% recognized the importance of periodic deworming, 93% understood the dangers of consuming raw animal products and 91% acknowledged the necessity of proper disposal of dead animals using lime and disinfectants (Ahmed *et al*., 2025). In Nepal, attitudes toward personal protection were notably weaker. Few farmers recognized the importance of personal protective equipment such as masks, gloves and boots and only 44.3% were aware that the anti-rabies vaccine (ARV) is freely available in government hospitals, indicating limited knowledge of preventive healthcare services (Bagale *et al*., 2023). Meanwhile, in Kenya, while most farmers acknowledged the need for medical attention for themselves and veterinary care for sick animals, religious beliefs played a significant role in shaping health behaviors, affecting the adoption of preventive measures (Ahmed *et al*., 2025).

In India, regional studies reveal disparities in attitudes. In Punjab, 80% of farmers understood the importance of regular deworming, yet many failed to recognize the risks of consuming raw milk, improper waste disposal and the lack of disease testing for their animals. Notably, 42% believed infected dead animals should be buried with lime (Singh *et al*., 2019). In contrast, a study in Andhra Pradesh highlighted severe deficiencies in emergency preparedness and interdisciplinary communication. Farmers showed limited awareness of hygienic practices when handling animals and their products, while veterinary and medical personnel primarily focused on rabies, anthrax, tuberculosis and overlooking other significant zoonotic threats (Babu *et al*., 2015). While Punjab farmers demonstrated better knowledge about deworming, their lack of awareness about disease transmission through raw milk and waste disposal remains a concern. In Andhra Pradesh, farmers exhibited broader shortcomings in hygiene and biosecurity measures, compounded by weak veterinary-medical collaboration.

Perceptions and attitudes toward zoonotic disease risks and hygiene practices are largely shaped by socioeconomic factors, cultural beliefs and access to education (Bagale *et al*., 2021). While farmers and sanitation workers generally recognize the importance of hygiene, resource constraints and inadequate infrastructure often hinder the adoption of preventive measures. Addressing these gaps requires targeted interventions, such as improved access to clean water, sanitation facilities and educational programs (Bagale *et al*., 2021). Capacity building among local health workers and community leaders can further enhance sustainability by fostering knowledgeable advocates (United Nations Environment Programme, 2021).

An example of the impact of educational initiatives is the Meena Media Initiative in Nepal. The study conducted in year 2002 found that 96% of children exposed to the program displayed at least one positive behavioral change, primarily in handwashing practices. Through at least seven episodes addressing key public health issues such as hand hygiene, worm infestation prevention and paediatric diarrheal diseases and the initiative was recognized by UNICEF as one of the most effective health education programs (Butala *et al*., 2021). This underscores the importance of integrating education, infrastructure development and cultural sensitivity in shaping attitudes toward zoonotic disease prevention. A holistic approach combining these elements is crucial to ensuring sustainable behavioral changes and reducing zoonotic disease risks among farmers and sanitation workers.

2.6.3. Practices for zoonotic disease control

Research globally highlights that many farmers continue to engage in high-risk practices that increase their exposure to zoonotic diseases. In Ethiopia, 68.3% of farmers consumed raw milk, while 74% ate raw meat and these are behaviors that significantly heighten infection risks. Additionally, 48.7% had never dewormed their animals, while disease testing remained alarmingly low, with 82.7% never testing for brucellosis and 83.3% never testing for bovine tuberculosis. Personal protective equipment (PPE) usage was poor, with 77.3% of farmers failing to use protective gear when handling sick animals (Abuna *et al*., 2024).

In Bangladesh, while 81% of farmers washed their hands after handling animals, only 19% and 20% tested their animals for brucellosis and tuberculosis, respectively. PPE usage was similarly low, with only 24% wearing masks, 29% using gloves and 29% wearing boots. However, 67% implemented biosecurity measures and 61% practiced proper carcass disposal, indicating some awareness of disease prevention (Ahmed *et al*., 2025). In Nepal, hygiene practices were limited, though 60.8% washed hands with soap after handling livestock, but only 6.6% wore masks, 1.8% used gloves and 1.3% wore boots. Only 12% maintained the recommended >15m distance between homes and livestock sheds. Cultural beliefs led to risky behaviors like consuming dead animals or skinning carcasses before disposal. Some preventive practices, such as isolating sick animals, washing livestock to remove ticks and seeking veterinary care, were observed (Bagale *et al*., 2021).

A comparative analysis indicates that Ethiopia has the highest consumption of raw animal products and the lowest levels of disease testing. Bangladesh exhibits better biosecurity measures and handwashing practices, yet PPE usage remains inadequate. Nepal, influenced by cultural beliefs, shows minimal use of protective equipment and poor spatial separation between homes and livestock, increasing zoonotic disease risks (Bagale *et al*., 2021; Ahmed *et al*., 2025; Abuna *et al*., 2024).

Studies in India reveal similar high-risk behaviors. In Punjab, over 70% of dairy farmers assisted in animal births barehanded and handled the placenta without protective measures. Although 95% washed their hands after handling animals, additional safety practices such as wearing gloves, boots, or properly disposing of dead animals were largely neglected. Notably, 46% reported walking barefoot on farms, increasing their risk of parasitic infections (Singh *et al*., 2019). In Andhra Pradesh, poor hygiene was evident, as none of the farmers used disinfectants to clean udders before milking and animal sheds were cleaned using only water (Babu *et al*., 2015). These findings highlight a critical gap in biosecurity awareness and emphasize the need for targeted education programs.

Scheduled Caste (SC) livestock farmers face additional challenges due to limited awareness and resource constraints, making them particularly vulnerable to zoonotic infections (Sharma *et al*., 2020). Comparative analyses suggest that community-based interventions, such as infection control training and biosecurity awareness programs, have proven effective in improving hygiene practices. While studies emphasize the resource and awareness gaps among SC farmers (Sharma *et al*., 2020), others highlight evidence-based solutions, such as PPE use and handwashing, as critical in mitigating risks (Njenga *et al*., 2020; Rimoldi *et al*., 2020).

Addressing these challenges requires targeted interventions, including improved access to resources, policy support and specialized training programs. A multi-faceted approach integrating education, infrastructure development and policy enforcement is essential to reducing zoonotic disease risks among vulnerable populations, particularly SC farmers and sanitation workers.

Despite significant burden of endemic and emerging zoonotic diseases in India, lack of knowledge, attitude and practice (KAP) studies among livestock farmers and sanitation workers, particularly from Scheduled caste (SC) communities, indicate gaps in awareness and preventive measures. Limited access to veterinary healthcare, inadequate biosecurity measures and occupational exposure to infected animals and contaminated environments heighten their vulnerability. Strengthening targeted educational interventions, improving access to healthcare services and fostering community based participatory approaches are essential for mitigating the risks associated with zoonotic diseases in these high-risk populations.

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Materials and Methods

3 MATERIALS AND METHODS

3.1 Study Area and Population

The study was conducted in the western region of Uttar Pradesh, specifically targeting the districts of Agra, Bareilly, Baghpat, Bijnor Firozabad, Mathura and Meerut, from December 2024 to July 2025. The primary target population comprised individuals from the Scheduled Caste (SC) community who were engaged in livestock rearing, animal handling, and sanitation work, as their regular contact with animals placed them at a higher risk of contracting zoonotic diseases. The number of respondents from each district (Table1) is as follows:

Table 1: Target area and population covered under the study

Target Districts	No. of Livestock Farmers	No. of Sanitation Workers
Agra	118	88
Baghpat	89	68
Bareilly	98	110
Bijnor	71	54
Firozabad	87	50
Mathura	51	50
Meerut	75	72
Total	**589**	**492**

3.2 Sampling Technique and Sample Size

To estimate the sample size, a pilot survey was conducted to assess the knowledge of livestock farmers and sanitation workers regarding zoonotic diseases. The survey revealed that 30% of the target population was aware of common zoonotic infections. This value was used as an input parameter in Statulator, an online sample size calculator (Dhand and Khatkar, 2014), to determine the required sample size with 5% precision and 95% confidence. Accordingly, a minimum of 323 livestock farmers and 323 sanitation workers was estimated for the KAP study. In addition, 100 serum samples were planned to be collected from small ruminants (goats and sheep) owned by SC livestock farmers, to be tested for seropositivity to coxiellosis and brucellosis. However, a total of 589 livestock farmers and 492 sanitation workers were ultimately surveyed, and 186 serum samples were collected from small ruminants in the selected districts. Any household member who voluntarily agreed to participate was considered a sampling unit. Data were collected using a closed-ended structured questionnaire, supplemented by face-to-face interviews to ensure clarity and completeness of responses. Interviews were conducted in the local language, Hindi, and on average, 10 to 15 minutes were spent with each respondent. Participation had been voluntary, and confidentiality of all responses was ensured.

3.3 Study Design

A well-structured, closed-ended questionnaire was designed separately for livestock farmers and sanitation workers to conduct the survey to assess their perceptions, knowledge, and attitudes regarding the causes, modes of transmission, and prevention of zoonotic diseases. A comprehensive literature review was conducted using Boolean operators ‘OR’ and ‘AND’ on Google Scholar, with keywords such as ‘zoonoses’ OR ‘zoonotic diseases’ AND ‘India’ OR ‘Uttar Pradesh’ to identify commonly reported zoonotic diseases in India, specifically in Uttar Pradesh. Another search strategy was applied using the keywords ‘zoonoses’ OR ‘zoonotic diseases’ AND ‘sanitation workers’ to determine the zoonotic diseases commonly reported among sanitation workers. Based on results of literature review questionnaire was designed.

A structured cross-sectional Knowledge, Attitude, and Practice (KAP) survey was carried out to assess awareness, risk perception, and hygiene practices related to zoonotic diseases. The questionnaire collected demographic information, occupation-related exposure risks, and preventive behaviours associated with zoonotic disease transmission.

3.4 Questionnaire Format

The questionnaire was specifically designed to assess the Knowledge, Attitude, and Practices (KAP) of sanitation workers and livestock farmers regarding zoonotic diseases and hygiene. Separate questionnaires were designed for sanitation workers and livestock farmers, covering four main sections. This structured format allowed for a comprehensive evaluation of awareness and preventive behaviours concerning zoonotic diseases in both occupational groups.

3.4.1 Sanitation Workers

The questionnaire for sanitation workers included 49 questions:

- 19 demographic questions
- 13 knowledge questions (9 on zoonoses and 4 on sanitation and hygiene)
- 8 attitude-related questions
- 9 questions on hygiene and occupational practices

3.4.2 Livestock Farmers

The questionnaire for livestock farmers included 59 questions:

- 22 demographic questions
- 14 knowledge questions
- 11 attitude-related questions
- 12 practice-related questions

3.5 Questionnaire for sanitation workers

The questionnaire was developed to assess the Knowledge, Attitude, and Practices (KAP) of sanitation workers with respect to zoonotic diseases and occupational hygiene. The questionnaire was organized into four key sections—demographic information, knowledge of zoonotic diseases, attitude towards hygiene and disease prevention, and hygiene and occupational practices—designed to comprehensively evaluate the awareness, perceptions, and routine behaviours of sanitation workers in relation to occupational health risks and preventive measures. The detailed questionnaire for sanitation workers is as given below.

Questionnaire for sanitation workers:

We are surveying under Community engagement project for prevention and control of Zoonoses funded by ICAR-IVRI. We want to know your knowledge, attitude and perception regarding the diseases transmitted from animals to humans. We wish to find out a good way to understand your needs and provide information to you. The information provided by you will be helpful for prevention and control of zoonotic diseases. All the information from this survey will be kept confidential. Your name will not be used in any published materials like reports and papers. Your participation is entirely voluntary and you can choose to stop answering questions at any time.

Do you want to participate in the survey?

Yes No

Signature

Section I – Demography

S. No.	Content	Details
1	Name	
2	Address	
3	Phone No.	
4	Age	
5	Gender	
6	Annual income	
7	Education	
8	Education/training related to sanitation (Before service)	
9	Education/training related to sanitation (After joining service)	
10	Occupation	
11	Working area	a) Human hospitals b) Veterinary dispensaries c) Household d) Farm place e) Laboratories
12	Type of sanitation work/waste handled	

13	Do you handle biomedical waste?	
14	Are you vaccinated against (tick those appropriate)	Hepatitis B COVID -19Any other
15	List all type of equipment used during sanitation work (tick those appropriate)	Hand Sanitizer Face Mask Safety Goggles Hand Gloves Reflective Safety Vest Full-Body Apron Safety Gumboot Safety Shoe Safety Helmet
16	Incidents of direct contact with (during last 3 months)	Human faecal matter (n=) Animal faecal matter (n=) Human body fluids (urine, blood, nasal excreta etc.) (n=) Animal body fluids (urine, blood, nasal excreta etc.) (n=)
17	Have you ever received any injury at your work place?	a) Yes b) No
18	Hospital visits due to any illness during the last year?	a) <3 /year b) 3-4/ year c) >5/year d) none
19	Have you been diagnosed with any disease (may be related to your work) since five last years? If yes, type of disease or diseases	a) Yes b) No Provide details:

Section II – Participant Knowledge

Zoonoses

1. Have you heard the term 'zoonosis'?

   a) Yes b) No

2. Have you heard about occupational health hazard?

   a) Yes   b) No

3. Which diseases names have you heard?

   Rabies   COVID-19

   Brucellosis   Avian influenza

   Tuberculosis   Plague

   Japanese encephalitis   Neurocystecercosis

   Leptospirosis   Typhoid/Salmonellosis

4. Do you know these diseases can be transmitted to humans through animals also?

   a) Yes   b) No

5. Have you ever heard about zoonotic pathogens are transmitted through direct contact with animals?

   a) Yes   b) No

6. Do you know zoonotic diseases are transmitted through bite of mosquitoes?

   a) Yes   b) No

   If yes, which diseases have you heard?

   Dengue   Chikungunya

   Japanese encephalitis   Malaria

7. Do you know zoonotic diseases are transmitted through rodents?

   a) Yes   b) No

   If yes, which diseases have you heard?

   Plague   Scrub Typhus

   Leptospirosis

9. Do you know there are zoonotic fungal infections that cause skin/lung diseases

   a) Yes   b) No

   If yes, which diseases have you heard?

   Ring worm   Aspergillosis

   Candidiasis   Cryptococcosis

Hygiene/sanitation

1. Do you know about disinfectant, sanitizer ?

   a) Yes b) No

2. Have you heard of different kind of waste?

   a) Yes b) No

   If yes, which type of waste

   a) Biomedical, b) animal, c) agriculture, d) dry, e) wet ....sharp

3. Are you aware that colour coded disposal bags/bins are used for disposing different categories of waste?

   a) Yes b) No

4. Do you know any method to manage waste like dumping , burial , composting ?

   a) Yes b) No

Section III –Participant Attitude

1. Are you willing to adopt new technologies for sanitation work?

   a) Yes b) No

2. Do you believe proper sanitation practice can prevent disease?

   a) Yes b) No

3. Do you report a safety concern to your supervisor?

   a) Yes b) No

4. Do you believe that sanitation work is important for public health in preventing zoonotic disease?

   a) Yes b) No

5. How concerned are you about contracting zoonotic disease through sanitation work ?

   a) Concerned b) Not at all

6. How important is taking personal precaution to prevent zoonotic disease transmission

   a) Very important b) Not at all

7. Do you think wearing mask at work place will protect you from diseases like influenza?

   a) Yes b) No

8. Are you willing to undertake training on hygiene and zoonoses?

   a) Yes b) No

9. Do you participate in regular health checkup?

   a) Yes b) No

Section IV – Participant Practices

1. Do you wear PPE kit during cleaning of affected area?

   a) Yes b) No

2. Do you use phenolic soap for hand washing after cleaning work?

   a) Yes b) No

3. Do you walk bare feet at your work place?

   a) Yes b) No

4. How often you clean or disinfectant the Mop?

   A) Daily B) Weekly

   C) Monthly

5. Where you dispose the waste?

   a) Dunghill b) Waste truck

   c) Incineration d) None of these

6. Do you take bath after cleaning work?

   a) Yes b) No

7. Do you use any sanitizer or disinfectant for cleaning?

   a) Yes b) No

8. Do you use label bins for segregating different waste?

   a) Yes b) No

3.5.1 Demographic Information

The demographic section of the questionnaire was designed to collect detailed personal and occupational information from each respondent. Personal data included age, gender, level of education, and annual income. Occupational information captured the respondent's role and work environment, including hospitals, veterinary dispensaries, households, agricultural farms, and laboratories. For sanitation workers, specific questions addressed the type of sanitation tasks performed, the categories of waste handled, and potential exposure to biomedical waste. Participants were also asked about their vaccination history, specifically regarding Hepatitis B and COVID-19. Furthermore, information was gathered on the use of personal protective equipment (PPE) such as gloves, masks, safety boots, and aprons, to evaluate adherence to occupational safety standards.

3.5.2 Knowledge of Zoonotic Diseases

To assess participants' knowledge of zoonotic diseases, the questionnaire included questions that determined whether respondents were familiar with the term "zoonosis" and aware of occupational health risks associated with their work. The questionnaire covered several commonly reported zoonotic diseases, including rabies, COVID-19, brucellosis, avian influenza, tuberculosis, Japanese encephalitis, leptospirosis, and neurocysticercosis. Participants' understanding of transmission pathways was evaluated for zoonotic diseases, such as direct animal contact, faecal-oral routes (e.g., salmonellosis, giardiasis, toxoplasmosis), mosquito-borne transmission (e.g., dengue, malaria, chikungunya), rodent-borne infections (e.g., leptospirosis, plague, scrub typhus), and fungal infections (e.g., ringworm, aspergillosis, candidiasis).

3.5.2.1 Knowledge Section Scoring Criteria

The knowledge component of the questionnaire included both single-response and multiple-response items, which assessed respondents' awareness of zoonotic diseases, modes of transmission, clinical symptoms, and animal sources specifically related to livestock. A weighted scoring system was applied to quantify the level of knowledge among participants.

- Single-response questions (such as Yes/No type) were scored as 1 point for a correct answer and 0 for an incorrect or "don't know" response.
- Multiple-response questions were evaluated based on the number of correct options selected. An interval-based scoring approach was used:
  - Selecting 1–2 correct responses = 1 mark
  - Selecting 3–4 correct responses = 2 marks
  - Selecting 5–6 correct responses = 3 marks
  - Selecting 7–8 correct responses = 4 marks

No negative marking was applied for incorrect selections; however, credit was awarded only for the correct options identified.

- Partial credit was granted in cases where respondents identified a subset of the correct options in multiple-response items. For example, if a question contained eight correct zoonotic diseases and the respondent correctly identified four, they were awarded marks as per the tiered system (e.g., 2 marks for 3–4 correct responses).
- Total knowledge score: The cumulative score obtained by each respondent across all knowledge items was calculated. Based on the structure of the questionnaire, the maximum attainable knowledge score was 21.

This scoring methodology provided a nuanced measure of each respondent's factual understanding of zoonotic diseases related to livestock and allowed for categorization into knowledge levels based on predefined cut-off scores, which were derived from the score distribution.

3.5.2.2 Classification of Knowledge Scores

To assess the level of awareness and understanding among respondents regarding zoonotic diseases associated with livestock, the total knowledge scores were analyzed and categorized into three distinct levels:

- Poor knowledge: score less than or equal to 50%,
- Moderate knowledge: score between 51% to 75%
- Good knowledge: score greater than 75%

This scoring system was designed to differentiate between respondents with minimal awareness, those with a basic or intermediate level of understanding, and those with a relatively comprehensive grasp of zoonotic disease-related knowledge.

3.5.3 Attitude Towards Hygiene and Disease Prevention

The attitudinal component of the questionnaire was designed to assess sanitation workers' perspectives on occupational hygiene, workplace safety, and the prevention of zoonotic diseases in the context of their daily work. Participants were asked whether they believed that proper cleaning and sanitation practices could reduce the risk of disease transmission, and whether they supported the adoption of improved waste management and disinfection technologies. Their willingness to consistently use personal protective equipment (PPE) such as gloves, masks, and boots was explored, along with their readiness to report workplace hazards to supervisors. The questionnaire also investigated workers' perceived risk of contracting zoonotic diseases through waste handling, their interest in participating in training programs on hygiene and disease prevention, and their acceptance of workplace safety protocols.

3.5.3.1 Attitude Section Scoring Criteria

To evaluate sanitation workers' attitudes toward the prevention and control of zoonotic diseases, a set of structured and targeted questions was included. The attitude section consisted primarily of close ended question (Yes/No type questions) aimed at evaluating beliefs, risk perception, and willingness to engage in preventive behaviours (e.g., accepting vaccination, using hygiene measures, or seeking veterinary care). The scoring system helped to determine the overall attitudinal orientation of the respondents whether they hold favourable or unfavourable views toward adopting preventive and protective measures related to zoonotic diseases

3.5.3.1.1 Scoring Method: A **binary scoring system** was applied.

Correct/positive/appropriate attitude responses were scored as 1.

Incorrect/negative/inappropriate attitude responses were scored as 0.

No partial marks were awarded.

3.5.3.1.1 Total Attitude Score

The cumulative score obtained by each respondent across all attitude items was calculated. Based on the structure of the questionnaire, the maximum attainable attitude score was 9. The individual scores for all attitude-related questions were summed to compute a total attitude score for each participant.

3.5.3.2 Classification of Attitude Scores

To assess the respondents' attitudinal orientation toward zoonotic disease prevention, a structured scoring system was applied based on their responses to targeted questions measuring risk perception, belief in preventive measures (such as animal vaccination and hygiene), and willingness to adopt protective behaviours. The total attitude scores were then categorized into three levels poor, moderate, and good using predefined scoring intervals.

- Poor attitude: score less than or equal to 50%,
- Moderate attitude: score between 51% to 75%
- Good attitude: score greater than 75%

This classification framework helped distinguish individuals with limited awareness and preventive mindset from those with a more moderate or highly favourable attitude toward disease control. It provided a clearer understanding of how the population perceives and prioritizes zoonotic disease prevention.

3.5.4 Hygiene and Occupational Practices

The final section of the questionnaire focused on actual hygiene and occupational safety practices followed by the respondents. It assessed the frequency and consistency of using PPE such as gloves, masks, aprons, and boots during routine work. Hand hygiene behaviours were evaluated, including the use of phenolic soap after contact with waste or animals. Foot hygiene, particularly the practice of walking barefoot in work environments, was also examined. Additionally, the frequency of cleaning and disinfecting work equipment, such as mops and brushes, was assessed. Waste disposal practices were documented, including the use of color-coded bins and disposal methods such as open dumping, burial, composting, or incineration. This section aimed to identify behavioural gaps between knowledge and practice to inform the development of targeted interventions for improving occupational health and safety.

3.5.4.1 Practice Section Scoring Criteria

To objectively assess the extent to which sanitation workers translated their awareness and attitudes into actual preventive behaviours, a structured and systematic scoring method was implemented for the practice section of the questionnaire. This scoring framework was designed to quantify the frequency, appropriateness, and consistency of essential occupational safety measures adopted during routine sanitation tasks.

3.5.4.1.1 Scoring Method

To quantitatively evaluate the preventive behaviours practiced by sanitation workers in relation to zoonotic disease prevention, a structured scoring system was applied to the practice-related items. Each question in this section focused on the presence, frequency, and appropriateness of workplace safety and hygiene practices during waste handling, cleaning operations, and related tasks.

A three-tier scoring approach was used:

- **2 marks** were awarded for selecting the most appropriate or highly recommended preventive behaviour (e.g., consistent use of personal protective equipment [PPE] such as gloves, masks, and boots; proper segregation and disposal of waste; use of disinfectants after cleaning high-risk areas).
- **1 mark** was given for responses reflecting partially correct or less optimal practices that provided some protection but did not fully meet recommended occupational safety standards (e.g., occasional PPE use, irregular handwashing, or infrequent equipment disinfection).
- **0 marks** were assigned for incorrect, risky, or absent practices—including no preventive action taken or unsafe behaviours such as working barefoot, dumping waste in open areas, or neglecting post-work hygiene.

This scoring method allowed for a more nuanced assessment of practical workplace behaviours, capturing both the quality and consistency of actions. It provided valuable insight into the extent to which sanitation workers were able to translate their knowledge and attitudes into real-world safety practices—information that is critical for designing effective occupational health interventions to reduce the risk of zoonotic disease transmission.

3.5.4.1.2 Total Practice Score

The cumulative score obtained by each respondent across all practice items was calculated. Based on the structure of the questionnaire, the maximum attainable score was 9. The individual scores for all practice-related question were summed to compute a total practice score for each participant.

3.5.4.1.3 Classification of Practice Scores

The cumulative practice scores were then categorized into three levels to determine the degree to which respondents translated knowledge and attitude into daily protective actions:

- Poor practice: score less than or equal to 50%,
- Moderate practice: score between 51% to 75%
- Good practice: score greater than 75%

This classification allowed for the identification of gaps in behavioural implementation, even among those with good knowledge or positive attitudes, highlighting areas in need of focused interventions.

3.6 Questionnaire for Livestock Farmers

The questionnaire was developed to assess the Knowledge, Attitude, and Practices (KAP) of livestock farmers with respect to zoonotic diseases, farm hygiene, and biosecurity measures. The questionnaire was structured into four key sections—demographic information, knowledge of zoonotic diseases, attitude towards hygiene and disease prevention, and hygiene and occupational practices—designed to comprehensively evaluate both behaviour of respondents at the farm level. The detailed questionnaire for livestock farmers is as given below.

Questionnaire for livestock farmers

We are surveying under Community engagement project for prevention and control of Zoonoses funded by ICAR-IVRI. We want to know your knowledge, attitude and perception regarding the diseases transmitted from animals to humans. We wish to find out a good way to understand your needs and provide information to you. The information provided by you will be helpful for prevention and control of zoonotic diseases. All the information from this survey will be kept confidential. Your name will not be used in any published materials like reports and papers. Your participation is entirely voluntary and you can choose to stop answering questions at any time.

Do you want to participate in the survey?

Yes No

Signature

Section I – Demography

S. No.	Content	Details
1	Name	
2	Address	
4	Age	
5	Gender	
6	Annual income	
7	Education	
8	Do you have any formal training in livestock farming?	
9	Have you attended any training programs on animal health and zoonotic diseases?	
10	Primary occupation: a) Livestock rearing b) Crops with livestock rearing c) others	
11	Type of livestock reared a) Cattle b) Buffalo c) Sheep d) Goat e) Pig f) Poultry g) Other	
12	Do you have pet animals on your farm? a) Dog b) Cat c) other	
13	How many years have you been raising livestock?	
14	Do you vaccinate your livestock? a) Brucellosis b) FMD c) Others	
15	How often do you deworm your livestock? a) Every 3 months b) Every 6 months c) Once a year d) Never	

16 List all type of equipment used during work (tick those appropriate)

a) Face Mask b) Hand Gloves

c) Safety Gumboot d) Safety Shoe

17 Hospital visits due to any illness during the last year?

a) <3 /year b) 3-4/ year

c) >5/year d) none

18 Incidence of dog bites in your residential area?

a) < 5/year b) 5-10/year

c) >10/year d) None

19 How often do veterinary doctors visit your farm?

a Regularly (every 1-3 months) b Occasionally (once a year)

c Only when an animal is sick d Never

20 Have you been diagnosed with any disease since five last years?

a) Yes b) No

If yes, type of disease or diseases Provide details:

21 Have your livestock has been diagnosed with any disease since five last years?

If yes, type of disease or diseases Provide details:

1. Abortion 2. TB

3. Diarrhoea 4. Rabies

5. Any other

QUESTIONNAIRE FOR LIVESTOCK FARMERS

KNOWLEDGE

1. Have you heard about the term zoonosis?

a. Yes b. No

2. Do you think livestock farmers are at risk for zoonotic disease?

a. Yes b. No

3. Do you know zoonotic diseases are transmitted through animal?

a. Yes b. No

Cattle	Dogs	Cats	Rodents
Buffalo	Pigs	Poultry	Sheep and Goat

If yes, Which animals do you think can transmit diseases to humans?

4. Which of the following zoonotic diseases have you heard?

Brucellosis	Tuberculosis	Avian influenza	Cysticercosis
Leptospirosis	Rabies	Salmonellosis	COVID-19

5. Do you know zoonotic diseases are transmitted through bite of mosquitoes?
   a. Yes b. No
   If yes, which diseases have you heard?
   Dengue Chikungunya
   Japanese encephalitis Zika virus disease
6. Do you know zoonotic diseases are transmitted through bite of ticks?
   a. Yes b. No
   If yes, which diseases have you heard?
   CCHF Lyme disease
   KFD Q fever
7. Do you know zoonotic diseases are transmitted through rodents?
   a. Yes b. No
   If yes, which diseases have you heard?
   Plague Scrub Typhus
   Leptospirosis
9. Do you know there are zoonotic fungal infections that cause skin/lung diseases
   a) Yes b) No
   If yes, which diseases have you heard?
   Ring worm Aspergillosis
   Candidiasis Cryptococcosis
10. Can dog bite cause rabies?
   a) Yes b) No
11. Raw milk consumption can transmit disease to human?
   a) Yes b) No
   If yes, which diseases have you heard?
   Tuberculosis Toxoplasmosis
   Coxiellosis Brucellosis

ATTITUDE

1 Do you think all farmers should be aware of zoonotic disease?
   a) Yes b) No
2 How concern you are about contracting zoonotic diseases?
   a) Mostly concerned b) Not at all concern
3 Do you believe zoonotic disease are a threat to your health?
   a) Yes b) No

4 Do you think proper farm hygiene can reduce the risk of zoonotic diseases?

a) Yes b) No

5 Would you like to receive training on zoonotic disease prevention and farm biosecurity?

a) Yes b) No

6 Do you believe regular deworming of livestock is necessary?

a) Yes b) No

7 Do you think wearing gloves or washing hands after handling animals can help prevent disease?

a) Yes b) No

8 Do you believe that drinking raw milk can be harmful to human health?

a) Yes b) No

9 Do you think proper disposal of dead animals is important to prevent disease spread?

a) Yes b) No

10 Are you willing to vaccinate your animals against zoonotic diseases ?

a) Yes b) No

11. Do you think handling animal waste like excreta, parturate material etc can cause zoonotic diseases?

a) Yes b) No

PRACTICE

1. Do you wash your hands with phenolic soap after handling animals?

a) Yes b) No

2. How do you typically dispose of animal waste (manure and bedding material)?

a) Leave them in open fields b) Compost

c) Biogas production d) Any other

3. How do you typically dispose of aborted material?

a) Deep burial b) Superficial burial

c) Burning d) Any other (Left for scavenging etc)

4. How do you dispose of dead animal?

a) Bury them properly b) Superficial burial

c) Burning d) Rendering

e) Any other (Left for scavenging etc)

5. How often do you conduct health checks on your animals?

a) Regularly b) Occasionally

c) Rarely

6. Do you visit veterinary doctor for help or information about animal health?
   a) Yes b) No
7. How often do you clean and disinfect animal enclosures?
   a) Daily b) Weekly
   c) Monthly d) Rarely
8. Do you use insect repellent or mosquito net to mosquito bites?
   a) Yes b) No
9. Do you use insect repellent to prevent tick bites?
   a) Yes b) No
10. How often do you administer parasite control measure?
    a) Regularly b) Occasionally
    c) Rarely
11. Do you vaccinate your animals against Brucellosis?
    a) Yes b) No
12. Do you wear protective gear (gloves, boots, masks) when handling sick animals?
    a) Yes b) No
13. Do you test your animals for brucellosis, tuberculosis or any other disease?
    a) Yes b) No
14. Do you allow animals inside your home?
    a) Yes b) No
15. Do you drink raw milk or prepare curd/sweets from raw milk?
    a) Yes b) No
16. In case of dog bite what practice do you follow?
    a) Apply turmeric or ash on wound b) Go to Quack
    c) Wash the wound with phenolic soap d) Go for vaccination to hospital

3.6.1 Demographic Information

The demographic section was designed to gather detailed personal and occupational information. This included data on age, gender, education level, annual income, and years of experience in livestock farming. Information was also collected regarding the types of livestock reared, such as cattle, buffalo, goats, or poultry. Additional questions addressed access to veterinary services, vaccination history of both the respondents and their animals, and previous incidents of workplace injuries. Exposure to potential zoonotic risk factors, such as dog bites, handling of animal waste, contact with sick or dead animals, and unhygienic environmental conditions, was also documented. This section aimed to contextualize respondent's occupational exposure and vulnerability to zoonotic infections.

3.6.2 Knowledge of Zoonotic Diseases

The knowledge section assessed the farmers' awareness and understanding of major zoonotic diseases commonly reported in India particularly in Uttar Pradesh. These included brucellosis, tuberculosis, leptospirosis, avian influenza, cysticercosis, rabies, salmonellosis, and COVID-19. Farmers were asked about the transmission pathways of these diseases, such as direct contact with infected animals, vector-borne transmission *via* mosquitoes, ticks, or rodents, and foodborne transmission through the consumption of raw milk or contaminated animal products. Awareness of zoonotic fungal infections, including ringworm, aspergillosis, candidiasis, and cryptococcosis, was also evaluated. In addition, participants were tested on their understanding of the risks associated with improper animal waste disposal, inadequate sanitation, and unsafe handling of sick animals. This section aimed to determine the breadth and depth of the farmers' knowledge related to zoonotic disease causation and prevention.

3.6.2.1 Knowledge Section Scoring Criteria

The knowledge component of the questionnaire included both single-response and multiple-response items, which assessed respondents' awareness of zoonotic diseases, modes of transmission, clinical symptoms, and animal sources specifically related to livestock. A weighted scoring system was applied to quantify the level of knowledge among participants.

- Single-response questions (such as Yes/No type) were scored as 1 point for a correct answer and 0 for an incorrect or "don't know" response.
- Multiple-response questions were evaluated based on the number of correct options selected. An interval-based scoring approach was used:
    - Selecting 1–2 correct responses = 1 mark
    - Selecting 3–4 correct responses = 2 marks
    - Selecting 5–6 correct responses = 3 marks
    - Selecting 7–8 correct responses = 4 marks

No negative marking was applied for incorrect selections; however, credit was awarded only for the correct options identified.

- Partial credit was granted in cases where respondents identified a subset of the correct options in multiple-response items. For example, if a question contained eight correct zoonotic diseases and the respondent correctly identified four, they were awarded marks as per the tiered system (e.g., 2 marks for 3–4 correct responses).
- Total knowledge score: The cumulative score obtained by each respondent across all knowledge items was calculated. Based on the structure of the questionnaire, the maximum attainable knowledge score was 17.

This scoring methodology provided a nuanced measure of each respondent's factual understanding of zoonotic diseases related to livestock and allowed for categorization into knowledge levels based on predefined cut-off scores, which were derived from the score distribution.

3.6.2.2 Classification of Knowledge Scores

To assess the level of awareness and understanding among respondents regarding zoonotic diseases associated with livestock, the total knowledge scores were analyzed and categorized into three distinct levels:

- Poor knowledge: score less than or equal to 50%,
- Moderate knowledge: score between 51% to 75%
- Good knowledge: score greater than 75%

This scoring system was designed to differentiate between respondents with minimal awareness, those with a basic or intermediate level of understanding, and those with a relatively comprehensive grasp of zoonotic disease-related knowledge.

3.6.3 Attitude Towards Hygiene and Disease Prevention

The attitude section focused on evaluating the respondent's perceptions and beliefs concerning disease prevention and farm biosecurity. Participants were asked about their level of concern regarding the risk of contracting zoonotic diseases and their willingness to implement protective and preventive measures. This included their attitude toward routine handwashing, the use of protective clothing while handling animals, and safe methods for disposing of animal waste. The questionnaire also explored farmer's readiness to vaccinate their livestock against preventable diseases, their perception of the importance of routine deworming, and their willingness to attend training sessions related to hygiene and zoonotic disease prevention. These questions provided insight into their behavioural intentions and motivational factors influencing health-related decision-making on farms.

3.6.3.1 Attitude Section Scoring Criteria

To evaluate the respondents' attitudes toward the prevention and control of zoonotic diseases, a series of structured questions was included in the questionnaire. This section focused on understanding how individuals perceive the risk of disease, the value they place on preventive measures such as animal vaccination, use of personal protective equipment, and maintaining hygiene and their willingness to adopt such protective behaviours. To quantitatively assess these attitudinal dimensions, a well-defined and standardized scoring scheme was employed.

The attitude section consisted primarily of close ended question (Yes/No type questions) aimed at evaluating beliefs, risk perception, and willingness to engage in preventive behaviours (e.g., accepting vaccination, using hygiene measures, or seeking veterinary care). The scoring system helped to determine the overall attitudinal orientation of the respondents—whether they hold favourable or unfavourable views toward adopting preventive and protective measures related to zoonotic diseases.

3.6.3.2 Scoring Method: A **binary scoring system** was applied.

Correct/positive/appropriate attitude responses were scored as 1.

Incorrect/negative/inappropriate attitude responses were scored as 0.

No partial marks were awarded.

3.6.3.3 Total Attitude Score

The cumulative score obtained by each respondent across all attitude items was calculated. Based on the structure of the questionnaire, the maximum attainable attitude score was 11. The individual scores for all attitude-related questions were summed to compute a total attitude score for each participant.

3.6.3.4 Classification of Knowledge Scores

To assess the respondents' attitudinal orientation toward zoonotic disease prevention, a structured scoring system was applied based on their responses to targeted questions measuring risk perception, belief in preventive measures (such as animal vaccination and hygiene), and willingness to adopt protective behaviours. The total attitude scores were then categorized into three levels—poor, moderate, and good—using predefined scoring intervals.

- Poor knowledge: score less than or equal to 50%,
- Moderate knowledge: score between 51% to 75%
- Good knowledge: score greater than 75%

3.7 Hygiene and Occupational Practices

The final section of the questionnaire focused on actual hygiene practices and biosecurity measures implemented by the farmers. Respondents were asked about their regular hand hygiene routines, including the use of soap, and the frequency with which they cleaned and disinfected animal enclosures, feeding equipment, and water troughs. Waste management practices were investigated, including the handling and disposal of manure, aborted materials, and carcasses. Disposal methods such as composting, deep burial, rendering, and open dumping were documented. The questionnaire also assessed behaviours such as the consumption of unpasteurized milk and milk products, handling of sick or dead animals without protective gear, and the actions taken following incidents such as dog bites. This section aimed to evaluate the practical implementation of hygiene protocols and identify risky behaviours that could contribute to the transmission of zoonotic diseases.

3.7.1 Practice Section Scoring Criteria

To objectively assess the extent to which respondents translated their awareness and attitudes into actual preventive behaviours, a structured and systematic scoring method was implemented for the practice section of the questionnaire. This scoring framework was designed to quantify the frequency, appropriateness, and consistency of key health-protective actions adopted by individuals in their routine interactions with livestock.

3.7.2 Scoring Method

To quantitatively evaluate the preventive behaviours adopted by respondents in relation to zoonotic disease control, a structured scoring system was employed for the practice-related items. Each question in this section was designed to assess the presence, frequency, and appropriateness of routine practices related to livestock handling and hygiene.

A three-tier scoring approach was applied to responses:

- **2 marks** were awarded for selecting the most appropriate or highly recommended preventive behaviour (e.g., regularly vaccinating livestock, regularly health checkup of animal, cleaning of the animal enclosure).
- **1 mark** was given for responses reflecting partially correct or less optimal practices that offered some level of protection but did not fully meet recommended standards (e.g., using gloves occasionally or washing hands only sometimes).
- **0 marks** were assigned for incorrect, risky, or absent practices—including answers indicating no preventive action taken or failure to respond.

This scoring method allowed for a more nuanced evaluation of individual behaviour, capturing both the quality and consistency of practical actions. It provided a comprehensive insight into how well respondents translated their knowledge and attitudes into real-world practices, which is crucial for designing effective intervention strategies to prevent zoonotic disease transmission.

Total Practice Score: The cumulative score obtained by each respondent across all practice items was calculated. Based on the structure of the questionnaire, the maximum attainable practice score was 20.

3.7.3 Classification of Practice Scores

The cumulative practice scores were then categorized into three levels to determine the degree to which respondents translated knowledge and attitude into daily protective actions:

- Poor knowledge: score less than or equal to 50%,
- Moderate knowledge: score between 51% to 75%
- Good knowledge: score greater than 75%

This classification allowed for the identification of gaps in behavioural implementation, even among those with good knowledge or positive attitudes, highlighting areas in need of focused interventions.

3.8 Pretesting and Validation

The questionnaires were initially pretested through a pilot survey conducted on a small subset (n=30) of each target population. The objective of the pilot study was to evaluate the clarity, cultural relevance, and contextual appropriateness of the questionnaire. This preliminary assessment also served to estimate the baseline level of awareness regarding zoonotic diseases among the target groups. Findings from the pilot survey indicated that approximately 30% of respondents possessed awareness of commonly occurring zoonotic infections. Based on the feedback obtained, necessary revisions were made to improve the structure and content of the questionnaire to ensure optimal comprehension and reliability. Content validity was subsequently reviewed and approved by experts in veterinary public health and epidemiology.

3.9 Data collection and analysis

Data were collected using structured questionnaires and face-to-face interviews to assess the level of awareness regarding zoonotic diseases among the respondents. Interviews were conducted in the local language (Hindi), and on average, 10 to 15 minutes were spent with each respondent. Prior to participation, oral informed consent was obtained from all respondents with their signature. The collected data were entered into Microsoft Excel and subsequently analyzed using statistical software R. Descriptive statistics were employed to summarize demographic variables, while knowledge, attitude, and practice (KAP) scores were evaluated based on participants responses. Each correct response was awarded a score of one, while incorrect or non-responses were scored zero. The knowledge, attitude, and practice (KAP) scores were then categorized into three levels: poor, fair, and good, based on predefined scoring criteria. This categorization provided a structured framework to clearly distinguish between participants with low, moderate, and high levels of knowledge, attitude, and practice related to zoonotic diseases. By segmenting respondents into these categories, it was possible to not only quantify the level of awareness, perception, and preventive behaviour but also to pinpoint where the most significant gaps existed.

Such classification facilitated meaningful comparisons across demographic groups, occupational categories, and districts, thereby revealing patterns in awareness and behaviour. For instance, it highlighted districts where preventive practices were consistently weak despite moderate or high knowledge levels, indicating a gap between awareness and action. Similarly, it allowed the identification of groups that might benefit most from targeted interventions, such as tailored training programs, awareness campaigns, and improved access to protective resources. The categorization served as a critical analytical tool for translating raw survey responses into actionable public health insights, enabling a more strategic approach toward reducing the occupational and community-level risk of zoonotic disease transmission. Building on this categorization, associations between cumulative KAP scores and selected demographic variables were further examined using logistic regression analysis to identify significant predictors of knowledge, attitude, and practice levels.

3.10 Regression Analysis of KAP Scores

To identify demographic factors influencing cumulative Knowledge, Attitude, and Practice (KAP) scores, we conducted a stepwise regression analysis. First, univariable linear regression analyses were performed separately for each explanatory variable to examine its individual association with KAP scores. This approach allowed us to screen potential predictors and understand the effect of each variable independently. Further, variables that showed potential association in univariable analyses ($p < 0.25$) or were deemed relevant based on prior evidence were included in multivariable linear regression models. This allowed us to estimate the independent effect of each predictor on KAP scores while controlling for confounding factors.

3.10.1 Univariable Linear Regression Analysis

Univariable linear regression analyses were conducted separately for livestock farmers and sanitation workers to examine the association between each explanatory variable and Knowledge, Attitude, and Practice (KAP) scores regarding zoonotic disease prevention and occupational hygiene.

- **For livestock farmers**, predictor variables included socio-demographic characteristics (age, gender, education, annual income, and district of residence) and occupational characteristics (type of farming, and years of farming experience).
- **For sanitation workers**, predictor variables included socio-demographic characteristics (age, gender, education, annual income, and district of residence), occupational characteristics (type of workplace, history of workplace injuries, contact with human/ animal faecal matter or body fluids), vaccination status (Hepatitis B and COVID-19), and health-seeking behaviours (hospital visits and prior disease diagnosis).

Each predictor was analysed in a separate regression model to estimate its individual effect on KAP scores. Regression coefficients (β) represented the average difference in KAP scores relative to the reference category, and p-values assessed statistical significance. The coefficient of determination (adjusted R^2) was calculated to determine the proportion of variability in KAP scores explained by each predictor individually. This approach enabled identification of factors that may influence KAP scores independently before considering potential confounders.

3.10.2 Multivariable Linear Regression Analysis

- **For livestock farmers**, the multivariable model included farming type, district of residence, and age. This approach allowed for adjustment of potential confounding variables, providing estimates of the independent contribution of each factor to differences in KAP scores. Regression coefficients (β) represented the adjusted average difference in KAP scores for each predictor, and p-values indicated statistical significance. The adjusted R^2 was calculated to indicate the proportion of variability in KAP scores explained by the combined predictors. Analysis of variance (ANOVA) was performed to assess the overall statistical significance of the model.

- **For sanitation workers**, the multivariable model included district of residence, workplace type, animal body fluids contact, and workplace injuries. Adjusted regression coefficients and p-values were interpreted similarly, while the adjusted R^2 indicated the total variability in KAP scores explained by these predictors. ANOVA was used to confirm the overall statistical significance of the model.

This combined regression approach univariable followed by multivariable allowed for a systematic assessment of both individual and adjusted effects of socio-demographic and occupational factors on KAP scores in the two occupational groups. All analyses were conducted using R software (version 2025.05.1) and statistical significance was considered at $p < 0.05$. Reference categories were defined for each categorical variable to ensure clarity in the interpretation.

3.11 Estimating the seropositivity of brucellosis and coxiellosis in small ruminants belonging to SC farmers of targeted areas

3.11.1 Study Area

The study aimed to estimate the seropositivity of brucellosis and coxiellosis in small ruminants owned by Scheduled Caste (SC) farmers residing in selected rural areas of Agra, Bareilly, and Baghpat districts of Western Uttar Pradesh, India, during the period from December 2024 to July 2025. These districts were chosen based on the high density of livestock-rearing SC households and accessibility for field data collection

3.11.2 Study Population

The study population comprised small ruminants (sheep and goats) owned by Scheduled Caste (SC) livestock farmers residing in the selected rural areas of Agra, Bareilly, and Baghpat districts. Only animals aged six months or older, and not in advanced stages of pregnancy, were included in the study.

3.11.3 Sample Size and Sampling Strategy

A total of 186 serum samples was collected from small ruminants owned by Scheduled Caste (SC) farmers across three districts. Among the collected samples, 35 were from sheep and 151 from goats. Specifically, 63 samples (17 sheep and 46 goats) were collected from Baghpat, 76 samples (18 sheep and 58 goats) from Agra, and 47 goat samples from Bareilly, where no sheep samples were obtained. The district-wise distribution of the samples is presented in the (Table 2).

Table 2: District-wise sample collection for seropositivity estimation

District	Sheep Samples	Goat Samples	Total Samples
Agra	18	58	76
Baghpat	17	46	63
Bareilly	0	47	47
Total	**35**	**151**	**186**

3.11.4 Sample Collection

Approximately 5 mL of blood was collected aseptically from the jugular vein of each animal using sterile gel vacutainer tubes. After collection, the blood samples were allowed to clot, centrifuged at 3000 rpm for 10 minutes, and sera were separated and stored at –20°C until laboratory testing.

3.11.5 Laboratory Analysis

Enzyme-Linked Immunosorbent Assays (ELISAs) were used to detect specific antibodies against *Brucella* spp. and *Coxiella burnetii*.

3.11.5.1 Commercially available IgG-ELISA kit (IDVET, France) for detecting antibodies against *C. burnetii* were used following the manufacturer's protocol as mention below.

1. Samples and both positive and negative controls were diluted in ratio of 1:50 by mixing 5 µl of each serum sample or controls in 245 µl of the dilution buffer.
3. Added 100 µl diluted controls (Positive and Negative) and serum samples to duplicate wells of ELISA plate.
4. Covered the plate and incubated for 45 min±4 min at 21°C (±5°C).
5. After incubation emptied the wells. Washed each well 3 times with at least 300 µl of the wash solution (1x). Care taken to avoid drying of the wells between washes.

6. Prepared the conjugate 1X by diluting the concentrated conjugate 10X to 1:10 in dilution buffer.
7. 100 µl of the diluted conjugate added to each well .
8. Covered the plate and incubated for 30 min ± 3 min at 21°C (±5°C).
9. Emptied the wells. Washed each well 3 times with at least 300 µl of the wash solution.
10. Added 100 µl of the substrate solution to each well.
11. Covered the plate and incubated for 15 min ± 2 min at 21°C (±5°C) in the dark.
12. Added 100 µl of the stop solution to each well in the same order as in step No.10, to stop the reaction.
13. Read and recorded the O.D. at 450 nm in spectrophotometer.
14. The results were interpreted by calculating S/P% of each sample using the equation given below and as per table 3.

$$S/P\% = \frac{\text{O.D. sample - O.D. negative control}}{\text{OD positive control - O.D. negative control}} \times 100$$

Table 3: Interpretation of results in commercial IgG-ELISA kit for coxiella

Sample to positive ratio (S/P %)	Result
≤40%	Negative
>40% to ≤50%	Doubtful
>50% to ≤80%	Positive
> 80%	Strong positive

3.11.5.2 Commercially available IgG-ELISA kit (IDVET, France) for detecting antibodies against *Brucella* was used as per the manufacturer's protocol mentioned below.

1. Samples and both positive and negative controls were diluted in ratio of 1:20 by mixing 10 µl of each serum sample or controls in 190 µl of the dilution buffer.
2. Covered the plate and incubated for 45 min (±4min) at 21°C.

3. Emptied the wells. Washed each well 3 times with at least 300 µl of the wash solution. Avoid drying of the wells between washes.
4. Conjugate was prepared by diluting the concentrate conjugate 10X to 1:10 in dilution buffer.
5. Added 100 µl of the diluted conjugate to each well.
6. Covered the plate and incubated for 30 min (±4min) at 21°C.
7. Emptied the wells. Washed each well 3 times with at least 300 µl of the wash solution.
8. Added 100 µl of the substrate solution to each well.
9. Covered the plate and incubated for 15 min ±2 min at 21C (±5°C) in the dark.
10. Added 100 µl of the stop solution to each well in the same order as in the step 8.
11. Read and recorded the O.D. at 450 nm in spectrophotometer.
12. The results were interpreted by calculating S/P% of each sample using the equation given below and as per table 4.

$$S/P\% = \frac{\text{O.D. sample - O.D. negative control}}{\text{OD positive control - O.D. negative control}} \times 100$$

Table 4: Interpretation of results in commercial IgG-ELISA kit for brucellosis

Sample to positive ratio (S/P %)	Result
≤110%	Negative
>110% to ≤120%	Doubtful
>120%	Positive

3.12 Data Management and Analysis

The results were entered into Microsoft Excel to calculate seropositivity rates of brucellosis and coxiellosis among the sampled small ruminants and data were systematically analysed to identify distribution across species and study locations.

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Results

4 RESULTS

4.1 Assessment of Knowledge, Attitudes, and Practices in Livestock Farmers

This analysis presents the detailed findings of the Knowledge, Attitude, and Practices (KAP) assessment conducted to evaluate livestock farmers' understanding and behaviours related to zoonotic diseases in the context of their farming activities. The assessment focused specifically on members of the Scheduled Caste (SC) community, who are involved in livestock rearing and are therefore regularly exposed to animals, animal waste, and potentially disease causing pathogens.

Data were collected from 589 farmers residing across seven districts of western Uttar Pradesh including Agra, Baghpat, Bareilly, Bijnor, Firozabad, Mathura and Meerut. These farmers worked closely with cattle, buffalo, goats, and sheep, performing daily tasks such as feeding, milking, cleaning sheds, handling manure, assisting in animal births, and caring for sick or injured animals. Such close and frequent contact with animals and their by products including milk, blood, and manure significantly increases the risk of contracting zoonotic infections. The primary aim of this assessment was to determine farmer's awareness of zoonotic diseases, their attitudes toward animal health and disease prevention, and their routine farming practices including hygiene maintenance, waste disposal methods, and use of protective measures.

4.1.1 Knowledge Assessment Related to Zoonotic Diseases

The knowledge assessment revealed heterogeneous levels of awareness among respondents, highlighting significant gaps in the understanding of zoonotic diseases. A limited proportion of participants (8.05%) were familiar with the term "zoonosis," despite a relatively higher number (32.36%) (Fig. 2) acknowledging that zoonotic diseases are transmissible from animals to humans (Table 5). These findings indicate a superficial understanding of fundamental zoonotic concepts within the study population.

Awareness regarding animal species associated with zoonotic disease transmission varied considerably among respondents. The highest levels of recognition were reported for dogs (74.14%) and cattle (61.30%), followed by poultry (26.88%) and buffaloes (24.83%), whereas other potential reservoirs including rodents (17.12%), pigs (16.78%), cats (14.04%), sheep (7.88%), and goats (7.88%) were identified by substantially fewer participants, indicating limited understanding of the broader spectrum of animal hosts. In terms of disease-specific awareness, COVID-19 (97.26%) and rabies (94.01%) exhibited the highest levels of recognition, likely reflecting recent pandemic exposure and ongoing national rabies prevention initiatives. Moderate levels of awareness were observed for tuberculosis (57.71%) and brucellosis (21.75%), both of which are endemic yet often underreported zoonoses in rural settings. In contrast, diseases such as leptospirosis (0.86%), avian influenza (5.14%), and cysticercosis (0%) were poorly recognized, (Fig. 1) highlighting significant gaps in knowledge of less-publicized, yet epidemiologically relevant, zoonotic infections. The assessment of vector-borne and environmentally transmitted zoonoses revealed considerable disparities in awareness levels among respondents. Recognition of mosquito-borne diseases was relatively high (92.29%), with chikungunya (85.27%), dengue (80.48%), and Japanese encephalitis (41.78%) being frequently identified. This trend likely reflects the endemicity of these arboviral infections and their visibility in public health campaigns. In contrast, Zika virus disease remained entirely unrecognized (n=0), suggesting limited dissemination of information regarding emerging zoonoses. Awareness of tick-borne diseases was markedly low; although 2.91% of respondents acknowledged ticks as potential vectors, none could identify specific tick-associated pathogens such as Crimean-Congo haemorrhagic fever (CCHF), Lyme disease, Kyasanur Forest disease (KFD), or Q fever, indicating a significant knowledge gap. Similarly, rodent-borne zoonoses were poorly understood while 8.39% of respondents acknowledged rodents as potential reservoirs, only a minority recognized associated diseases such as plague (4.97%) and leptospirosis (0.86%), with no awareness of scrub typhus (0%). Fungal zoonoses showed a mixed pattern of recognition, ringworm (75.86%) was widely known, possibly due to its visible dermatological presentation, whereas systemic fungal infections like aspergillosis (n=0), candidiasis (0.34%), and cryptococcosis (n=0) were virtually unknown (Table 5). These findings underscore a skewed awareness profile, biased towards well-publicized, endemic infections, and highlight critical deficiencies in knowledge pertaining to emerging diseases.

A substantial proportion of respondents (84.25%) correctly identified dog bites as a potential source of rabies transmission, indicating high awareness of this well-known zoonosis. In the context of foodborne transmission, 25.00% of participants acknowledged raw milk as a potential risk, with tuberculosis (20.72%) and brucellosis (2.05%) being the most frequently cited associated diseases. However, awareness of other milk-borne zoonoses, such as toxoplasmosis (n=0) and coxiellosis (n=0), was entirely absent. These findings suggest that knowledge among respondents is predominantly limited to widely publicized zoonotic diseases, with considerable deficiencies in the recognition of less-known but epidemiologically relevant zoonoses, particularly those associated with food safety and emerging health threats.

Table 5: Assessment of Knowledge parameters related to zoonoses amongst the livestock farmers

S. no	Knowledge questions	Response	No. of positive response	% of respondent with positive response
1	Have you heard about the term zoonosis?	Yes	47	8.05
2	Do you think livestock farmers are at risk for zoonotic disease?	Yes	156	26.71
3	Can dog bite cause rabies?	Yes	492	84.25
4	Do you know zoonotic diseases are transmitted through animals?	Yes	189	32.36
5	Which animals can transmit diseases?	Cattle	358	61.3
		Dogs	433	74.14
		Cat	82	14.04
		Rodent	100	17.12
		Buffalo	145	24.83
		Pig	98	16.78
		Sheep	46	7.88

		goat	46	7.88
		poultry	157	26.88
6	Which zoonotic diseases have you heard?	COVID-19	568	97.26
		Salmonellosis/foodborne	101	17.29
		Rabies	549	94.01
		Brucellosis	127	21.75
		Tuberculosis	337	57.71
		Avian influenza	30	5.14
		Cysticercosis	0	0
		Leptospirosis	5	0.86
7	Do you know zoonotic disease are transmitted through bite of mosquitoes?	YES	539	92.29
		Dengue	470	80.48
		Chikungunya	498	85.27
		Japanese encephalitis	244	41.78
		Zika virus disease	0	0
8	Do you know zoonotic disease are transmitted through bite of tick?	CCHF	0	0
		Lyme disease	0	0
		KFD	0	0
		Q fever	0	0
		Yes	17	2.91
9	Do you know zoonotic disease are transmitted through rodents?	Yes	49	8.39
		Plague	29	4.97
		Scrub Typhus	0	0
		Leptospirosis	5	0.86
10	Do you know zoonotic fungal infections that cause skin/lung disease?	Yes	285	48.8
		Ring worm	443	75.86
		Aspergillosis	0	0
		Candidiasis	2	0.34
		Cryptococcosis	0	0
11	Can raw milk consumption transmit disease to humans?	Yes	146	25
		Tuberculosis	121	20.72
		Toxoplasmosis	0	0
		Coxiellosis	0	0

4.1.1.2 Knowledge assessment using scoring method

This scoring system was designed to differentiate between respondents with minimal awareness, those with a basic or intermediate level of understanding, and those with a relatively

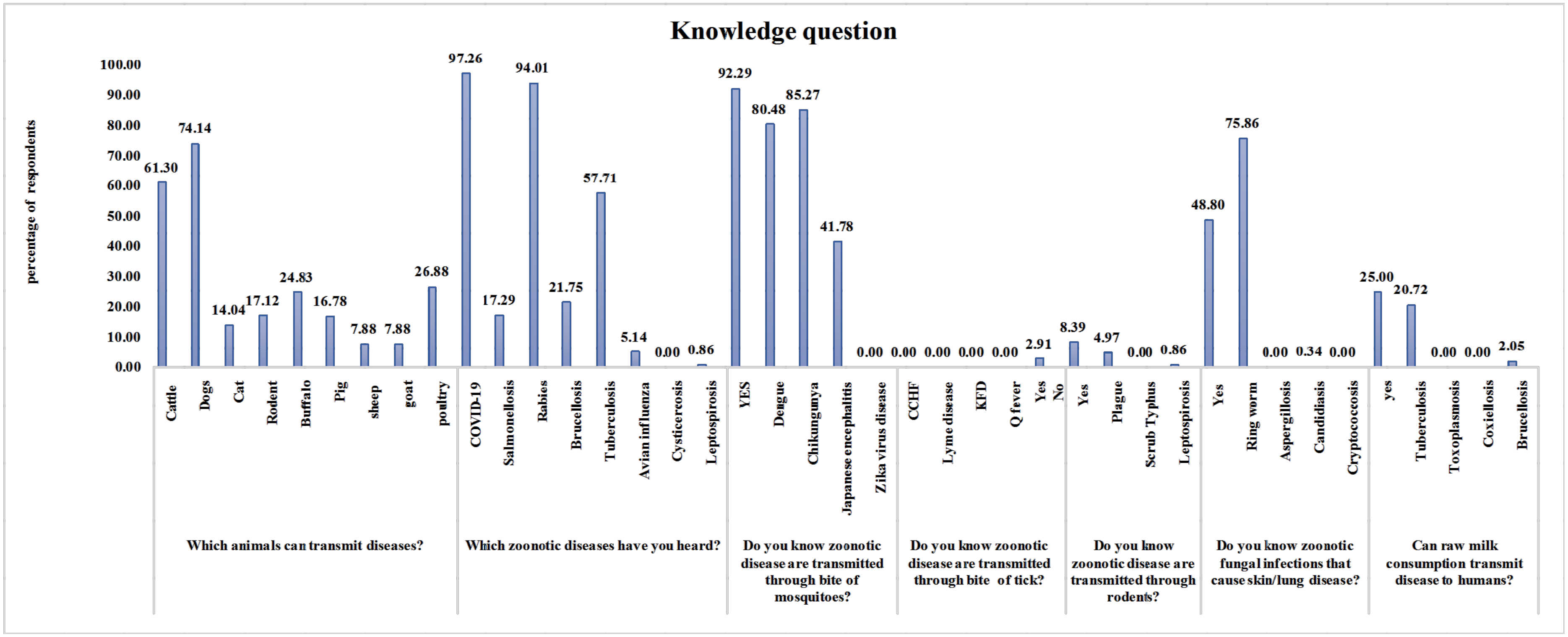

Fig. 1: Assessment of zoonoses knowledge amongst the livestock farmers

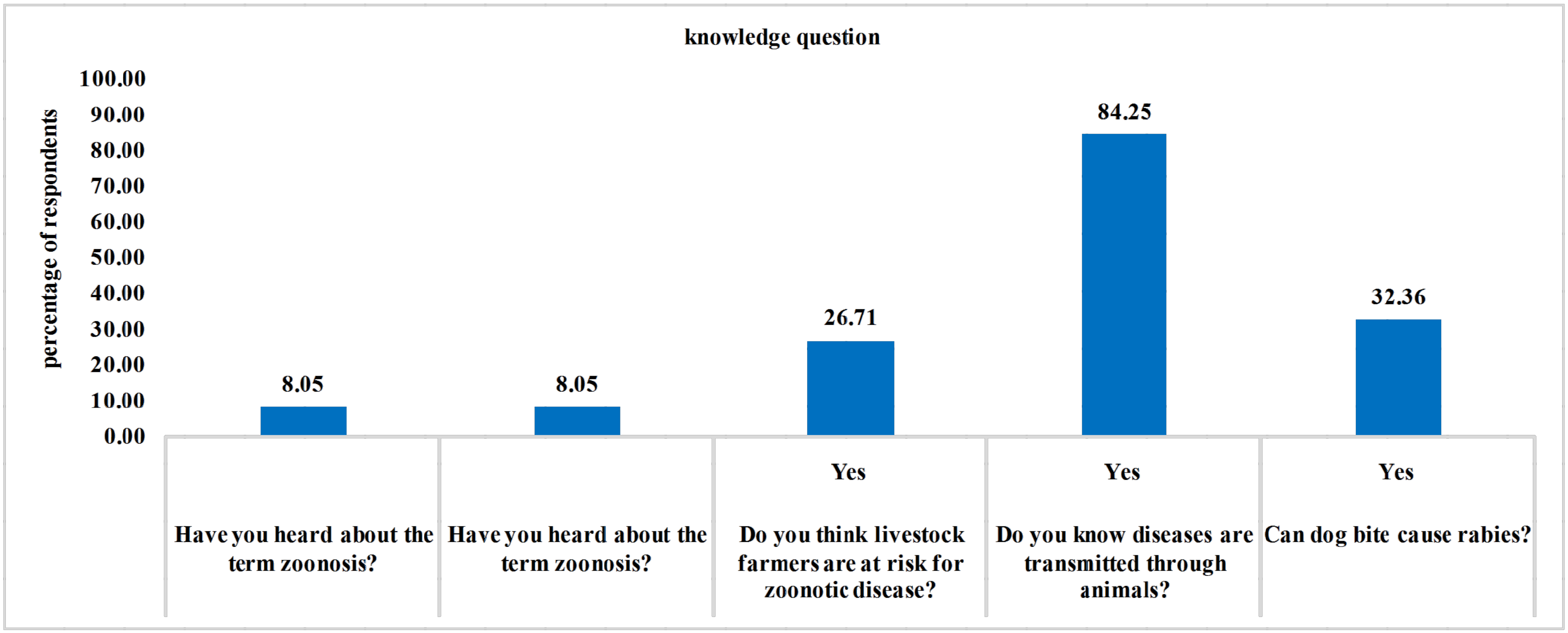

Fig. 2: Assessment of zoonoses knowledge (binary response questions) amongst the livestock farmers

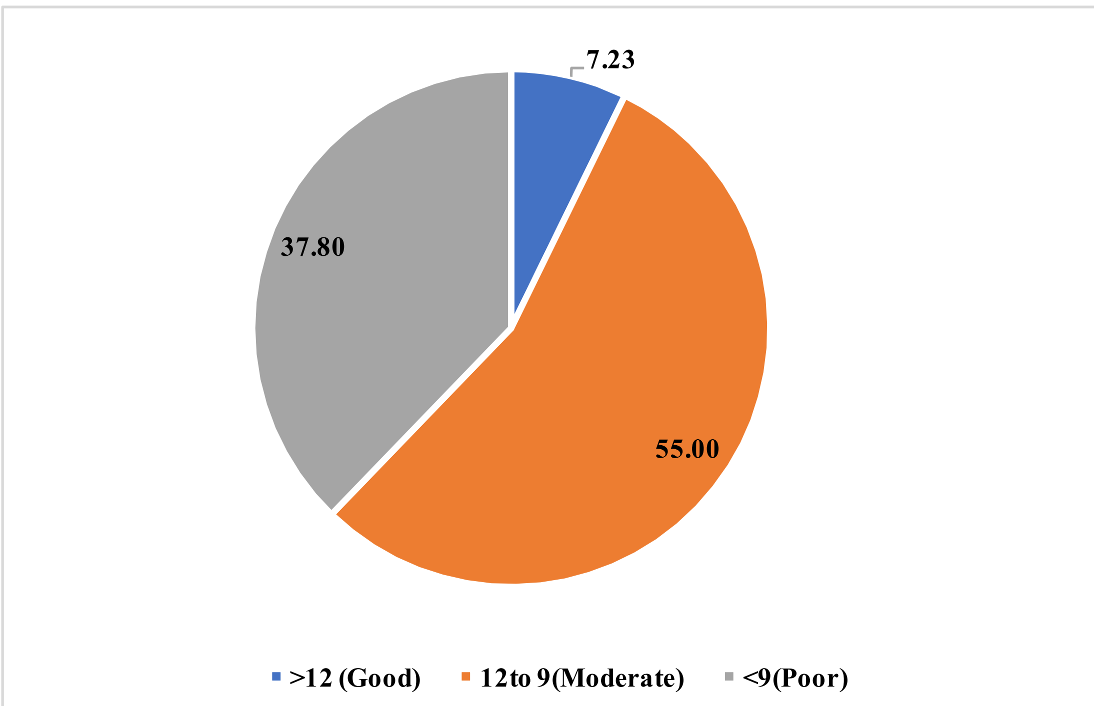

Fig. 3: Knowledge score of zoonotic diseases amongst livestock farmers

comprehensive grasp of zoonotic disease related knowledge. Out of a total of 589 livestock farmers, 42 (7.19%) demonstrated good knowledge, 321 (54.97%) had moderate knowledge, and 226 (37.84%) showed poor knowledge (Fig.3).

A total of 42 livestock farmers fell into the good knowledge category. They clearly understood what zoonotic diseases are, the risks linked to livestock handling, and how such diseases can spread to humans. They were well informed about safe animal handling practices, biosecurity measures, and effective preventive steps such as vaccination, proper waste management, and maintaining hygiene in animal enclosure. The largest group, 321 farmers, had moderate knowledge. They were aware of common zoonotic diseases and some of their transmission routes and followed basic preventive measures. However, they lacked a deep understanding of less known diseases, multiple modes of transmission, and advanced prevention strategies. Their practices were often inconsistent, which could still leave them and their livestock vulnerable to infection. A significant number, 221 farmers, were in the poor knowledge category. They had very limited understanding of zoonotic diseases, their symptoms, and how they spread. Many were unaware of safe handling techniques, basic hygiene measures, or disease prevention practices, placing them at high risk of contract in and spreading zoonotic infections through their daily livestock related activities.

4.1.1.3 Comparative District-wise Assessment of Knowledge score on Zoonotic Diseases

The analysis of knowledge levels regarding zoonotic diseases among respondents from seven districts in western Uttar Pradesh highlights substantial inter-district variation. The classification was based on three categories: Good, Moderate, and Poor knowledge. According to scoring criteria, Agra recorded the highest proportion of respondents with good knowledge (11.02%), followed by Bareilly (8.16%), Bijnor (9.30%), and Firozabad (9.30%) (Table 6; Fig 4). These districts reflect relatively better awareness about zoonotic disease transmission and prevention among livestock farmers, possibly due to better access to veterinary services or exposure to awareness campaigns. Moderate knowledge dominates in most districts as the majority of respondents fell into the moderate knowledge category. This trend was most prominent in Firozabad (70.93%), Bijnor (66.28%), and Bareilly (62.24%), indicating a fair understanding of basic zoonotic risks but with noticeable gaps in deeper disease knowledge and preventive practices. Alarmingly, poor knowledge was extremely high in Meerut (74.32%) and Mathura (68.00%), where over two thirds of respondents lacked even basic understanding of zoonotic diseases and their prevention. The farmers of Baghpat (34.09%) also showed a notable proportion with poor knowledge. These findings indicate that targeted awareness campaigns, veterinary outreach programs, and farmer focused training sessions are urgently needed in these high risk districts.

Table 6: District-wise Assessment of Knowledge score on zoonotic amongst livestock farmers

District	% GOOD	% MODERATE	% POOR
Agra	11.02	59.32	29.66
Bareilly	8.16	62.24	29.59
Baghpat	5.68	60.23	34.09
Bijnor	9.30	66.28	24.42
Firozabad	9.30	70.93	19.77
Meerut	0.00	25.68	74.32
Mathura	0.00	32.00	68.00

4.1.2 Attitude Assessment Related to Zoonotic Diseases

This section presents the detailed findings on the attitudes of respondents toward zoonotic diseases originating from livestock. The attitude component of the questionnaire was designed to explore the perceptions, beliefs, and level of concern among livestock handlers regarding their susceptibility to zoonotic infections and the importance of preventive actions. The respondents' views on the seriousness and health impact of such diseases were also evaluated to understand how they perceive the threat of zoonotic infections in daily life.

The attitude assessment revealed a generally positive perception among respondents toward zoonotic disease prevention and control, though with varying degrees of conviction. A large proportion (73.97%) strongly agreed that all farmers should be aware of zoonotic diseases, and more than half (57.53%) recognized zoonotic diseases as a threat to human health (Table 7: Fig. 5). However, concern about contracting zoonotic diseases was moderate, with 54.97% reporting concern. Regarding perception on preventive practices, 52.74% agreed that farm

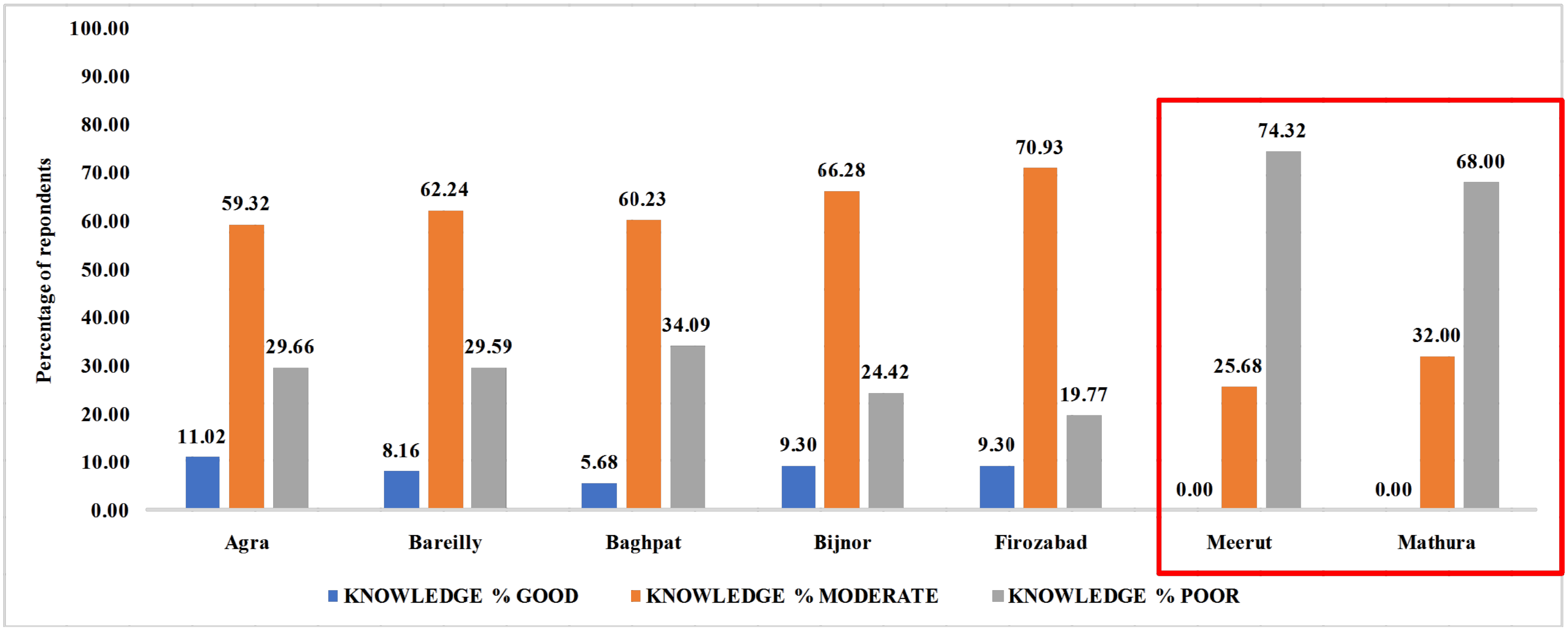

Fig. 4: District-wise Assessment of Knowledge amongst livestock farmers

hygiene can help in reducing zoonotic risk, and 56.68% expressed interest in receiving training on zoonotic prevention and biosecurity. Similarly, 55.65% supported regular deworming of livestock, and 51.88% acknowledged that hand hygiene and glove use can help in preventing disease transmission. Despite this, awareness of specific risks remained modest; only 50.86% believed raw milk could be harmful, and 50.68% recognized the importance of proper disposal of animal carcasses. Notably, only 46.75% indicated willingness to vaccinate animals against zoonoses, and just over half (50.51%) acknowledged that handling animal waste could result in disease transmission. These findings suggest a foundational awareness and willingness to engage in good animal husbandry practices, though critical gaps remain in attitudes toward certain high-impact interventions, such as vaccination and safe handling of animal products and waste.

Table 7: Assessment of attitude parameter related to zoonoses amongst the livestock farmers

S. no	Attitude questions	Response	No. of positive response	% of respondent with positive response
1	Should all farmers be aware of zoonotic disease?	Yes	432	73.97
2	How concern about contracting zoonotic diseases?	Mostly concerned	321	54.97
3	Do you believe zoonotic diseases are a threat to health?	Yes	336	57.53
4	Does farm hygiene reduce zoonotic risk?	Yes	308	52.74
5	Would you like training on zoonotic prevention and biosecurity?	Yes	331	56.68
6	Is regular livestock deworming necessary?	Yes	325	55.65
7	Can handwashing/glove use prevent disease?	Yes	303	51.88
8	Is raw milk harmful to humans?	Yes	297	50.86
9	Is proper disposal of dead animals important?	Yes	296	50.68
10	Willing to vaccinate animals against zoonotic diseases?	Yes	273	46.75
11	Can handling animal waste cause zoonotic diseases?	Yes	295	50.51

4.1.2.1 Attitude assessment using scoring method

This scoring system was designed to differentiate between respondents with limited concern for occupational safety, those with a basic or moderately positive outlook, and those with a strong and proactive attitude toward zoonotic disease prevention. Out of a total of 589 livestock farmers, 47 (7.88%) demonstrated a good attitude, 325 (55.31%) had a moderate attitude, and 217 (36.81%) showed a poor attitude (Fig. 6).

A total of 46 livestock farmers fell into the good attitude category. They consistently recognized the risks of zoonotic diseases, valued the importance of preventive practices, and were willing to adopt protective measures. These respondents showed a proactive approach toward occupational safety, including readiness to use personal protective equipment (PPE), follow safe handling protocols, and maintain hygiene in animal rearing environments. The majority, 323 farmers, displayed a moderate attitude. They acknowledged the importance of safe livestock handling and disease prevention but were inconsistent in applying these measures in their daily activities. While they were generally aware of the benefits of protective practices, their adoption was not systematic, leaving gaps in their overall prevention efforts. A considerable number, 215 farmers, had a poor attitude toward zoonotic disease prevention. They showed limited concern for occupational risks and often underestimated the importance of following protective measures. Many were reluctant to adopt PPE, maintain biosecurity, or reporting health concerns, thereby increasing the risk of disease transmission to themselves, their families, and the wider community.

4.1.2.3 Comparative District-wise Assessment of Attitude score on Zoonotic Diseases

The analysis of knowledge levels regarding zoonotic diseases among respondents from seven districts in western Uttar Pradesh highlights substantial inter-district variation. The classification was based on three categories: Good, Moderate, and Poor knowledge.

According to scoring criteria, out of 589 respondents, Bijnor recorded the highest proportion of respondents with good attitude (22.60%), followed by Meerut (21.62%) and Mathura (6.00%) (Table 8 : Fig. 7). These districts reflect relatively stronger perceptions of occupational safety and a greater willingness to adopt preventive measures, which may be

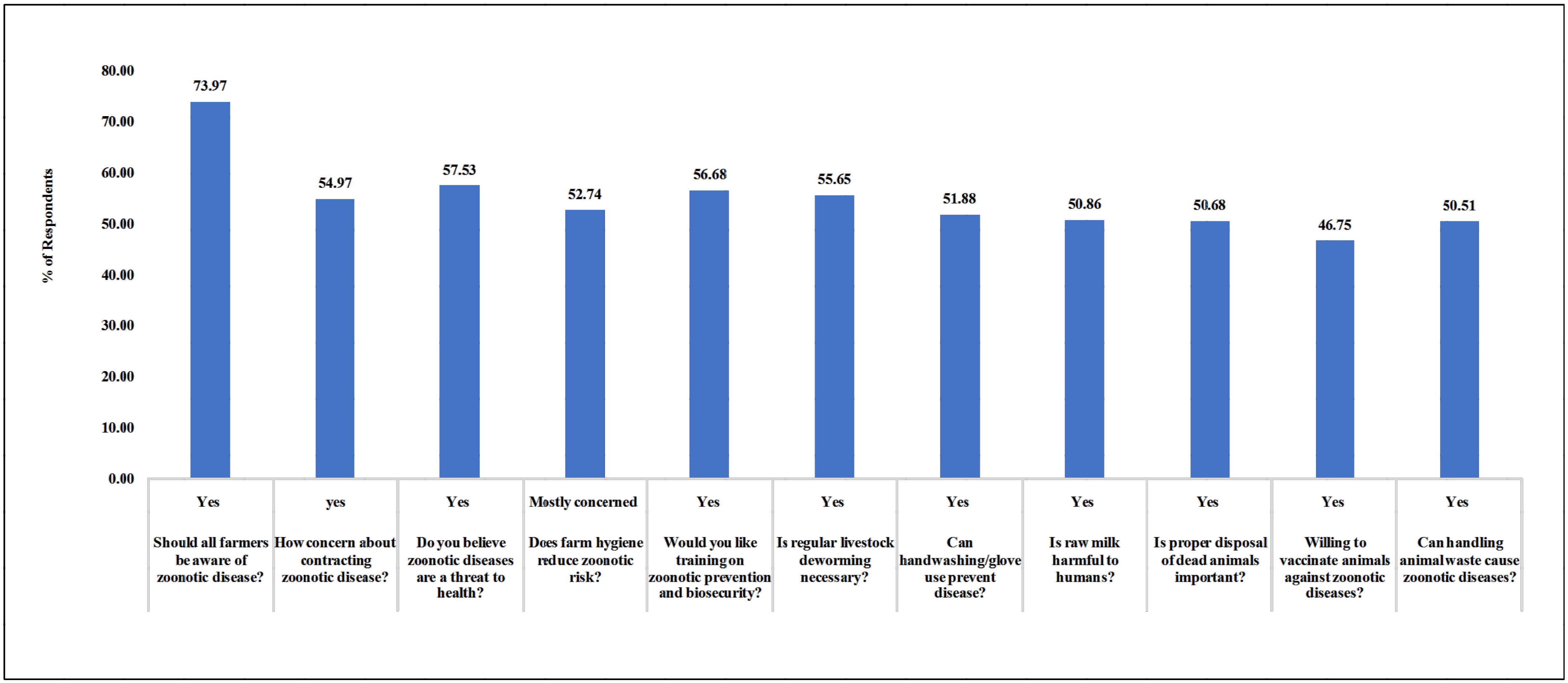

Fig. 5: Assessment of zoonoses attitude amongst the livestock farmers

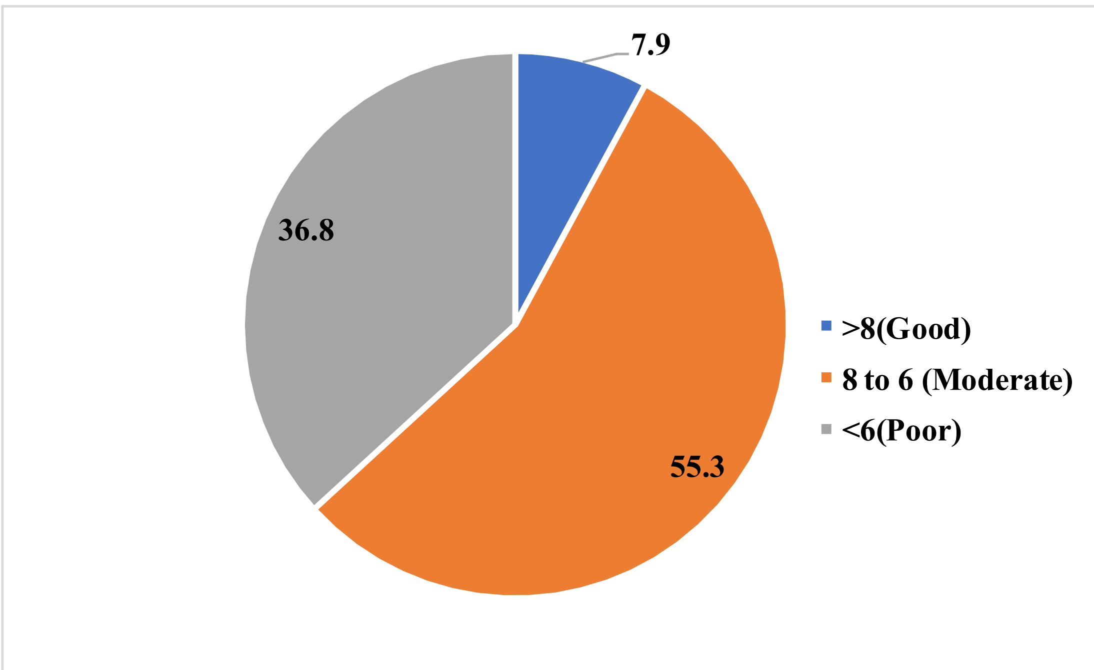

Fig. 6: Attitude score of zoonotic diseases amongst livestock farmers

linked to better local workplace safety practices. The majority of respondents in most districts fell into the moderate attitude category. This trend was most prominent in Bijnor (80.23%), Agra (59.32%), and Firozabad (55.81%), indicating that while workers recognize the importance of occupational safety, their commitment to consistently practicing protective measures remains partial. Even in districts with relatively low "Good" attitude scores, moderate attitudes were common, showing potential for targeted reinforcement through training and awareness programs. Poor attitude levels were particularly high in Bareilly (53.06%), Mathura (48.00%), and Baghpat (45.45%). In these districts, a large share of workers displayed limited concern for occupational safety, infrequent use of PPE, and reluctance to report safety issues, which heighten the risk of occupational exposure to zoonotic diseases. These areas require urgent and sustained behaviour change interventions, alongside stronger enforcement of workplace safety measures.

Table 8 : District-wise Assessment of Attitude score on zoonotic disease amongst livestock farmers

District	% GOOD	% MODERATE	% POOR
Agra	2.54	59.32	38.14
Bareilly	2.04	44.90	53.06
Baghpat	2.27	52.27	45.45
Bijnor	22.60	80.23	1.16
Firozabad	4.65	55.81	39.53
Meerut	21.62	52.70	25.68
Mathura	6.00	46.00	48.00

4.1.3 Practice Assessment Related to Zoonotic Diseases

This section assessed the preventive behaviours of respondents in relation to zoonotic disease control, focusing on how often and how consistently they applied safe practices. Key aspects included the use of personal protective equipment, regular handwashing, safe disposal of animal waste and aborted materials, avoidance of raw animal products, livestock vaccination, and seeking veterinary care for sick animals. The aim was to evaluate how well respondents translated their knowledge and attitudes into practical, protective actions and to identify the gaps that may increase the risk of zoonotic disease transmission.

Concerning the disposal of animal waste, a considerable proportion of respondents (40.75%) reported adopting composting methods, which are generally considered safe and environmentally friendly (Table9; Fig8a). A smaller share (6.85%) used biogas systems, which not only aid in waste management but also contribute to renewable energy production. However, it is concerning that 3.94% of respondents still disposed of manure in open fields—a practice known to cause environmental contamination and increase the risk of zoonotic disease transmission. The remaining 48.46% reported using other disposal methods, such as transporting waste by truck, landfilling and also dumping near water bodies indicating a continued reliance on traditional disposal approaches that may pose environmental and public health risks. When it came to the disposal of high risk biological materials, such as aborted foetuses, the majority (82.19%) followed the recommended practice of proper burial, ensuring safe containment and reduced risk of disease spread. In contrast, 14.38% resorted to superficial burial, which is less effective in preventing environmental contamination. Less than 1% reported burning such materials, while 2.43% admitted to unsafe alternatives such as leaving them for scavenging. A similar pattern was observed in the disposal of animal carcasses. Proper burial was the most widely practiced method, reported by 82.02% of respondents. However, 14.73% engaged in superficial burial, 2.91% relied on rendering, and a small fraction (0.34%) left carcasses for scavenging. These findings highlight that, while most respondents follow safe disposal practices, a proportion of farmers still engage in improper methods that may contribute to environmental hazards and the spread of zoonotic diseases. Following dog bite incidents, 48.29% of respondents reported seeking professional medical attention at health facilities, while 46.23% practiced wound hygiene using phenolic soap. Encouragingly, 21.06% undertook both protective measures: thoroughly washing the wound with phenolic soap and obtaining timely professional care. Despite these positive practices, reliance on traditional or non-evidence-based approaches remained notable with 7.71% of respondents applied household substances such as turmeric or ash directly to the bite site, and 9.25% sought treatment from unlicensed practitioners or "quacks (Table 9 : Fig. 8b). These behaviours highlight the ongoing influence of deep-rooted cultural beliefs, gaps in awareness, and possible barriers to accessing formal healthcare.

Routine veterinary health monitoring of livestock was found to be severely inadequate with only 2.05% of respondents reported conducting regular health check-ups, while 22.09%

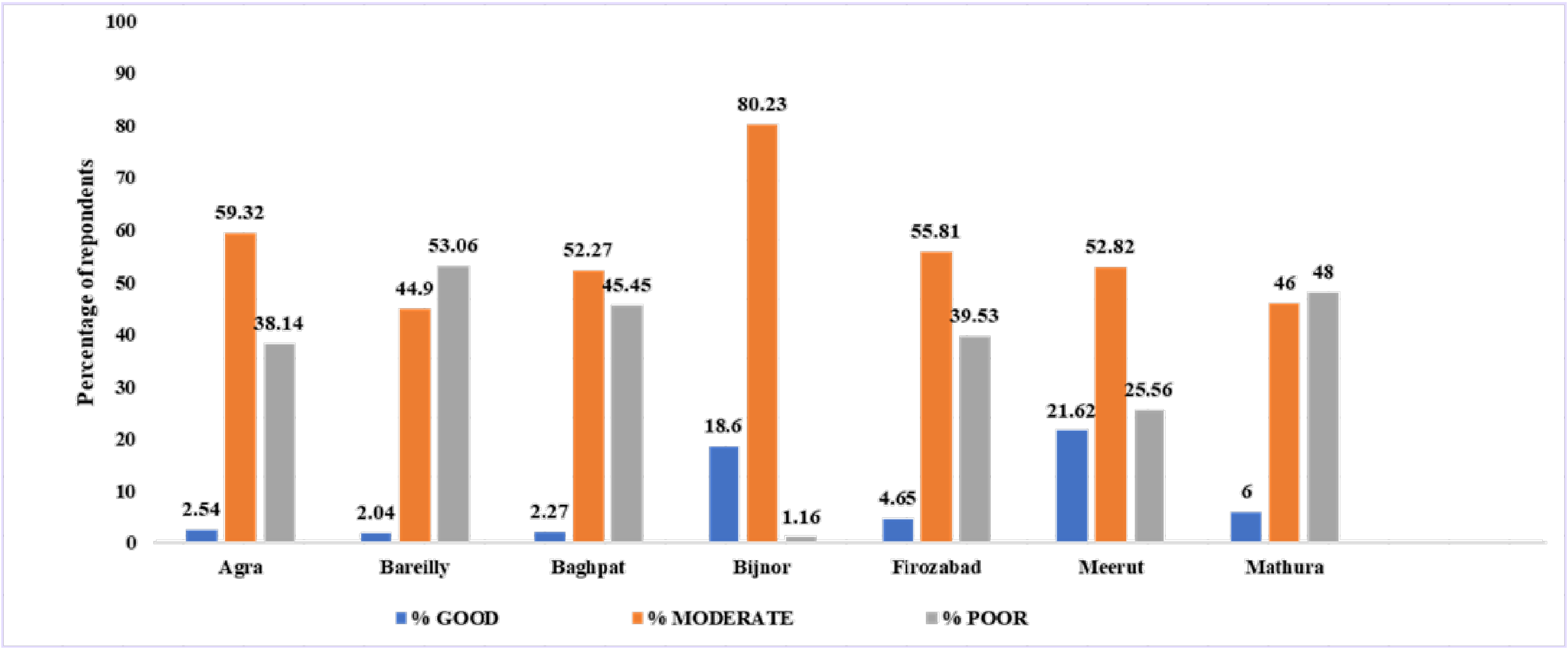

Fig. 7: District-wise Assessment of Attitude amongst livestock farmers

did so occasionally and the majority of 75.86% did only when animals were visibly ill. This limited frequency represents a significant gap in the early detection and timely management of zoonotic diseases. In contrast, hygiene practices within animal enclosures were generally strong. A large proportion of 94.35% of respondents reported cleaning and disinfecting enclosures on a daily basis, an essential measure for reducing environmental pathogen loads and lowering the risk of disease transmission. However, 5.36% cleaned only once a week, which may be insufficient to effectively control pathogen buildup and prevent disease spread and remaining, 0.29% do it monthly.

The implementation of internal and external parasite control measures showed moderate compliance. Regular deworming and ectoparasite control were reported by 40.41% of respondents, while 40.24% practiced such measures occasionally, and 19.35% acknowledged rare engagement in these practices. This variability highlights the need for greater consistency and awareness in disease prevention.

4.1.3.1 Practice assessment using scoring method

This scoring system was designed to distinguish between respondents with poor adherence to recommended preventive measures, those with moderately consistent practices, and those who consistently followed good preventive behaviours related to zoonotic disease control. Out of a total of 589 livestock farmers, only 1 (0.20%) followed good practices, 455 (77.40%) had moderate practices, and 133 (22.43%) showed poor practices (Fig.8). The only individual who followed good preventive practices consistently followed all recommended safety measures, including the regular use of personal protective equipment (PPE) while working, routine veterinary consultations for livestock, proper disposal of animal waste, and strict personal hygiene. Such practices greatly reduce the likelihood of zoonotic disease transmission and reflect a strong commitment to occupational and public health safety. The majority of farmers, 452 respondents (77.40%), fell into the moderate practice category. They followed some preventive measures such as occasional PPE use, periodic veterinary visits, and partial adherence to safe waste disposal methods. However, these practices were applied inconsistently, creating gaps that could still allow zoonotic diseases to spread. A significant proportion, 131 respondents (22.43%), displayed poor preventive practices with many individuals rarely or never used PPE, failed to seek timely veterinary care, and often disposed of animal waste unsafely such as dumping in open areas or near water bodies. These unsafe behaviours considerably increase the risk of zoonotic disease transmission to themselves, their animals, and the wider community.

Table 9 : Assessment of practices parameter related to zoonoses amongst the livestock farmers

S. no	Attitude questions	Response	No. of positive response	% of respondent with positive response
1	How do you dispose of animal waste (manure)?	Open fields	23	3.94
		Compost	238	40.75
		Biogas	40	6.85
		Other	0	0
2	How do you dispose of aborted material?	Bury properly	480	82.19
		Superficial burial	84	14.38
		Burning	3	0.51
		Other	0	0
3	How do you dispose of dead animal?	Bury properly	479	82.02
		Superficial burial	86	14.73
		Burning	4	0.68
		Rendering	17	2.91
		Other	2	0.34
4	How often do you conduct animal health checks?	Regularly	12	2.05
		Occasionally	129	22.09
		Rarely	443	75.86
5	How often do you clean and disinfect animal enclosures?	Daily	551	94.35
		Weekly	33	5.65
		Monthly	0	0
		Rarely	0	0
6	Frequency of parasite control measures?	Regularly	236	40.41
		Occasionally	235	40.24
		Rarely	159	27.23
7	What do you do in case of dog bite?	Apply turmeric/ash	45	7.71
		Go to quack	54	9.25
		Wash with phenolic soap	270	46.23

8	Go to hospital	Yes	282	48.29
9	Do you wash hands with phenolic soap after handling animals?	Yes	368	63.01
10	Do you vaccinate animals against Brucellosis?	Yes	292	50
11	Use of protective gear when handling sick animals?	Yes	160	27.4
12	Do you test animals for brucellosis, TB or other disease?	Yes	155	26.54
13	Do you allow animals inside your home?	Yes	329	56.34
14	Do you drink or use raw milk to make curd/sweets?	Yes	182	31.16
15	Do you use insect repellent or mosquito net to mosquito bite?	Yes	265	45.38
16	Do you use insect repellent to prevent tick bite?	Yes	143	24.49
17	Do you visit veterinary doctors for help and information about animal health ?	Yes	338	57.88

4.1.3.2 Comparative District-wise Assessment of Practice score on Zoonotic Diseases

The analysis of knowledge levels regarding zoonotic diseases among respondents from seven districts in western Uttar Pradesh highlights substantial inter-district variation. The classification was based on three categories: Good, Moderate, and Poor knowledge. Good practice scores were almost absent in all districts, with the only exception being Firozabad, where one respondent demonstrated strong preventive behaviour. This extremely low prevalence of good practices highlights a serious gap between knowledge, attitude, and the actual implementation of preventive measures against zoonotic diseases. Moderate practice levels were the most common across all districts, indicating that while some preventive behaviours are being followed, they are often inconsistent or incomplete. The highest proportions of moderate practices were seen in Agra (88.14%), Mathura (88.00%), Bijnor (82.56%), and Bareilly (76.53%) (Table 10; Fig. 9). Other districts such as Firozabad (73.26%), Baghpat (72.73%), and Meerut (63.51%) also showed a majority in the moderate range, suggesting partial compliance with recommended safety and hygiene measures.

Poor practice scores were still prominent in several districts, indicating risky behaviours and a lack of adoption of even basic preventive measures. Meerut recorded the highest poor practice rate at 36.49%, followed by Baghpat (27.27%), Firozabad (25.58%), and Bareilly (23.47%). Comparatively lower levels were observed in Bijnor (17.44%), Mathura (12.00%), and Agra (11.86%), yet the persistence of unsafe practices in these areas remains a concern for public and occupational health.

Table 10 : District-wise Assessment of Practice score on zoonotic disease amongst livestock farmers

District	% GOOD	% MODERATE	% POOR
Agra	0.00	88.14	11.86
Bareilly	0.00	76.53	23.47
Baghpat	0.00	72.73	27.27
Bijnor	0.00	82.56	17.44
Firozabad	1.16	73.26	25.58
Meerut	0.00	63.51	36.49
Mathura	0.00	88.00	12.00

4.1.4 Univariable Linear Regression Analysis

Understanding the factors that influence farmers knowledge, attitudes, and practices (KAP) regarding zoonotic diseases is essential for designing targeted interventions. This study applies univariable regression analysis to examine how socio-demographic and occupational characteristics such as age, district of residence, gender, annual income, education level, type of farming, and years of livestock farming experience influence KAP scores related to zoonotic diseases. Each predictor was analyzed in a separate model, with the estimation of regression coefficient, and the *p*-value indicating statistical significance (Table11). Interpreting these results helps identify which factors are most strongly associated with KAP, guiding the development of geographically and demographically tailored prevention strategies.

The regression analysis examining the association between age and KAP scores used the youngest age group (18-35) as the reference category. Farmers aged 36–53 years had a regression coefficient of 0.1048 with a *p*-value of 0.730, indicating no statistically significant

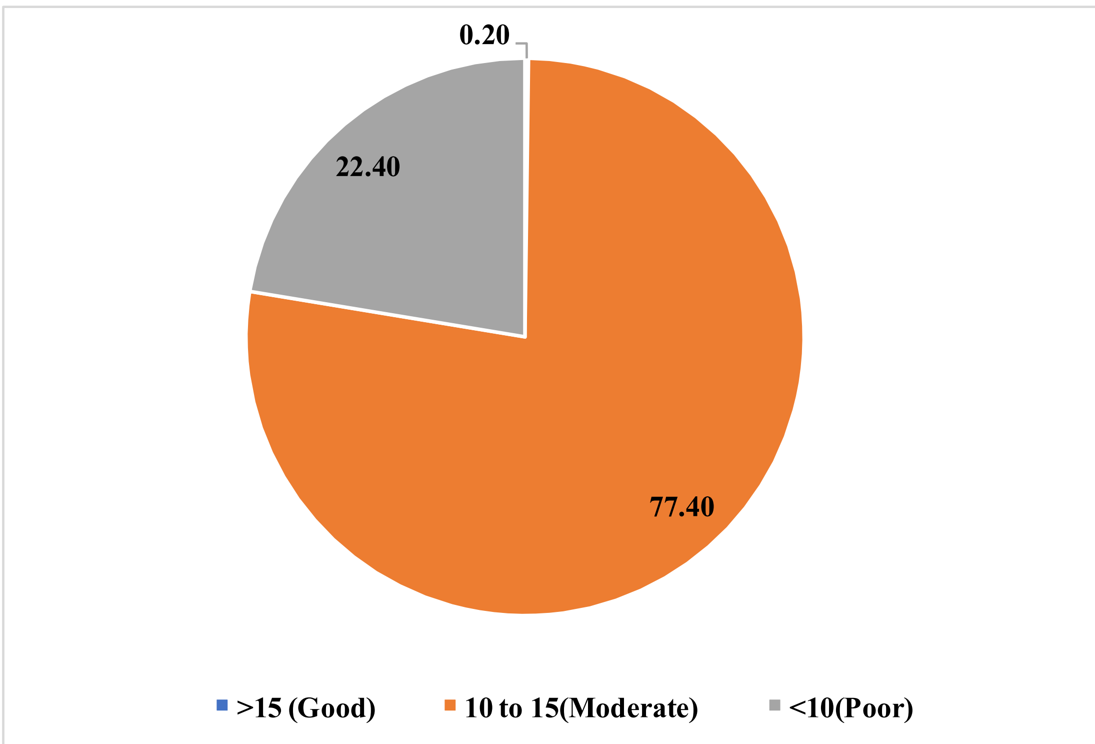

Fig. 8: Practice score of zoonotic diseases amongst livestock farmers

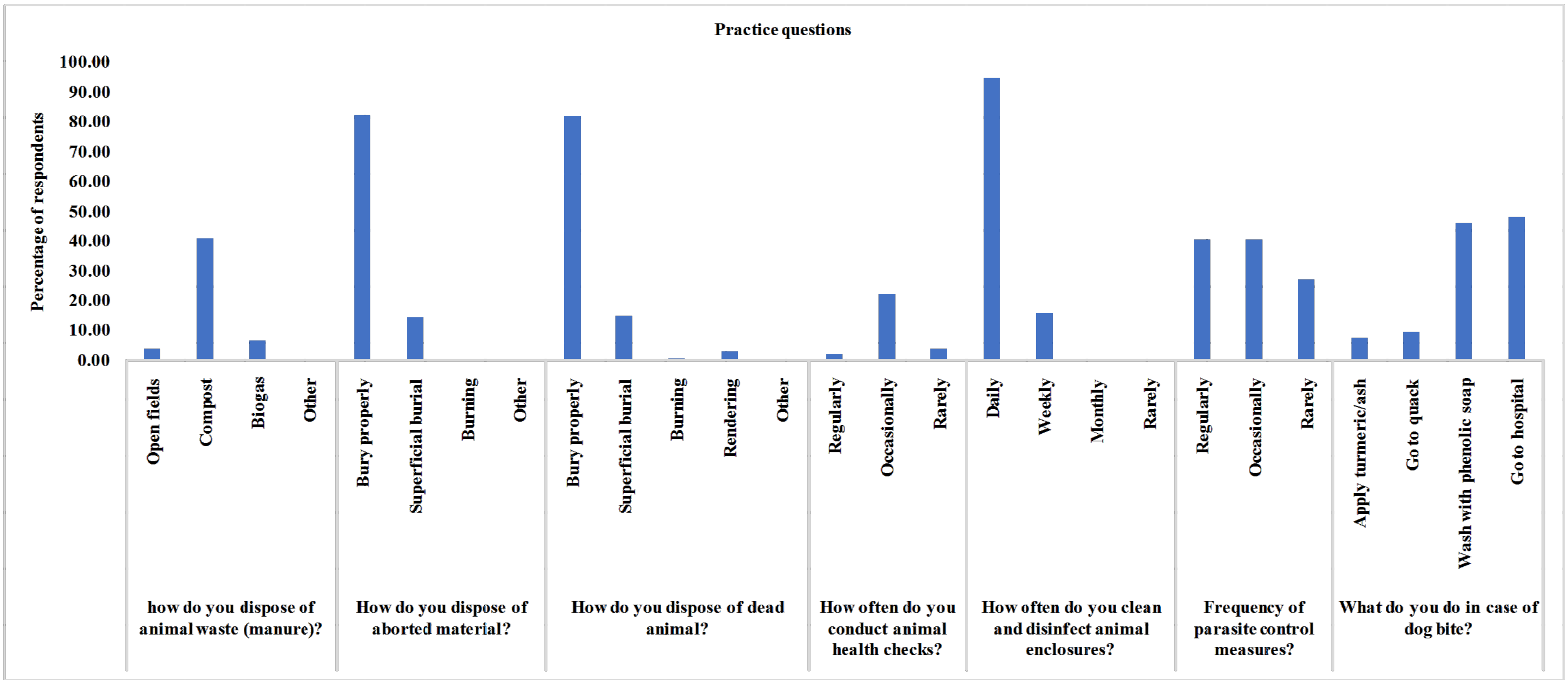

Fig. 8a: Assessment of zoonoses practice amongst the livestock farmers

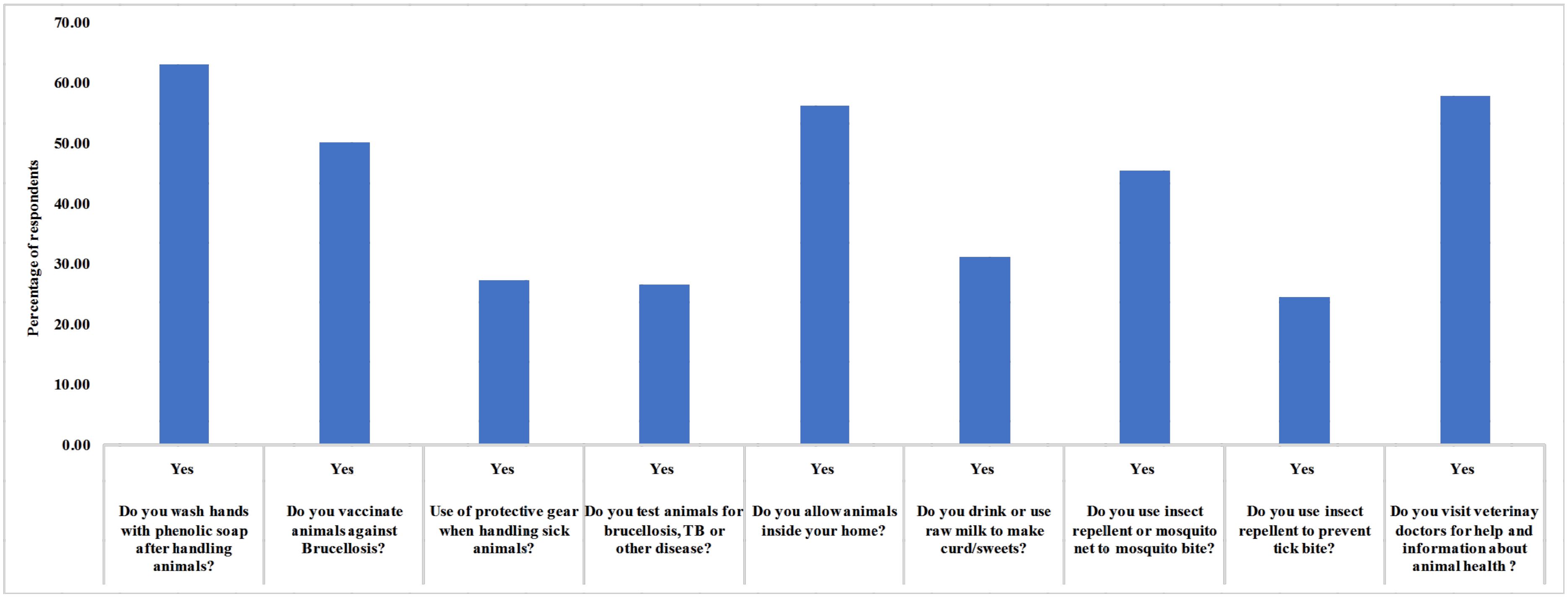

Fig.8b: Assessment of zoonoses practice amongst the livestock farmers

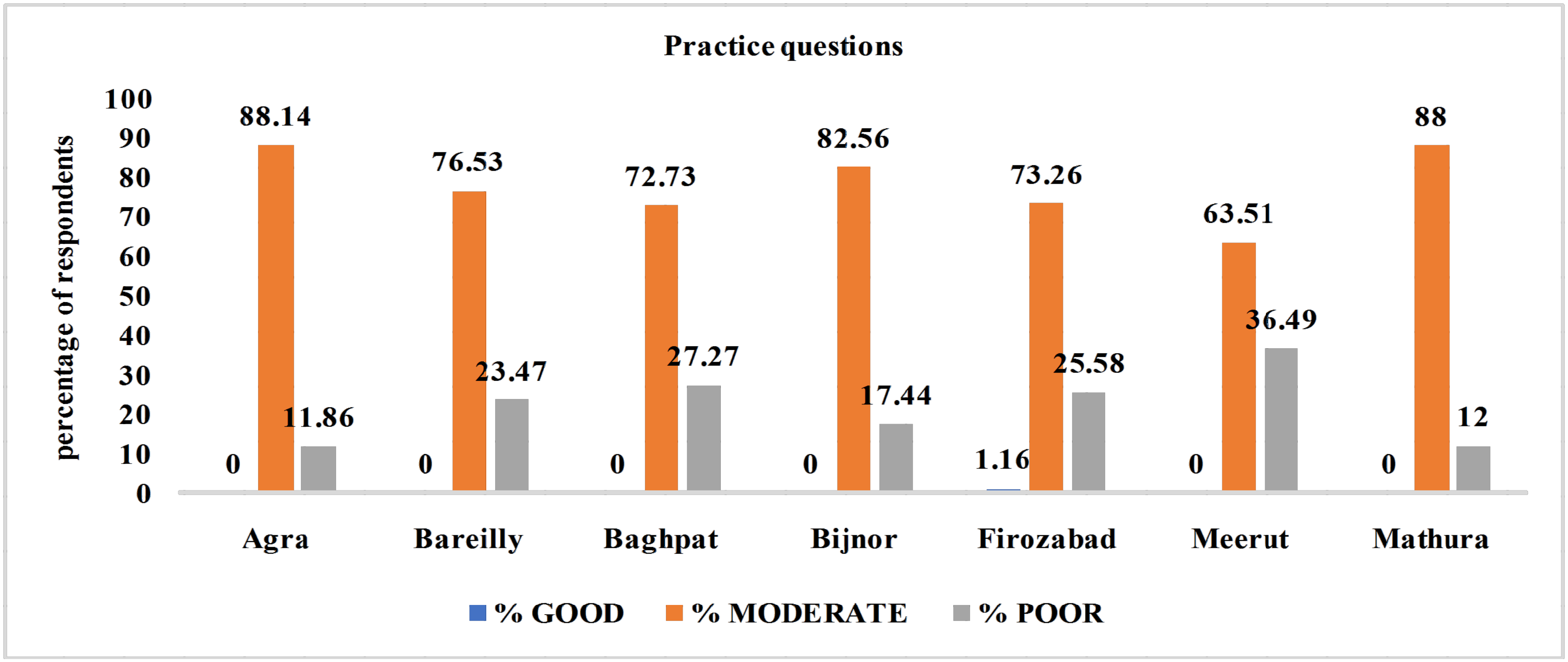

Fig. 9: District-wise Assessment of Practice amongst livestock farmers

difference in KAP scores compared to the youngest group. This suggests that middle-aged farmers do not exhibit notably higher or lower knowledge, attitudes, or practices related to zoonotic disease prevention than their younger counterparts. In contrast, farmers aged 54–72 years had regression coefficient estimate of 1.2292 with a highly significant *p*-value of $p < 0.001$ meaning they scored, on average, about 1.23 points higher on the KAP scale than the youngest group. This finding implies that older farmers tend to have better awareness and practices regarding zoonotic diseases, possibly due to accumulated farming experience, repeated exposure to disease events, and greater personal or community-level risk perception over time. Similarly, regression analysis demonstrated that a farmer's district of residence is a strong determinant of their KAP score, indicating a clear geographic influence. Using the reference district (Agra), results showed that farmers from Bareilly (Regression coefficient = –1.7535, $p < 0.001$), Baghpat (Regression coefficient = –1.3172, $p < 0.001$), Mathura (Regression coefficient = –2.1537, $p < 0.001$), and Meerut (Regression coefficient = –2.1576, $p < 0.001$) had significantly lower KAP scores, with Mathura and Meerut recording the largest deficits. Bijnor farmers, on the other hand, scored significantly higher (Regression coefficient = 1.2255, $p = 0.00887$/ $p > 0.001$) compared to the reference district, while Firozabad showed no meaningful difference (Regression coefficient = –0.3599, $p > 0.1$). These patterns suggest that where a farmer lives has a considerable impact on their level of zoonotic disease knowledge, attitudes, and practices. Lower-performing districts may have fewer disease surveillance activities or limited dissemination of livestock health information, whereas high-scoring districts like Bijnor may benefit from timely access to veterinary advice and more effective communication channels for zoonotic disease awareness. This geographic variability underscores the need for location-specific intervention strategies rather than a uniform, statewide approach to zoonotic disease prevention. By analysing gender and KAP score, it was observed that using females as the reference category, male farmers had a coefficient of 0.3914 ($p = 0.205$), indicating a small, non-significant increase in KAP scores compared to females. This suggests that there is no meaningful gender-based difference in knowledge, attitudes, or practices regarding zoonotic disease prevention among the study population. The absence of a significant gap may reflect the fact that both men and women in these rural communities are actively engaged in livestock management tasks, leading to similar levels of exposure, experience, and awareness related to zoonotic risks. Similarly, analysing annual income and KAP score, it was found that farmers earning more than >25,000 annually had an estimated coefficient increase by only 0.01858 points compared to those earning >25,000 or less ($p = 0.947$), indicating no meaningful difference between the groups. This suggests that financial capacity alone does not significantly influence knowledge, attitudes, or practices related to zoonotic disease prevention in the study population. The result implies that factors other than income such as access to information, availability of veterinary services, and community awareness programs may play a more critical role in shaping KAP levels. By analysing the association between education level and KAP score, with farmers possessing more than five years of formal schooling considered as the reference group, it was observed that those with five years or less of education achieved, on average, 0.3791 points higher on the KAP scale (p = 0.17) as shown in (Table11) This difference, however, was not statistically significant, indicating that a lower level of formal education does not necessarily correspond to poorer knowledge, attitudes, or practices concerning zoonotic diseases. A plausible explanation for this finding is that farmers with limited formal schooling may depend more heavily on experiential learning acquired through daily livestock management, community-based knowledge exchange, and intergenerational transmission of farming practices, which may be more directly relevant to zoonotic disease prevention than formal education . Similarly analysing farming type and KAP score, with farmers engaged in other farming activities as the reference group, it was observed that those involved in livestock rearing scored, on average, 2.2663 points higher ($p < 0.01$), a statistically significant difference. This finding suggests that individuals directly involved in rearing livestock possess higher levels of knowledge, attitudes, and practices regarding zoonotic disease prevention. The likely explanation is that regular and close interaction with animals increases farmers' exposure to livestock health challenges, thereby enhancing their awareness of disease risks and encouraging the adoption of preventive measures. By analysing years of livestock farming experience and KAP score, with farmers having 25 years or less of experience as the reference group, it was found that those with more than 25 years of experience scored, on average, 0.5090 points lower (p = 0.184), a difference that was not statistically significant. This finding challenges the common assumption that longer exposure to farming activities inherently leads to higher levels of knowledge, attitudes, and practices regarding zoonotic disease prevention .

Table 11 Univariable linear regression analysis, demonstrating the influence of explanatory variables on the outcome variables

Variable	Category	B (Regression coefficient)	p-value	Adjusted R^2
Age	18–35 yrs	Reference	—	0.0013
Age	36–53 yrs	0.1048	0.73	
Age	54–72 yrs	1.2292	>0.001	
District	Agra	Reference	—	0.0676
District	Bareilly	–1.7535	<0.001	
District	Baghpat	–1.3172	0.0026	
District	Bijnor	1.2255	0.0089	
District	Firozabad	–0.3599	0.413	
District	Mathura	–2.1537	<0.001	
District	Meerut	–2.1576	<0.001	
Gender	Female	Reference	—	0.0014
Gender	Male	0.3914	0.205	
Income	≤25k	Reference	—	0
Income	≤25k	0.0186	0.947	
Education	>5th std	Reference	—	0.0021
Education	d”5th std	0.3791	0.17	
Farming type	Crops + livestock	Reference	—	0.0244
Farming type	Livestock	2.2663	0.001	
Experience	≤25 yrs	Reference	—	0.0021
Experience	>25 yrs	–0.5090	0.184	

4.1.5 Multivariable Analysis

In the multivariable regression analysis, three predictors including farming type, district of residence, and age were included in the same model to examine their combined and independent effects on Knowledge, Attitude, and Practice (KAP) scores among farmers. This approach allowed for the adjustment of potential confounding factors, meaning that the observed effect of each predictor was estimated while holding the other variables constant. This approach is particularly important in behavioural and epidemiological research, where socio-demographic and occupational factors are often interrelated and may otherwise obscure true associations. The results revealed that farming type remained a statistically significant predictor even after adjustment. Specifically, farmers engaged in livestock rearing scored, on average, 1.463 points higher on the KAP scale compared to those involved in other forms of farming (p<0.05). This suggests that direct and frequent contact with animals continues to enhance awareness and preventive practices, even when differences in age and district are taken into account. The persistence of this association in the adjusted model highlights livestock rearing as an independent driver of higher KAP scores, likely due to repeated exposure to livestock-related health challenges, heightened risk perception, and more frequent interaction with veterinary services. Similarly, district of residence was also a strong and independent predictor of KAP scores. Using the reference district for comparison, the adjusted model revealed significantly lower KAP scores in Bareilly (Regression coefficient = –1.8336, $p < 0.001$), Baghpat (Regression coefficient = –1.4189, $p = 0.0010$), Mathura (Regression coefficient = –2.2538, $p < 0.001$), and Meerut (Regression coefficient = –2.2937, $p < 0.001$) as shown in (Table12). These differences are substantial, representing reductions of KAP score relative to the reference district. In contrast, farmers in Bijnor scored significantly higher (Regression coefficient = 0.9435, p<0.05), while Firozabad did not differ significantly. These patterns point to marked geographic heterogeneity in farmers' zoonotic disease awareness and preventive behaviours, likely reflecting underlying disparities in veterinary infrastructure, extension service coverage, socio-economic conditions, and intensity of public health campaigns. Similarly, adjusted multivariable analysis for age remained a significant predictor of KAP scores. Farmers in the 54–72 age group scored, on average, 1.309 points higher than the youngest reference group ($p < 0.001$), indicating that older farmers tend to have greater knowledge, more positive attitudes, and better preventive practices related to zoonotic diseases. This association is likely explained by the cumulative effects of long-term farming experience, repeated exposure to livestock health problems, and a heightened perception of disease risks gained over time. In contrast, the 36–53 age group did not differ significantly from the youngest category (regression coefficient = 0.1470, $p = 0.607$), suggesting that the benefits of farming experience and accumulated knowledge may not fully manifest until later in life, when individuals have had more years to observe and respond to animal health challenges.

The coefficient of determination for the multivariable regression model ($R^2 = 0.133$) indicates that farming type, district of residence, and age together accounted for approximately 13.3% of the variability in KAP scores among farmers. Although this proportion confirms that these factors have a measurable influence, it also suggests that a large proportion of the variation is explained by other factors not captured in the model, such as prior exposure to training, access to veterinary services, or local community health practices. The analysis of variance (ANOVA) further confirmed the statistical significance of each predictor farming type ($p = 0.001$), district ($p < 0.001$), and age ($p = 0.000275$) indicating that each variable independently contributes to differences in KAP scores after adjusting for the others. These results demonstrate that geographic location, direct involvement in livestock rearing, and older age are independent determinants of higher KAP levels. Consequently, interventions aiming to improve zoonotic disease awareness should prioritise addressing district-level disparities, utilise livestock farmers as peer knowledge resources, and develop age-specific awareness strategies to ensure improvements across all demographic groups.

Table 12: Multivariable linear regression analysis, demonstrating the influence of explanatory variables on the outcome variables

Variable	Category	B (Regression coefficient)	p-value	Adjusted R^2
Farming type	Crops + livestock	Reference	—	**0.133**
Farming type	Livestock	1.463	0.0398	
District	Agra	Reference	—	
District	Bareilly	–1.8336	<0.001	
District	Baghpat	–1.4189	0.001	
District	Bijnor	0.9435	0.0475	
District	Firozabad	–0.410	0.317	
District	Mathura	–2.2538	<0.001	
District	Meerut	–2.2937	<0.001	
Age	18–35 yrs	Reference	—	
Age	36–53 yrs	0.147	0.607	
Age	54–72 yrs	1.309	<0.001	

4.2 Assessment of Knowledge, Attitude and Practices in Sanitation Worker

This analysis presents the detailed findings of the Knowledge, Attitude, and Practices (KAP) assessment conducted to evaluate sanitation workers' understanding and behaviours related to zoonotic diseases in the context of their occupational environment. The assessment focused specifically on members of the Scheduled Caste (SC) community engaged in sanitation work and therefore more frequently exposed to waste materials, contaminated environments, and potential disease causing pathogens.

Data were collected from a total of 492 respondents engaged in sanitation related occupations, such as street sweeping, drain cleaning, waste collection, and disposal and residing across seven districts of western Uttar Pradesh including Agra, Bareilly, Mathura, Meerut, Baghpat, Firozabad, and Bijnor. These occupations place workers in direct contact with solid and liquid waste, decomposed organic matter, animal carcasses, and potentially infectious materials, which substantially increases their risk of contracting zoonotic infections. This analysis aimed to assess sanitation workers' awareness of zoonotic diseases, attitudes toward workplace safety, and routine practices such as hygiene, PPE use, and waste handling. The findings highlight strengths, pinpoint weaknesses, and guide targeted interventions to improve safety and reduce disease transmission.

4.2.1 Knowledge Assessment of Zoonotic Diseases Among Sanitation Workers

This section presents the findings from the knowledge assessment (Table13), which examined respondents' familiarity with zoonotic diseases, their transmission routes, and prevention methods, providing insight into both existing knowledge strengths and critical gaps that may affect community-level disease prevention and control programs.

A little over half of the respondents (54.07%) reported having heard the term zoonosis, indicating that while the concept is familiar to some, a substantial portion of the population remains unaware of the term itself. Similarly, fewer than half (48.78%) of sanitation workers were aware of the concept of occupational health hazards. This reflects a considerable gap in understanding the health risks associated with their work, particularly given their frequent contact with animal waste, contaminated materials, and environments that may harbour zoonotic pathogens. Such limited awareness can hinder the adoption of protective measures, increasing the likelihood of occupational exposure and related health problems. Awareness of specific zoonotic diseases showed considerable variation among respondents (Fig.10a). COVID 19 (100%) and rabies (95.33%) were almost universally recognized, likely due to their high public visibility through mass media coverage, widespread public health campaigns, and, in some cases, direct personal or community experience. Moderate awareness was reported for brucellosis (59.55%), and typhoid (52.64%), which remain significant public health concerns but may receive less focused educational outreach. Awareness declined further for avian influenza (49.80%), plague (42.07%), and Japanese encephalitis (44.92%), while knowledge of leptospirosis (0.20%) and neurocysticercosis (n=0) was virtually absent. These findings reveal a sharp gap between awareness of well-known diseases and limited knowledge of less-recognized zoonoses, indicating the need for specific awareness interventions. Understanding of disease transmission from animals to humans among sanitation workers was generally limited. Slightly more than half (53.46%) recognized that zoonotic diseases could be spread through direct or indirect contact with animals and animal waste. Familiarity with specific pathogens transmitted through direct contact was moderate for salmonellosis (51.42%) but dropped sharply for hepatitis E (17.48%). Notably, none of the sanitation workers had heard of cryptosporidiosis or amoebiasis (n=0 each), (Fig. 10b) despite their relevance in environments where poor hygiene conditions and regular handling of animal waste increase the risk of exposure. In contrast, knowledge of vector-borne transmission was relatively stronger. A large majority (78.46%) knew that mosquitoes could act as vectors for zoonotic diseases. Among these, malaria (89.02%) and dengue (85.59%) were the most commonly recognized, likely due to their frequent occurrence in the community and sustained public health campaigns. Recognition of chikungunya (50.20%) and Japanese encephalitis (44.92%) was moderate, possibly reflecting lower perceived occupational risk or limited targeted education for sanitation workers. Awareness of rodent-borne zoonotic diseases was considerably lower (46.75%). Plague (43.70%) was the most frequently mentioned, while scrub typhus (11.41%) and leptospirosis (0.20%) were far less familiar. None of the respondents identified giardiasis (n=0) highlighting a significant gap in understanding protozoan infections that can be transmitted by rodents an important concern given the occupational exposure risks sanitation workers face in waste collection and disposal settings. Awareness of zoonotic fungal infections among respondents was moderate overall (68.29%). Ringworm was the most frequently recognized (56.71%), likely due to its widespread occurrence and easily identifiable symptoms in both humans and animals. However, knowledge of other fungal diseases such as aspergillosis, candidiasis, and cryptococcosis was entirely lacking (n=0). This complete absence of recognition suggests that fungal zoonoses remain a neglected area of public health awareness in the community, despite their potential to cause serious skin and respiratory illnesses. By comparison, knowledge of hygiene practices and waste management was relatively stronger. Two-thirds (67.89%) of respondents were aware of disinfectants and sanitizers, reflecting a reasonable understanding of basic preventive measures., Awareness of waste categories was uniformly high, with all respondents (100%) recognizing biomedical, animal, agricultural, dry, and wet waste. Similarly, a large proportion (82.11%) reported familiarity with colour coded disposal bags or bins used for segregating different categories of waste. Furthermore, 76.46% could identify at least one waste management method such as dumping, burial, or composting. While this demonstrates a solid foundation of knowledge, it is important to note that consistent and correct application of these practices in day to day work may still require reinforcement through community level training, occupational safety programs, and regular monitoring.

Table 13 : Assessment of Knowledge parameters related to zoonoses amongst the sanitation worker

S.No	Knowledge Question	Response	Percentage
1	Have you heard the term zoonosis?	Yes	54.07
2	Have you heard about occupational health hazards?	Yes	48.78
3	Which diseases names have you heard?	Rabies	95.33
		COVID-19	100.00
		Brucellosis	59.55
		Avian influenza	49.80
		Tuberculosis	54.07
		Plague	42.07

		Japanese encephalitis	44.92
		Leptospirosis	0.20
		Neurocysticercosis	0.00
		Typhoid	52.64
4	Do you know these diseases can be transmitted to humans through animals?	Yes	53.46
5	Have you ever heard about zoonotic pathogens transmitted through direct contact with animals?	Yes	50.41
		Salmonellosis	51.42
		Hepatitis E	17.48
		Cryptosporidiosis	0.00
		Amoebiasis	0.00
6	Do you know zoonotic diseases are transmitted through bite of mosquitoes?	Yes	78.46
		Dengue	61.59
		Chikungunya	50.20
		Japanese Encephalitis	50.41
		Malaria	76.02
7	Do you know zoonotic diseases are transmitted through rodents?	Yes	46.75
		Plaque	43.70
		Scrub typhus	13.41
		Leptospirosis	0.20
		Giardiasis	0.00
8	Do you know there are zoonotic fungal infections that cause skin/lung diseases?	Yes	68.29
		Ringworm	56.71
		Aspergillosis	7.52
		Candidiasis	5.28
		Cryptococcosis	6.10
9	Do you know about about disinfectant, sanitizer?	Yes	67.89
10	Have you heard of different kind of waste?	Biomedical	94.31
		Animal	93.70
		Agricultural	94.92
		Dry	93.09
		Wet	92.28
11	Are you aware that colour coded disposal bags/bins are used for disposing different categories of waste?	Yes	82.11
12	Do you know any method to manage waste like dumping, burial, composting?	Yes	66.46

4.2.1 Knowledge assessment using scoring method

This scoring system was designed to differentiate between respondents with minimal awareness, those with a basic or intermediate level of understanding, and those with a relatively comprehensive grasp of zoonotic disease related knowledge. Out of 492 sanitation workers, 79 (16.06%) demonstrated good knowledge, 323 (65.65%) had moderate knowledge, and 90 (18.29%) showed poor knowledge (Fig. 11.). A total of 79 sanitation workers (16.06%) fell into the good knowledge category. These individuals clearly understood what zoonotic diseases are, the occupational risks associated with waste handling, and the multiple ways these diseases can spread to humans. The majority, 323 sanitation workers (65.65%), had moderate knowledge. They were aware of several common zoonotic diseases and understood some basic preventive measures. However, their understanding was often limited to well publicised diseases and did not extend to lesser known zoonoses, varied transmission routes, or advanced preventive strategies. A significant proportion, 90 sanitation workers (18.29%), were in the poor knowledge category. These workers had minimal understanding of zoonotic diseases, limited awareness of safe handling techniques, and little or no knowledge of proper waste disposal or consistent PPE usage. Such gaps in awareness place them at a heightened risk of contracting and potentially transmitting zoonotic infections through their daily sanitation activities.

4.2.1.2 Comparative District-wise Assessment of Knowledge score on Zoonotic Diseases

The descriptive analysis of knowledge levels regarding zoonotic diseases among respondents from seven districts in western Uttar Pradesh highlights lee inter-district variation (Table14; Fig 12). According to scoring criteria good knowledge proportion is seen quiet constantly among the different districts with Firozabad (30.00%) recording the highest proportion of respondents having good knowledge, closely followed by Agra (28.41%) and Mathura (27.94%). Bareilly (22.73%), Meerut (22.22%), Bijnor (20.37%), and Bahgat (20.00%) also had a fair proportion of workers demonstrating strong understanding of zoonotic diseases and their prevention. Moderate knowledge was the most common category across all districts, with the highest in Bijnor (75.93%), Baghpat (72.00%), Meerut (70.83%), and Bareilly

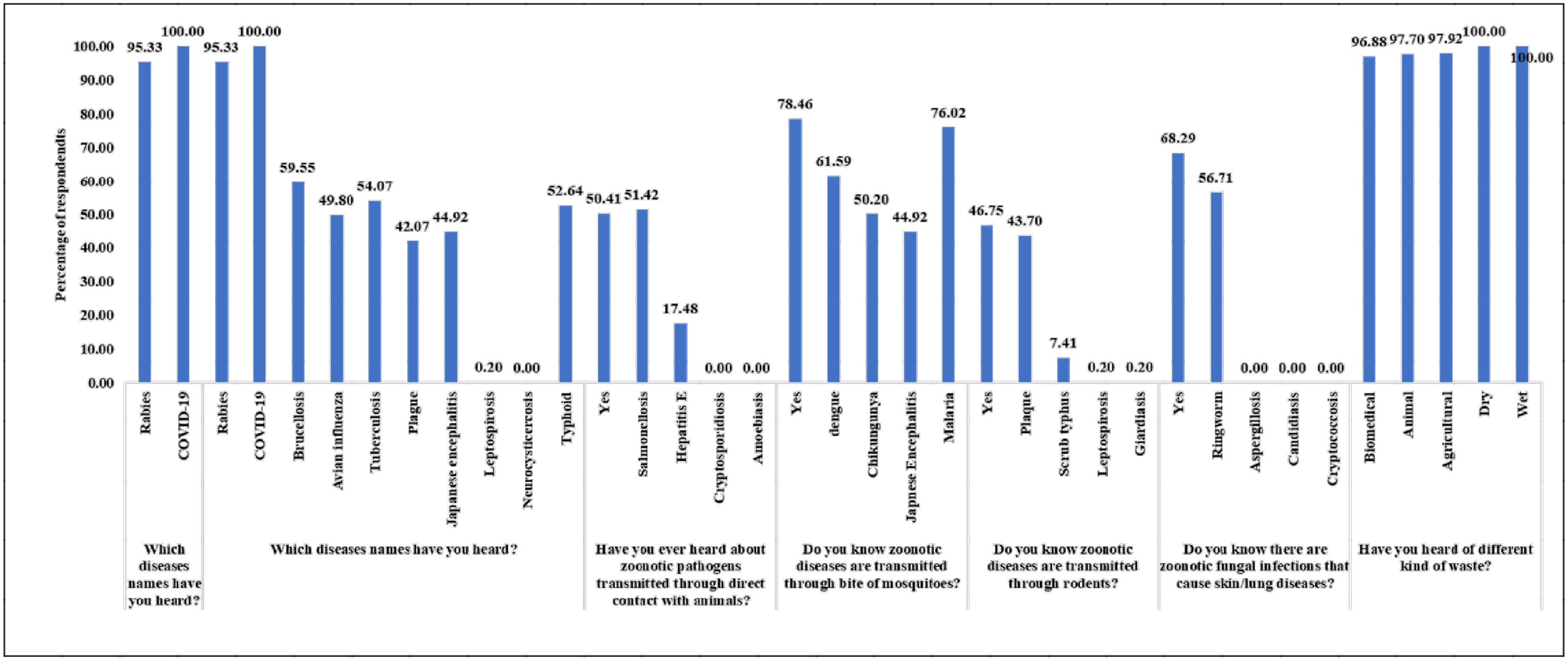

Fig. 10a: Assessment of zoonoses knowledge amongst the sanitation farmers

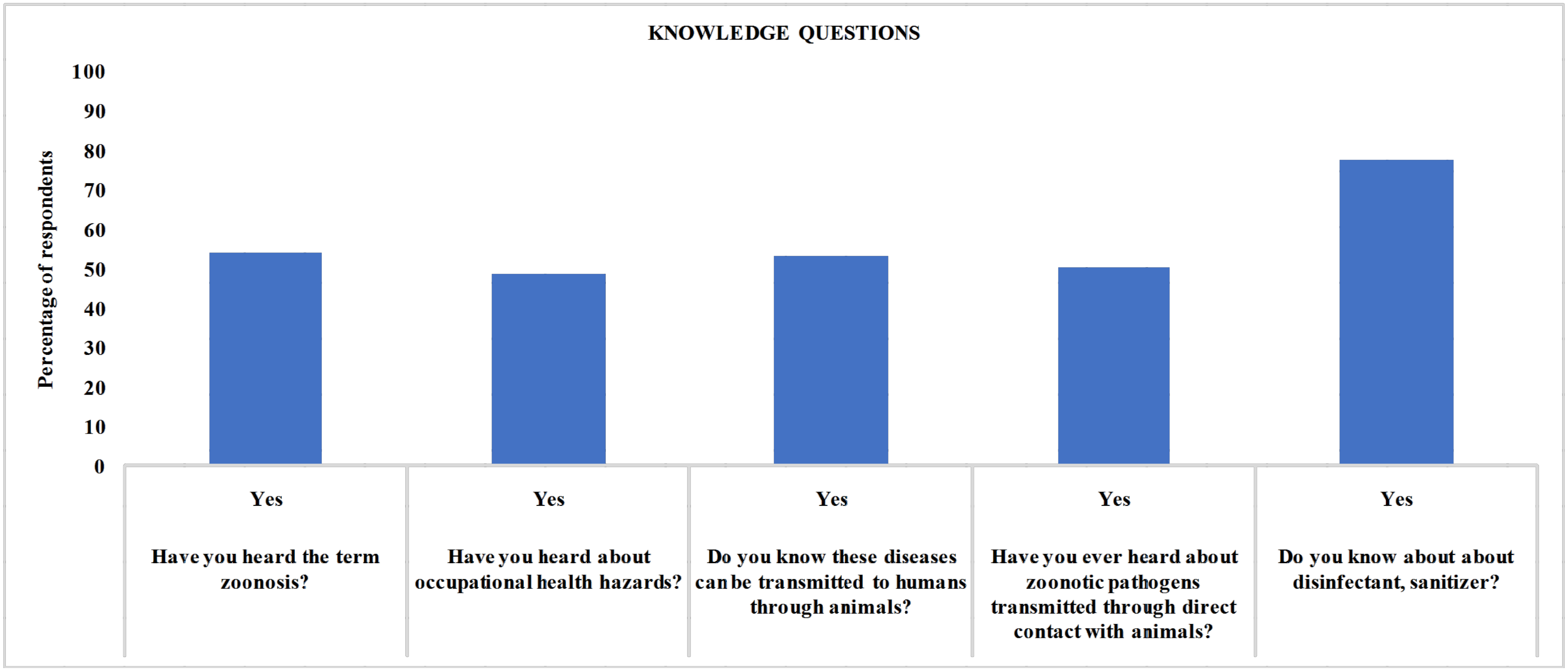

Fig. 10b: Assessment of zoonoses knowledge amongst the sanitation farmers

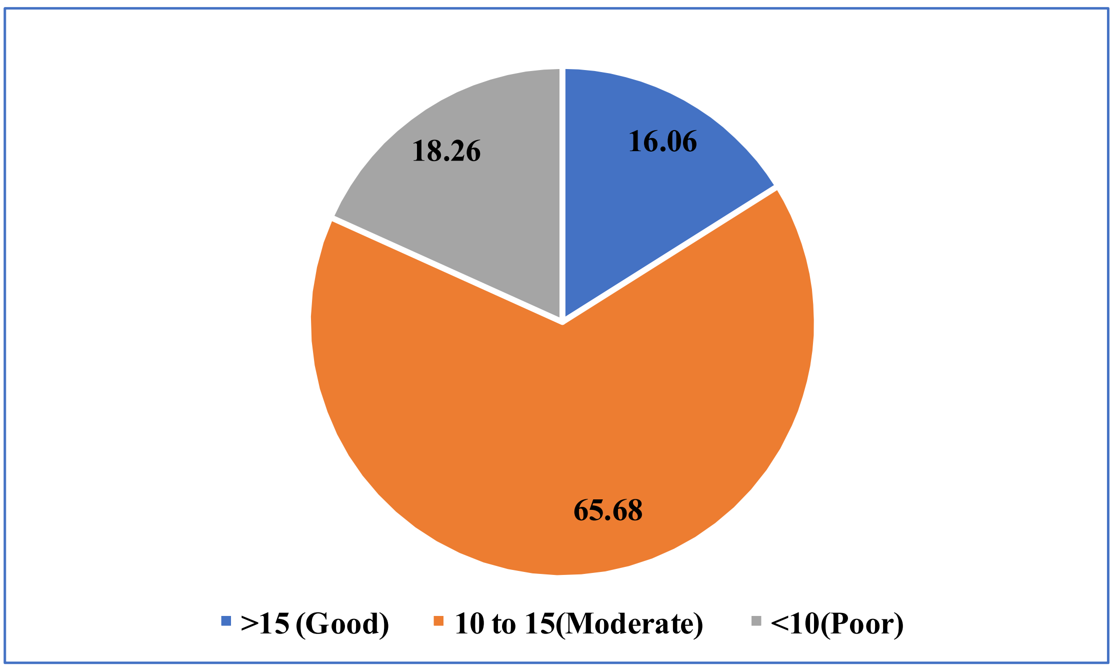

Fig . 11: Knowledge score of zoonotic diseases amongst sanitation farmers

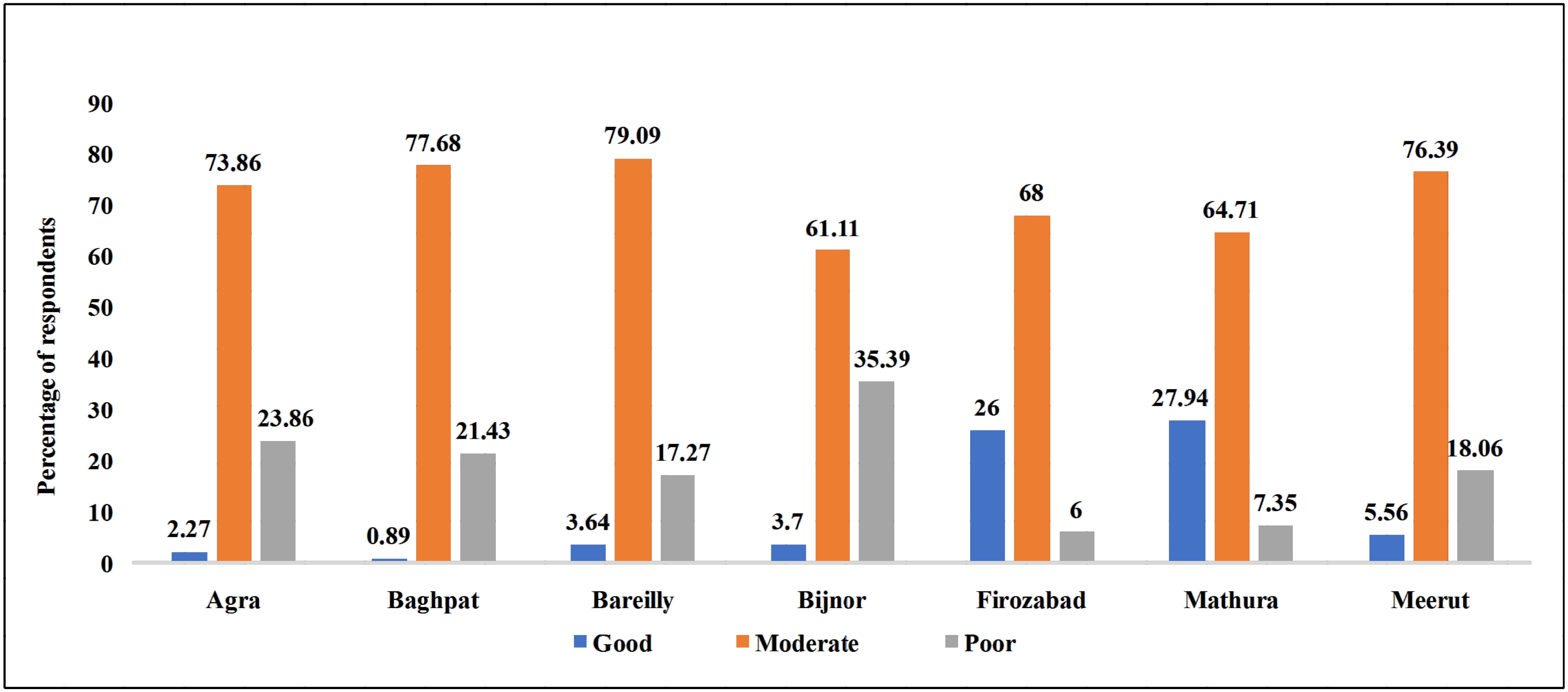

Fig. 12: District-wise Assessment of Knowledgement of amongst sanitation workers

(70.00%). Agra (63.64%), Firozabad (66.00%), and Mathura (64.71%) also had a majority of respondents in this category, indicating a reasonable but incomplete grasp of the subject. Poor knowledge levels were comparatively low across all districts, though still present. The highest proportion was seen in Baghpat (8.00%) followed by Agra (7.95%), Bareilly (7.27%), Mathura (7.35%), and Meerut (6.94%). Firozabad (4.00%) and Bijnor (3.70%) had the lowest poor knowledge percentages. These findings suggest that while most sanitation workers have at least a moderate understanding of zoonotic disease-related knowledge, consistent reinforcement through targeted awareness campaigns is still needed.

Table 14: District-wise Assessment of knowledge score on zoonotic disease amongst sanitation workers

District	% GOOD	% MODERATE	% POOR
Agra	28.41	63.64	7.95
Bijnor	20.37	75.93	3.7
Baghpat	20	72	8
Bareilly	22.73	70	7.27
Firozabad	30	66	4
Mathura	27.94	64.71	7.35
Meerut	22.22	70.83	6.94

4.2.2 Attitude Assessment of Zoonotic Diseases Among Sanitation Workers

Following the knowledge assessment, the attitudes of sanitation workers toward occupational health, safety, and disease prevention were evaluated to better understand how their perceptions align with workplace practices. More than half (52.44%) reported being willing to adopt new technologies in sanitation work, reflecting an openness to modernization that could enhance both efficiency and safety. A slightly higher proportion (54.47%) recognized that proper sanitation practices play a vital role in preventing disease, suggesting a reasonable appreciation of the connection between their work and community health (Table 15; Fig.13).

Workplace safety attitudes revealed that 56.10% of sanitation workers were willing to report safety concerns to their supervisors, indicating some level of proactive safety engagement. Similarly, 54.88% considered sanitation work to be important for public health. While these figures suggest a moderate sense of responsibility, the fact that nearly half of workers did not share the same level of concern highlights the need for reinforcing the public health significance of their role.

In terms of personal health risks, 50.61% expressed concern about contracting zoonotic diseases through their work. However, fewer workers (48.58%) stressed the importance of taking personal precautions, such as consistent use of personal protective equipment (PPE) and proper hygiene practices, to prevent transmission. Specific preventive measures, like wearing masks, were recognized by just over half (51.83%) as effective in reducing risks from diseases such as influenza.

When it came to training and health monitoring, 52.24% expressed willingness to participate in training programs on hygiene and zoonoses, suggesting potential receptiveness to targeted awareness initiatives. However, participation in regular health check ups remained relatively low, with only 49.80% reporting routine medical monitoring. This pattern indicates that while sanitation workers show a degree of willingness to improve their practices, the translation of positive attitudes into consistent protective behaviour remains incomplete, underscoring the need for continuous engagement, training, and workplace support.

Table 15: Assessment of Attitude parameters related to zoonoses amongst the sanitation workers

Attitude question	Response	Percentage of response
Are you willing to adopt new technologies for sanitation work?	Yes	52.44
Do you believe proper sanitation practices can prevent disease?	Yes	54.47
Do you report a safety concern to your supervisor?	Concerned,	56.10
Do you believe sanitation work is important for public health?	Very important	54.88
How concerned are you about contracting zoonotic disease through sanitation work?	Yes	50.61
How important is taking personal precaution to prevent zoonotic disease transmission?	Yes	48.58
Do you think wearing mask at work place will protect you from diseases like influenza?	Yes	51.83
Are you willing to undertake training on hygiene and zoonoses?	Yes	52.24
Do you participate in regular health checkups?	Yes	49.80

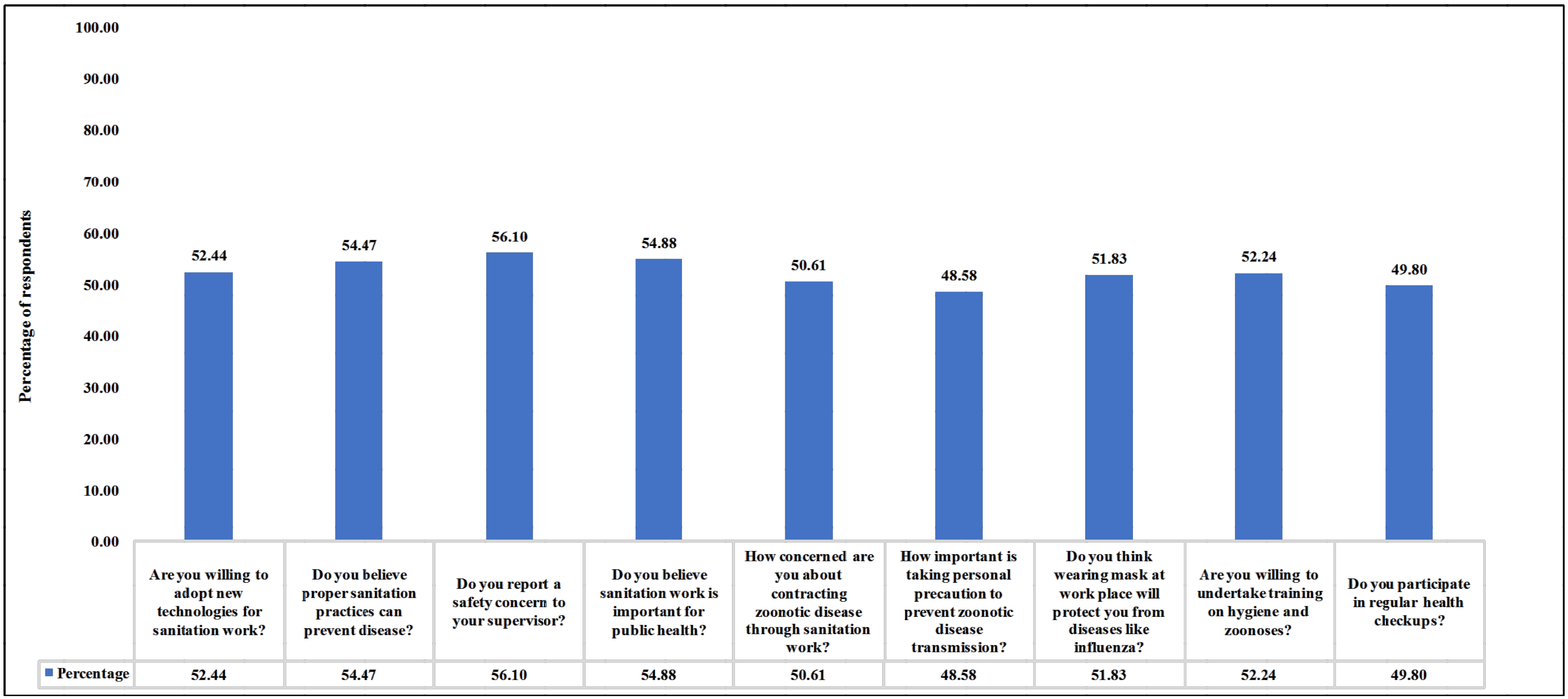

Fig. 13: Assessment of zoonoses attitude amongst the sanitation workers

4.2.2.1 Attitude assessment using scoring method

This scoring system was designed to differentiate between sanitation workers with a limited attitude toward occupational safety, those with a basic or moderately positive outlook, and those with a strong and proactive approach. Out of 492 respondents, 23 (4.67%) demonstrated a good attitude, 248 (50.41%) had a moderate attitude, and 221 (44.92%) showed a poor attitude (Fig.14). A total of 23 sanitation workers (4.67%) scored in the good attitude category as they displayed a strong sense of responsibility toward occupational safety and health. Their mindset reflects a proactive and prevention oriented approach, which is essential for minimizing occupational health risks.The largest group, 248 sanitation workers (50.41%), fell into the moderate attitude range. This group generally recognized the importance of sanitation work for public health and expressed some willingness to follow safety measures and attend training sessions. A considerable proportion, 221 sanitation workers (44.92%), were classified under poorattitude. Workers in this group showed limited concern for occupational safety and often neglected essential preventive measures. Many were reluctant to report safety hazards or attend training, and some did not perceive sanitation work as a critical factor in public health.

4.2.2.2 Comparative District-wise Assessment of Attitude score on Zoonotic Diseases

According to scoring criteria, Firozabad showed the highest proportion of respondents with a good attitude (8.00%), followed by Agra (6.82%), Mathura (5.88%), and Bareilly (4.55%) (Table16; Fig 15.). These districts reflect relatively stronger commitment toward occupational safety and a more proactive approach to zoonotic diseases prevention compared to others. Meerut (4.17%) and Bijnor (1.85%) showed lower levels of good attitude, while Baghpat reported none (0%). Moderate attitude was the most common category across all districts. It was most prominent in Firozabad (56.00%), Mathura (52.94%), and Agra (52.27%). Bijnor (51.85%) and Bareilly (49.09%) also had high proportions in this category, indicating that a large segment of sanitation workers in these areas recognize the importance of safety and hygiene. Even in districts with low 'Good' attitude scores, the majority still fell into the moderate category, suggesting potential for attitude improvement through structured awareness and training programs. Poor attitude was notably high in Baghpat (56.00%) and Meerut (48.61%), indicating that a significant proportion of workers in these areas lacked a strong commitment to occupational safety measures. Bareilly (46.36%) and Bijnor (46.30%) also showed similar trends, with nearly half of respondents falling into this category. These findings highlight the urgent need for behavioural change initiatives and regular reinforcement of safety protocols to strengthen the safety culture among sanitation workers.

Table 16 : District-wise Assessment of Attitude score on zoonotic disease amongst sanitation workers

District	% GOOD	% MODERATE	% POOR
Agra	6.82	52.27	40.91
Baghpat	0	44	56
Bareilly	4.55	49.09	46.36
Bijnor	1.85	51.85	46.3
Firozabad	8	56	36
Mathura	5.88	52.94	41.18
Meerut	4.17	47.22	48.61

4.2.3 Practice Assessment of Zoonotic Diseases Among Sanitation Workers

The assessment of occupational practices among sanitation workers revealed a mixed picture of adherence to safety protocols, with some encouraging behaviours but also several concerning gaps that increase the risk of occupational exposure to infectious diseases, including zoonoses (Table 17; Fig. 16a). An evaluation of Personal Protective Equipment (PPE) usage among sanitation workers revealed concerning gaps in safety compliance with only 47.36% workers reported consistently wearing a PPE kit while cleaning contaminated or high risk areas. This means that more than half of the workforce carries out hazardous cleaning tasks without the essential protective barrier, greatly increasing the risk of direct exposure to infectious agents, hazardous chemicals, and unsafe waste materials.

Hand hygiene emerged as one of the relatively stronger practices among sanitation workers as majority of respondents (71.75%) reported using phenolic soap for handwashing after cleaning tasks, a crucial step in breaking the chain of disease transmission. This encouraging

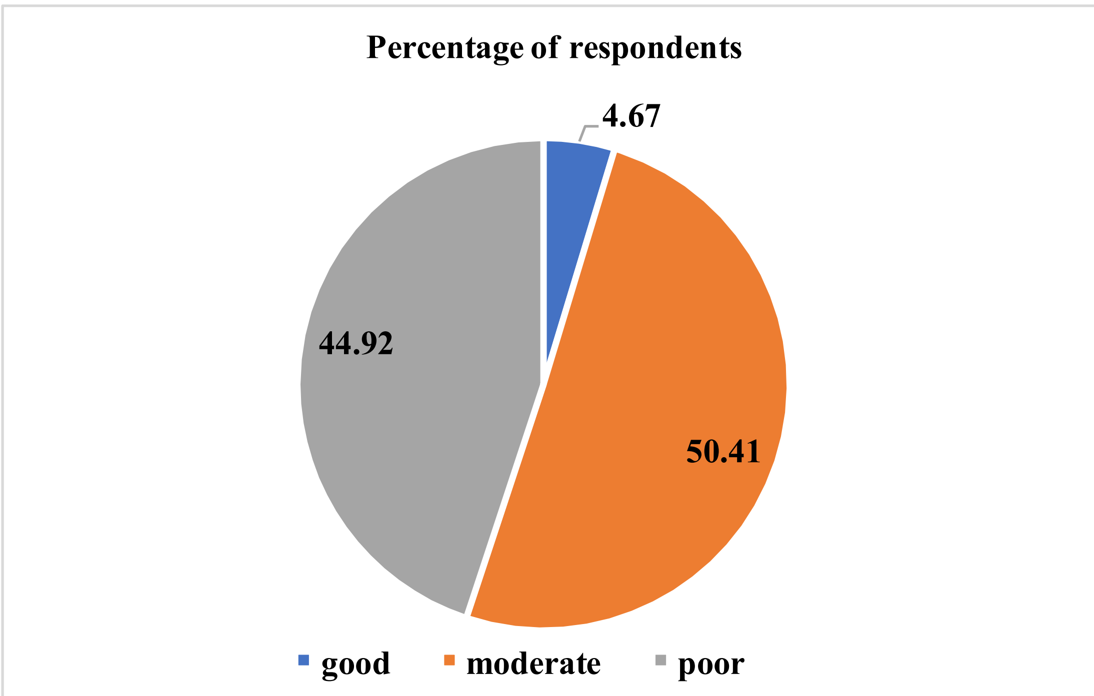

Fig. 14: Attitude score of zoonotic diseases amongst sanitation farmers

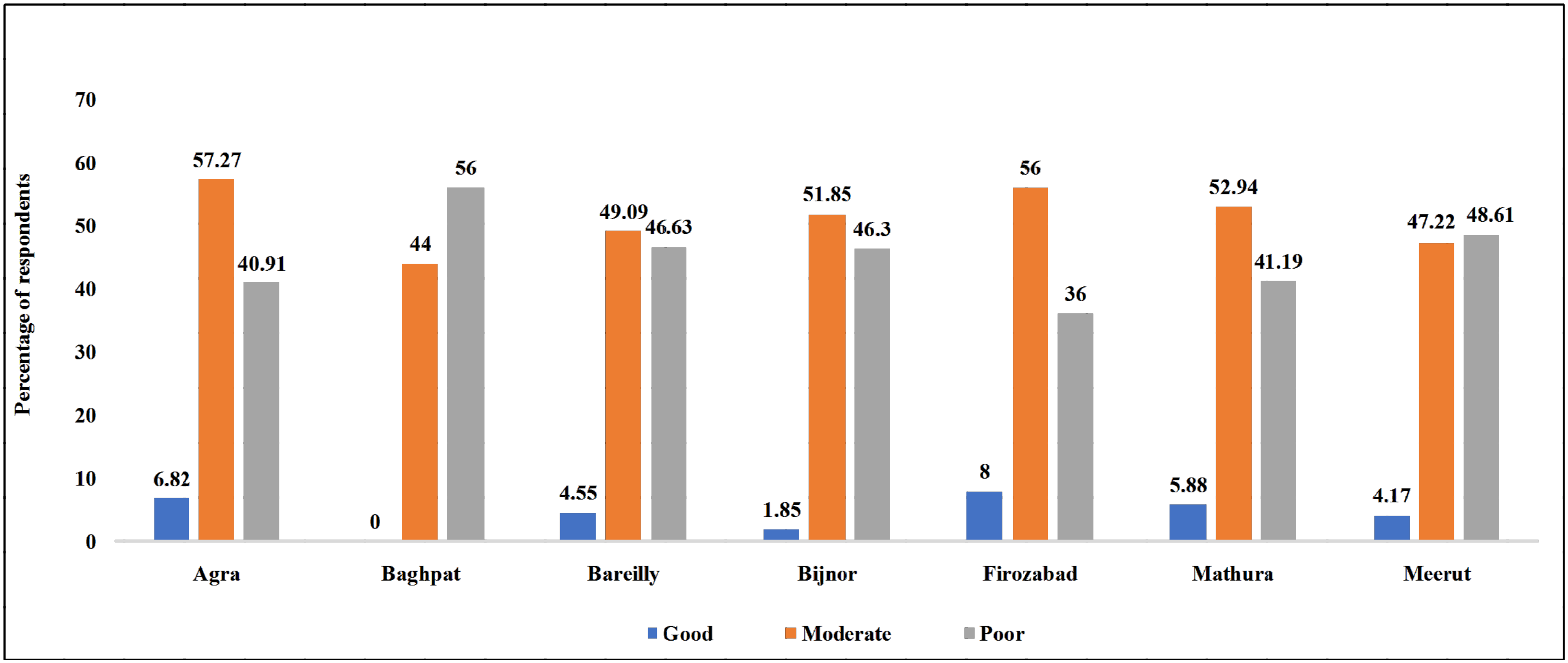

Fig. 15: District-wise Assessment of Attitude of amongst sanitation workers

trend reflects some awareness of the importance of personal hygiene in preventing infections. However, the fact that more than a quarter of workers do not follow this practice remains a serious concern, as it leaves a significant gap through which contamination and the spread of pathogens can still occur. When it comes to personal hygiene routines, 55.69% of workers reported taking a bath immediately after completing their cleaning duties, which helps in removing contaminants and reducing the risk of bringing pathogens into their homes. A concerning 46.75% admitted to walking barefoot in the workplace, a dangerous habit that exposes them to sharp objects, chemical residues, and infectious materials present on contaminated floors.

The use of sanitizers or disinfectants during cleaning activities was reported by only 50.20% of workers. This suggests that a significant number of sanitation workers still rely solely on water or less effective cleaning agents, which may not be adequate for eliminating infectious microorganisms from surfaces. Regarding waste segregation, 57.93% reported using labelled bins to separate biomedical, organic, and other waste types — a critical step in safe waste management. Yet, more than 40% of workers do not follow this practice, which increases the risk of cross contamination and unsafe disposal (Fig. 16b).

The cleaning and disinfection of mops, a key cleaning tool that can harbour pathogens showed relatively better results. A majority of workers (79.90%) cleaned and disinfected their mops daily, which aligns with good hygiene standards. However, 15.59% did so only weekly and 4.51% monthly, which is insufficient for effective infection control in sanitation work. Waste disposal methods also varied considerably. The most common approach was the use of waste trucks (39.08%) for collection and disposal, followed by incineration (31.85%), both of which are relatively safe if properly managed. However, 10.96% of respondents still disposed of waste in dunghills, a practice that can lead to serious environmental and public health hazards. Even more concerning, 18.11% reported not following any of these recognized disposal methods, suggesting a complete absence of structured waste management in their work (Fig. 16b).

Table 17 Assessment of practices related to zoonoses amongst the sanitation workers

Attitude question	Response		Percentage of response
Do you wear PPE kit during cleaning of affected area?	Yes		47.36
Do you use phenolic soap for hand washing after cleaning work?	Yes		71.75
How often do you clean or disinfect the Mop?	a)	Daily	52.03
	b)	Weekly	24.59
	c)	Monthly	19.51
Where do you dispose the waste?	a)	Dunghill	34.96
	b)	Waste truck	30.08
	c)	Incineration	27.85
	d)	None of these	41.67
Do you walk barefoot at your workplace?	Yes		46.75
Do you take bath after cleaning work?	Yes		55.69
Do you use any sanitizer or disinfectant for cleaning?	Yes		50.20
Do you use labelled bins for segregating different waste?	Yes		57.93

4.2.3.1 Scoring Analysis of Practices on Zoonotic Diseases amongst sanitation workers

This scoring system was designed to differentiate between sanitation workers with poor workplace practices, those with basic or moderately consistent practices, and those who regularly follow recommended occupational safety and hygiene protocols. Out of a total of 492 respondents, 45 (9.15%) demonstrated good practices, 343 (69.72%) had moderate practices, and 104 (21.14%) showed poor practices (Fig.17). A total of 45 sanitation workers (9.15%) fell into the good practice category as these individuals consistently followed safety guidelines, including the regular use of PPE, proper handwashing with phenolic soap, daily cleaning and disinfection of mops, and correct waste segregation using labelled bins. They also adhered to safe waste disposal methods, avoiding unsafe dumping practices. Their work habits reflect a high level of compliance and a clear understanding of the importance of hygiene and occupational safety in reducing health risk. The majority, 343 sanitation workers (69.72%), were in the moderate practice category such as occasional PPE use and partial adherence to waste segregation rules. Some important measures, such as daily PPE use, strict adherence to waste management protocols, or consistent equipment disinfection, were often overlooked.

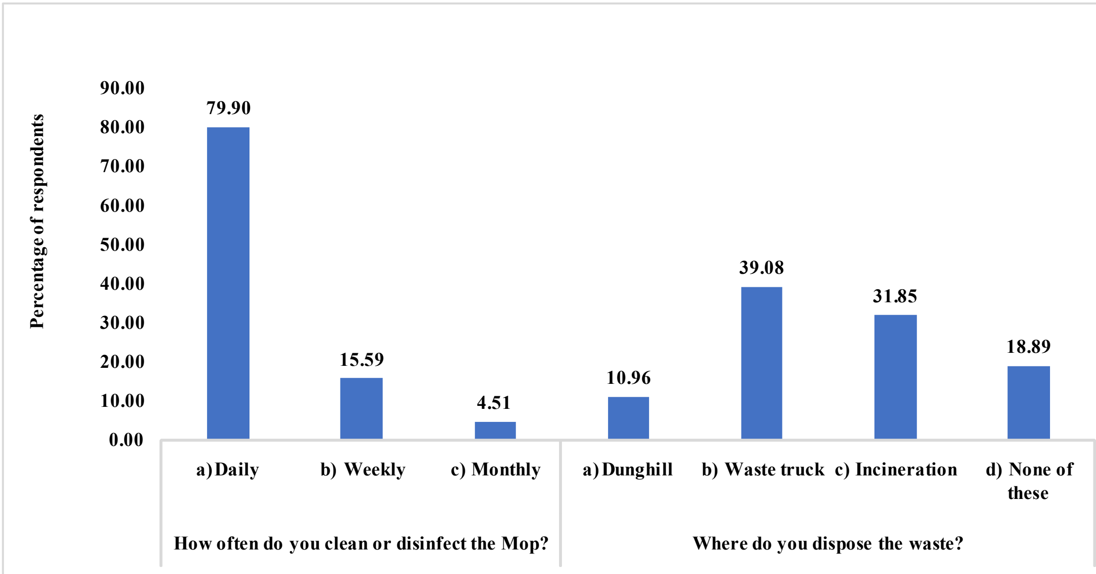

Fig. 16a: Assessment of zoonoses practice amongst the sanitation farmers

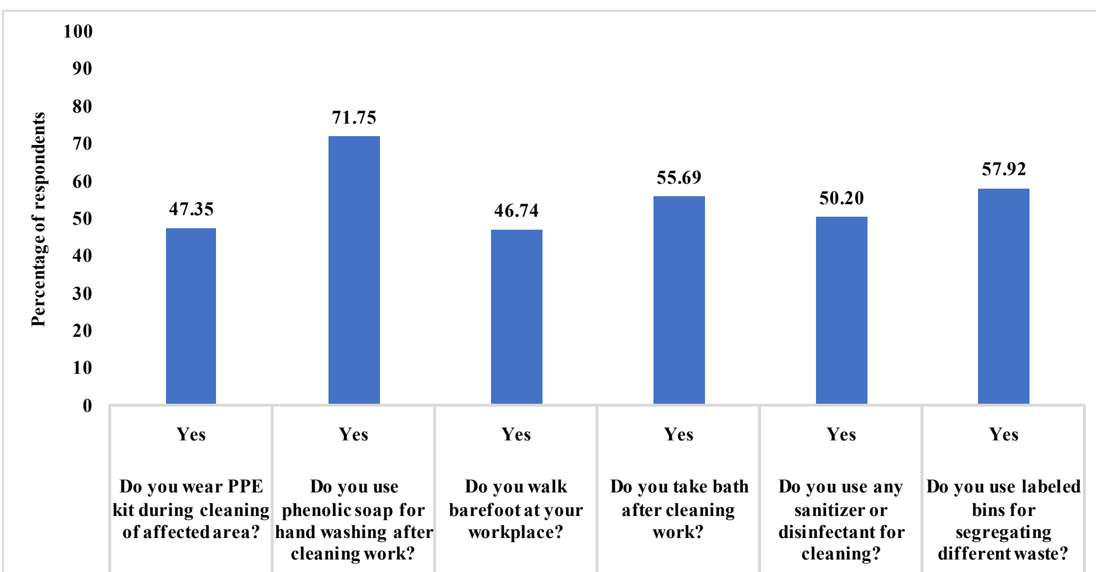

Fig. 16b: Assessment of zoonoses practice amongst the sanitation farmers

This partial compliance means they still face avoidable occupational health risk. A total of 104 sanitation workers (21.14%) were categorized as having poor practices. These workerrarely used PPE, often neglected hand hygiene, failed to segregate waste properly, and sometimes disposed of waste in unsafe locations. Many did not clean or disinfect tools regularly and engaged in risky behaviours, such as walking barefoot in contaminated areas. These unsafe practices significantly increase the likelihood of occupational exposure to infectious agents and other workplace hazards.

4.2.3.2 Comparative District-wise Assessment of practices score on Zoonotic Diseases

The district wise distribution of practice scores among sanitation workers revealed that maximum respondents across all districts followed moderate practices (Table18; Fig.18). Further, Mathura (27.94%) and Firozabad (26.00%) recorded the highest proportions of workers with good practice scores, suggesting relatively stronger compliance with recommended occupational safety measures. While Meerut (5.56%), Bijnor (3.70%), Bareilly (3.64%), and Agra (2.27%) had much lower levels of good practices, while Baghpat reported the lowest proportion (0.89%). Moderate practice scores dominated across most districts, with particularly high proportions in Bareilly (79.09%), Baghpat (77.68%), Meerut (76.39%), and Agra (73.86%) followed by Firozabad (68.00%), Mathura (64.71%), and Bijnor (61.11%). This indicates that while many sanitation workers are following some recommended safety measures, there remains scope for improvement in consistency and comprehensiveness of safe work practices. Poor practices scores were most prevalent in Bijnor (35.19%) and Agra (23.86%), followed closely by Baghpat (21.43%) and Meerut (18.06%). Bareilly (17.27%), Mathura (7.35%), and Firozabad (6.00%) reported comparatively lower poor practice levels. The relatively high poor practice rates in certain districts point to persistent gaps in adherence to safe sanitation protocols, emphasizing the need for targeted interventions in these areas.

Table 18 : District-wise Assessment of practice score on Zoonotic Diseases amongst sanitation worker

District	% GOOD	% MODERATE	% POOR
Agra	2.27	73.86	23.86
Baghpat	0.89	77.68	21.43
Bareilly	3.64	79.09	17.27
Bijnor	3.7	61.11	35.19
Firozabad	26	68	6
Mathura	27.94	64.71	7.35
Meerut	5.56	76.39	18.06

4.2.4 Univariable Linear Regression Analysis

Understanding the factors that influence sanitation workers' knowledge, attitudes, and practices (KAP) regarding occupational hygiene and zoonotic disease risk is essential for designing targeted interventions. This study applies univariable regression analysis to examine how socio-demographic and occupational characteristics such as age, district of residence, gender, annual income, education level, type of workplace, vaccination status, occupational exposures (contact with human or animal faecal matter and body fluids), history of workplace injury, and health-seeking behaviours influence KAP scores among sanitation workers (Table19). Each predictor was analyzed in a separate model, with the regression coefficient representing the average difference in KAP score compared to a reference group, and the p-value indicating statistical significance. Interpreting these results allows identification of factors that are significantly associated with KAP scores, highlighting high-risk subgroups and work environments.

The regression analysis examining the association between age and KAP scores used the <40 years age group as the reference category. Workers aged 40–59 years had a regression coefficient of 0.513 with a p-value of 0.103, indicating no statistically significant difference in KAP scores compared to the youngest group. Workers aged 60–79 years had a regression coefficient of 0.274 with a p-value of 0.730, also showing no significant difference relative to the reference group. This finding implies that age alone is not a strong predictor of KAP among sanitation workers. Similarly, the association between gender and KAP scores used females

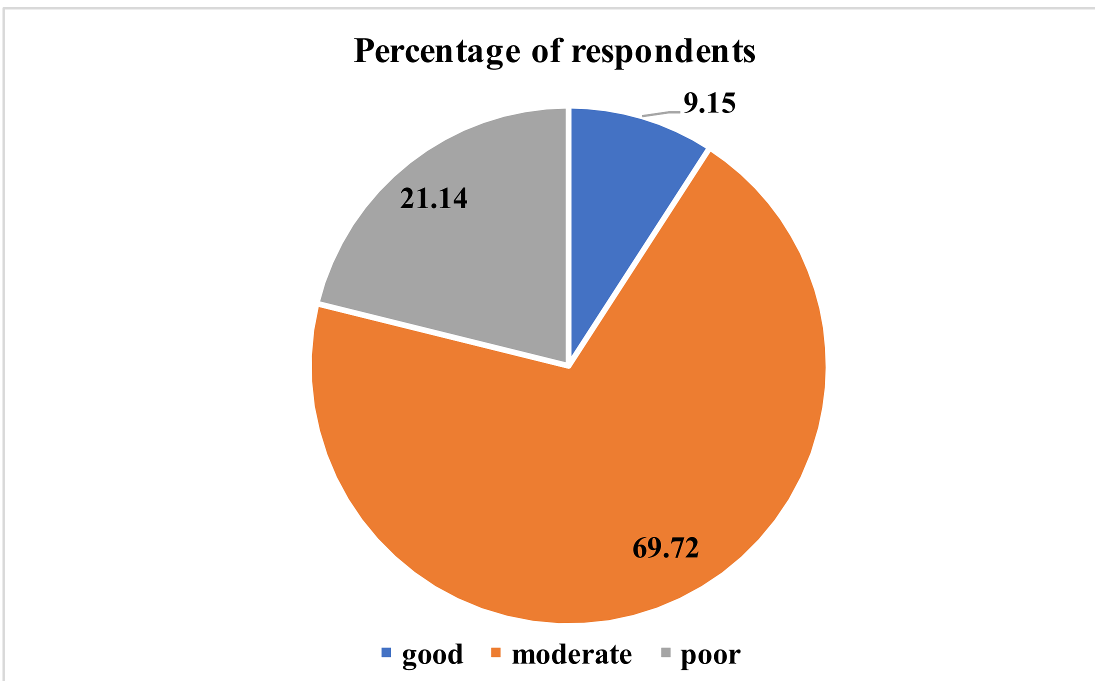

Fig. 17: Practice score of zoonotic diseases amongst sanitation farmers

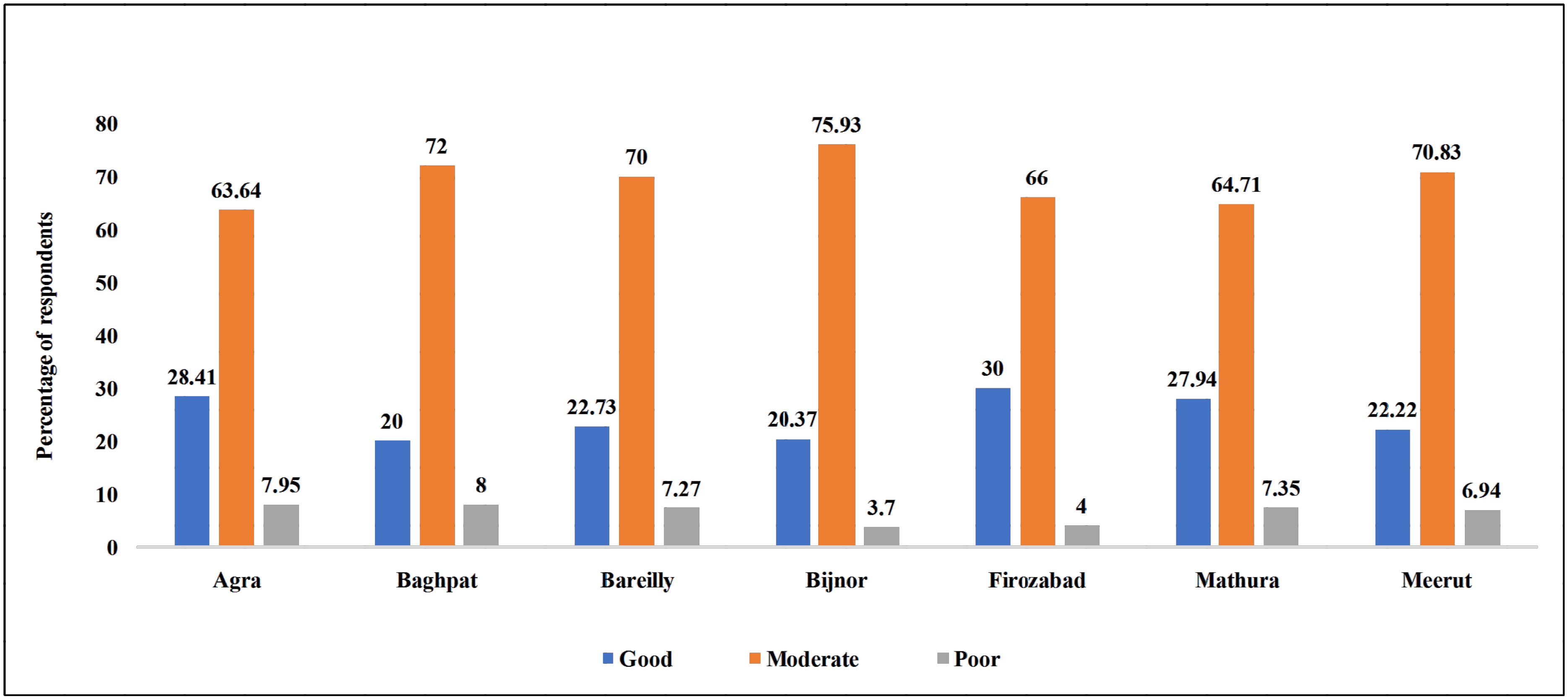

Fig. 18: District-wise Assessment of Practices of amongst sanitation workers

as the reference group. Male sanitation workers had a regression coefficient of 0.453 with a p-value of 0.662, indicating no statistically significant difference in KAP scores compared to females. These results suggest that gender does not significantly influence knowledge, attitudes, or practices related to occupational hygiene and zoonotic disease prevention among sanitation workers. Similarly, the association between district of residence and KAP scores revealed notable regional differences. Using the reference district as a baseline, workers from Firozabad (regression coefficient = 1.542, p = 0.001) and Mathura (regression coefficient = 1.502, p = 0.011) exhibited significantly higher KAP scores. In contrast, workers from Baghpat showed a marginal negative trend (regression coefficient = -0.892, p = 0.097), while Bareilly, Bijnor, and Meerut did not differ significantly from the reference district. Annual income and education level were not significantly associated with KAP scores. Workers earning more than 50,000 INR annually had a regression coefficient of 0.023 (p = 0.950), while education levels ranging from less than 5 years of schooling to graduate-level education had coefficients between -0.019 and -1.360 (p > 0.4 for all categories). These results suggest that socioeconomic status and formal education alone may not strongly influence sanitation workers' KAP regarding occupational hygiene and zoonotic disease prevention. Similarly, Workplace type showed partial significance. Workers in public spaces had lower KAP scores (regression coefficient = -1.660, p = 0.022), whereas workers in human hospitals (-2.148, p = 0.199) and veterinary dispensaries (-0.403, p = 0.705) did not differ significantly from the reference group. This suggests that the work environment may influence hygiene-related knowledge and practices, particularly in public spaces where exposure to resources and training might be limited. By analysing vaccination status for Hepatitis B (regression coefficient = -1.011, p = 0.33) and COVID-19 (regression coefficient = -0.461, p = 0.319) was not significantly associated with KAP scores, indicating that prior vaccination did not correlate with knowledge, attitudes, or practices among sanitation workers. Similarly, exposure to human faecal matter, animal faeces, human body fluids, and animal body fluids were examined individually. None of these factors were significantly associated with KAP scores, though animal body fluids contact showed a positive trend (regression coefficient = 0.442, p = 0.150). Workplace injuries also did not significantly influence KAP (regression coefficient = -0.416, p = 0.177), suggesting that direct occupational exposures may not directly translate into higher or lower knowledge and preventive practices. Similarly, Workers' history of hospital visits and previously diagnosed diseases showed no significant associations with KAP scores. Regression coefficients for hospital visits (>5/year and 3–4/year) were -0.167 (p = 0.799) and 0.280 (p = 0.380), respectively, while disease diagnosis had a coefficient of 0.161 (p = 0.601).

4.2.5 Multivariable analysis

In the multivariable regression analysis, four predictors—district of residence, workplace type, animal body fluids contact, and workplace injuries—were simultaneously included in the model to examine their combined and independent effects on Knowledge, Attitude, and Practice (KAP) scores among sanitation workers.(Table 20) This analytical approach allowed for the adjustment of potential confounding variables, meaning that the effect of each predictor on KAP scores was estimated while holding the other factors constant. Such an approach is essential in occupational health research, as socio-demographic characteristics, work environment, and exposure-related variables are often interrelated and may otherwise mask or exaggerate true associations. By including multiple relevant factors in the same model, the analysis provides a clearer understanding of which determinants are independently associated with sanitation workers' knowledge, attitudes, and practices regarding occupational hygiene and zoonotic disease prevention. The results demonstrated significant geographical variation in KAP scores. Specifically, workers from Firozabad (regression coefficient = 1.416, p = 0.018) and Mathura (regression coefficient = 1.467, p = 0.013) had significantly higher KAP scores compared to the reference district, suggesting that sanitation workers in these districts possessed better knowledge, more positive attitudes, and more consistent preventive practices related to occupational hygiene and zoonotic disease prevention. Conversely, workers from Baghpat had a significantly lower KAP score (regression coefficient = -1.288, p = 0.022), indicating potential gaps in awareness, training, or access to resources in this region. Similarly, Workplace type also influenced KAP scores, albeit to a lesser extent. Workers employed in public spaces exhibited a marginally lower KAP score (regression coefficient = -1.297, p = 0.071) compared to workers in the reference workplace category, suggesting that the work environment may affect the opportunities for formal training, availability of protective equipment, and adherence to hygiene protocols. In contrast, neither animal body fluids contact (regression coefficient = 0.291, $p = 0.335$) nor workplace injuries (regression coefficient = -0.151, $p = 0.624$) were significant predictors of KAP scores, indicating that direct occupational exposures and injury history alone did not strongly influence knowledge or preventive behaviours. By analysis of variance further supported these findings, showing that district of residence ($F = 5.187$, $p < 0.001$) and workplace type ($F = 3.431$, $p = 0.017$) were the only factors that significantly contributed to variations in KAP scores, while animal body fluids contact and workplace injuries did not have a statistically meaningful impact.

The coefficient of determination for the multivariable regression model (adjusted $R^2 = 0.0607$) indicates that district of residence, workplace type, animal body fluids contact, and workplace injuries together accounted for approximately 6.1% of the variability in KAP scores among sanitation workers. Although this proportion demonstrates that these factors have a measurable influence, it also suggests that a substantial part of the variation is explained by other unmeasured factors, such as individual motivation, prior training or experience, participation in community health programs, or access to sanitation resources. The analysis of variance (ANOVA) further confirmed the statistical significance of district ($F = 5.187$, $p < 0.001$) and workplace type ($F = 3.431$, $p = 0.017$), indicating that these variables independently contribute to differences in KAP scores after adjusting for the other predictors. These results highlight that regional context and workplace environment are important determinants of sanitation workers' knowledge, attitudes, and practices. Consequently, interventions aiming to improve occupational hygiene and zoonotic disease prevention should prioritise district-level strategies and workplace-focused training programs while also considering additional factors that may influence KAP to ensure comprehensive improvements across this occupational group.

Table 19: Univariable linear regression analysis, demonstrating the influence of explanatory variables on the outcome variables

Predictor	Category	Regression Coefficient (β)	p-value	Adjusted R^2
Age	<40 years (ref)	—	—	0.0013
	40–59 years	0.513	0.103	
	60–79 years	0.274	0.73	
Gender	Female (ref)	—	—	-0.0017
	Male	0.453	0.662	
District	Reference district	—	—	0.0479
	Bareilly	-0.346	0.467	
	Baghpat	-0.892	0.097	
	Bijnor	-0.818	0.154	
	Firozabad	1.542	0.009	
	Mathura	1.502	0.011	
	Meerut	-0.207	0.695	
Education	Illiterate / $\leq$5 years (ref)	—	—	-
	$\leq$5 years	-0.019	0.97	
	6–10 years	-0.328	0.46	0.0045
	Graduate	-1.36	0.498	
	Postgraduate	-0.812	0.413	
Annual income	$\leq$50,000 (ref)	—	—	
	>50,000	0.023	0.95	
Workplace	Other (ref)	—	—	0.002
	Human hospitals	-2.148	0.199	
	Public spaces	-1.66	0.022	0.0091
	Veterinary dispensaries	-0.403	0.705	
Hepatitis B vaccination	No (ref)	—	—	-0.0001
	Yes	-1.011	0.33	
COVID-19 vaccination	No (ref)	—	—	-0.0001
	Yes	-0.461	0.319	
Human faecal matter contact	—	0.064	0.834	-0.002
Animal faecal matter contact	—	-0.175	0.568	-0.0014
Human body fluids contact	—	-0.112	0.715	-0.0018
Animal body fluids contact	—	0.442	0.15	0.0022
Workplace injuries	—	-0.416	0.177	0.0017
Hospital visits	$\leq$2/year (ref)	—	—	-0.0021
	3–4/year	0.28	0.38	
	>5/year	-0.167	0.799	
Diagnosed diseases	No (ref)	—	—	-0.0015
	Yes	0.161	0.601	

Table 20: Multivariable linear regression analysis, demonstrating the influence of explanatory variables on the outcome variables

Predictor	Category	Regression Coefficient (β)	p-value	Adjusted R^2
District	Reference district	—	—	0.0607
	Bareilly	-0.38	0.424	
	Baghpat	-1.288	0.022	
	Bijnor	-0.806	0.16	
	Firozabad	1.416	0.018	
	Mathura	1.467	0.013	
	Meerut	-0.265	0.618	
Workplace	Other (ref)	—	—	
	Human hospitals	-0.795	0.636	
	Public spaces	-1.297	0.071	
	Veterinary dispensaries	0.907	0.416	
Animal body fluids contact	—	0.291	0.335	
Workplace injuries	—	-0.151	0.624	

4.3 Seropositivity of Brucellosis in Small Ruminants

Brucellosis, a highly contagious bacterial zoonosis caused by *Brucella* spp., poses a significant public health and economic threat, particularly in developing countries. Recognizing the need for improved disease surveillance, the present study was undertaken to determine the seropositivity of brucellosis among small ruminants reared by Scheduled Caste (SC) livestock farmers in three districts of western Uttar Pradesh including Agra, Bareilly, and Baghpat. These districts were purposively selected based on high small ruminant density and epidemiological importance for zoonotic disease transmission. A total of 186 serum samples comprising 151 goats and 35 sheep were collected and screened using the IDvet Brucellosis Indirect Multi-Species ELISA Kit, a widely used and validated assay for the detection of *Brucella*-specific antibodies in ruminants.

4.3.1 Goat Seropositivity Patterns

Out of the 151 goat serum samples analysed, 66 samples (43.71%) were seropositive for Brucella antibodies, indicating a considerable burden of infection in the study population

(Table22; Fig. 19). The details of all 151 samples have been mentioned in (Table 21). Highest positivity rate was recorded in Bareilly, with 44 out of 47 samples (93.62%) testing positive, indicating an alarmingly high positivity in this region. In contrast, moderate seropositivity rate of 31.03% (18/58) was found in Agra, while the lowest positivity was recorded from Baghpat with only 4 out of 46 samples (8.70%) seropositive. These findings underscore the need for enhanced surveillance, targeted interventions, and region-specific control strategies, particularly given the chronic nature of brucellosis and its significant zoonotic potential.

Table 21: Details of goat samples screened for brucellosis using IgG ELISA kit

Districts	Sample number	(S/P%) value	Result
Baghpat	1	-1.76	NEGATIVE
Baghpat	2	1.76	NEGATIVE
Baghpat	3	63.22	NEGATIVE
Baghpat	4	61.41	NEGATIVE
Baghpat	5	-13.42	NEGATIVE
Baghpat	6	44.89	NEGATIVE
Baghpat	7	68.49	NEGATIVE
Baghpat	8	25.43	NEGATIVE
Baghpat	9	22.63	NEGATIVE
Baghpat	10	83.78	NEGATIVE
Baghpat	11	22.15	NEGATIVE
Baghpat	12	145.08	POSITIVE
Baghpat	13	70.89	NEGATIVE
Baghpat	14	58.81	NEGATIVE
Baghpat	15	68.25	NEGATIVE
Baghpat	16	98.32	NEGATIVE
Baghpat	17	27.82	NEGATIVE
Baghpat	18	21.21	NEGATIVE
Baghpat	19	104.84	NEGATIVE
Baghpat	20	87.28	NEGATIVE
Baghpat	21	82.28	NEGATIVE
Baghpat	22	77.92	NEGATIVE
Baghpat	23	136.25	POSITIVE
Baghpat	24	98.46	NEGATIVE
Baghpat	25	83.98	NEGATIVE

Table 21: Contd...

Districts	Sample number	(S/P%) value	Result
Agra	47	101.80	NEGATIVE
Agra	48	70.75	NEGATIVE
Agra	49	109.78	NEGATIVE
Agra	50	122.98	POSITIVE
Agra	51	66.37	NEGATIVE
Agra	52	41.36	NEGATIVE
Agra	53	102.72	NEGATIVE
Agra	54	86.58	NEGATIVE
Agra	55	91.57	NEGATIVE
Agra	56	11.07	NEGATIVE
Agra	57	113.88	DOUBTFUL
Agra	58	99.42	NEGATIVE
Agra	59	102.21	NEGATIVE
Agra	60	27.65	NEGATIVE
Agra	61	91.36	NEGATIVE
Agra	62	115.03	NEGATIVE
Agra	63	96.21	NEGATIVE
Agra	64	112.59	NEGATIVE
Agra	65	78.15	NEGATIVE
Agra	66	30.72	NEGATIVE
Agra	67	-30.72	NEGATIVE
Agra	68	17.27	NEGATIVE
Agra	69	170.11	POSITIVE
Agra	70	141.40	POSITIVE
Agra	71	107.81	NEGATIVE
Agra	72	203.23	POSITIVE
Agra	73	113.97	NEGATIVE
Agra	74	88.60	NEGATIVE
Agra	75	66.45	NEGATIVE
Agra	76	33.29	NEGATIVE
Agra	77	170.83	POSITIVE
Agra	78	97.20	NEGATIVE
Agra	79	78.35	NEGATIVE
Agra	80	116.94	NEGATIVE

Table 21: Contd...

Districts	Sample number	(S/P%) value	Result
Agra	81	92.29	NEGATIVE
Agra	82	89.82	NEGATIVE
Agra	83	36.16	NEGATIVE
Agra	84	113.18	NEGATIVE
Agra	85	178.38	POSITIVE
Agra	86	153.07	POSITIVE
Agra	87	121.13	POSITIVE
Agra	88	147.00	POSITIVE
Agra	89	138.96	POSITIVE
Agra	90	76.43	NEGATIVE
Agra	91	-3.46	NEGATIVE
Agra	92	166.64	POSITIVE
Agra	93	241.20	POSITIVE
Agra	94	314.80	POSITIVE
Agra	95	183.95	NEGATIVE
Agra	96	206.30	POSITIVE
Agra	97	131.28	POSITIVE
Agra	98	125.28	POSITIVE
Agra	99	53.03	NEGATIVE
Agra	100	187.77	POSITIVE
Agra	101	359.59	POSITIVE
Bareilly	102	228.35	POSITIVE
Bareilly	103	295.42	POSITIVE
Bareilly	104	337.31	POSITIVE
Bareilly	105	210.22	POSITIVE
Bareilly	106	192.49	POSITIVE
Bareilly	107	110.45	NEGATIVE
Bareilly	108	135.79	POSITIVE
Bareilly	109	291.13	POSITIVE
Bareilly	110	249.21	POSITIVE
Bareilly	111	175.68	POSITIVE
Bareilly	112	189.88	POSITIVE
Bareilly	113	289.09	POSITIVE
Bareilly	114	134.71	POSITIVE

Bareilly	115	138.76	POSITIVE
Bareilly	116	192.39	POSITIVE
Bareilly	117	360.18	POSITIVE
Bareilly	118	304.85	POSITIVE
Bareilly	119	202.70	POSITIVE
Bareilly	120	262.99	POSITIVE
Bareilly	121	210.68	POSITIVE
Bareilly	122	191.20	POSITIVE
Bareilly	123	139.62	POSITIVE
Bareilly	124	261.70	POSITIVE
Bareilly	125	331.84	POSITIVE
Bareilly	126	282.79	POSITIVE
Bareilly	127	264.01	POSITIVE
Bareilly	128	264.34	POSITIVE
Bareilly	129	237.74	POSITIVE
Bareilly	130	173.04	POSITIVE
Bareilly	131	106.46	NEGATIVE
Bareilly	132	290.87	POSITIVE
Bareilly	133	423.20	POSITIVE
Bareilly	134	396.90	POSITIVE
Bareilly	135	272.74	POSITIVE
Bareilly	136	282.50	POSITIVE
Bareilly	137	250.33	POSITIVE
Bareilly	138	209.33	POSITIVE
Bareilly	139	82.73	NEGATIVE
Bareilly	140	345.45	POSITIVE
Bareilly	141	426.86	POSITIVE
Bareilly	142	311.37	POSITIVE
Bareilly	143	284.90	POSITIVE
Bareilly	144	325.25	POSITIVE
Bareilly	145	297.79	POSITIVE
Bareilly	146	249.44	POSITIVE
Bareilly	147	227.39	POSITIVE
Bareilly	148	134.80	POSITIVE
Bareilly	149	143.44	POSITIVE
Bareilly	150	131.76	POSITIVE
Bareilly	151	141.54	POSITIVE
Baghpat	26	80.27	NEGATIVE

Table 21: Contd...

Districts	Sample number	(S/P%) value	Result
Baghpat	27	87.86	NEGATIVE
Baghpat	28	83.01	NEGATIVE
Baghpat	29	82.52	NEGATIVE
Baghpat	30	71.96	NEGATIVE
Baghpat	31	87.12	NEGATIVE
Baghpat	32	99.95	NEGATIVE
Baghpat	33	94.97	NEGATIVE
Baghpat	34	88.68	NEGATIVE
Baghpat	35	93.77	NEGATIVE
Baghpat	36	92.19	NEGATIVE
Baghpat	37	79.89	NEGATIVE
Baghpat	38	64.17	NEGATIVE
Baghpat	39	97.64	NEGATIVE
Baghpat	40	132.31	POSITIVE
Baghpat	41	126.79	POSITIVE
Baghpat	42	101.04	NEGATIVE
Baghpat	43	105.44	NEGATIVE
Baghpat	44	90.68	NEGATIVE
Baghpat	45	89.50	NEGATIVE
Baghpat	46	75.29	NEGATIVE

Table 22 : Overall seropositivity of goat clinical samples for brucellosis in different districts of western Uttar Pradesh

District	Total samples	Positive samples	Seropositivity
Agra	58	18	31.03%
Baghpat	46	4	8.70%
Bareilly	47	44	93.62%
Total	151	66	43.71%

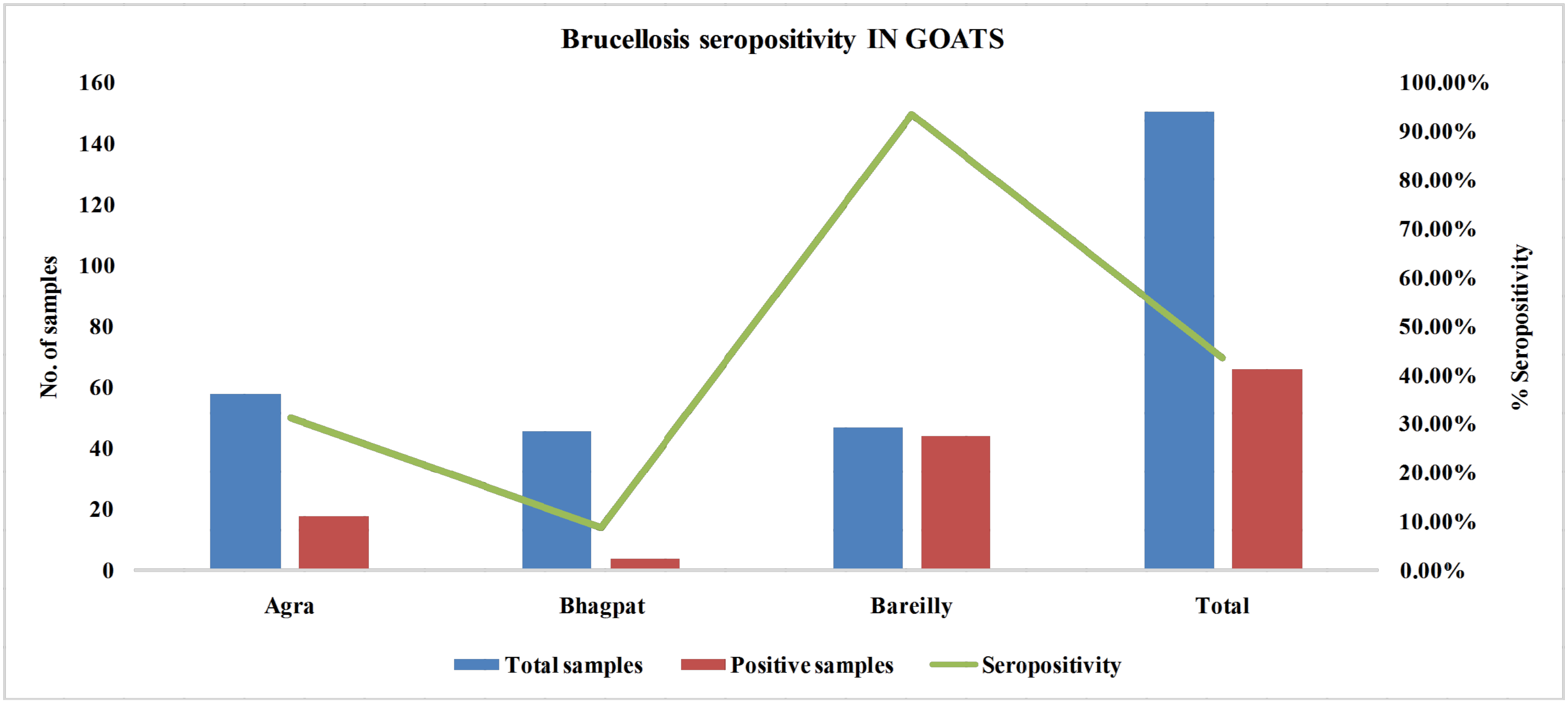

Fig. 19: District-wise seropositivity of brucellosis in goat population of targeted districts of western Uttar Pradesh

4.3.2 Sheep Seropositivity Patterns

Among the 35 sheep serum samples collected from Agra and Baghpat, a total of 14 animals (40.00%) tested seropositive for Brucella antibodies, indicating a considerable level of exposure within the sampled ovine population. The details of samples screened have been mentioned in (Table 23). Highest seropositivity was recorded in Agra, with 9 out of 18 samples (50.00%) testing positive, whereas comparatively lower positivity of 29.41% (5/17) was found in Baghpat. Although the number of sheep samples was smaller compared to goats, the relatively high seropositivity still reflects a significant burden of brucellosis among sheep in the region.

Table 23 : Details of sheep samples screened for brucellosis using IgG ELISA

Districts	Sample number	(S/P%) value	Result
Agra	1	122.08	POSITIVE
Agra	2	148.12	POSITIVE
Agra	3	78.09	NEGATIVE
Agra	4	118.51	NEGATIVE
Agra	5	120.43	POSITIVE
Agra	6	127.08	POSITIVE
Agra	7	41.19	NEGATIVE
Agra	8	16.28	NEGATIVE
Agra	9	132.82	POSITIVE
Agra	10	148.84	POSITIVE
Agra	11	61.26	NEGATIVE
Agra	12	56.06	NEGATIVE
Agra	13	128.85	POSITIVE
Agra	14	123.44	POSITIVE
Agra	15	49.08	NEGATIVE
Agra	16	109.59	NEGATIVE
Agra	17	18.49	NEGATIVE
Agra	18	129.27	POSITIVE
Baghpat	19	92.15	NEGATIVE
Baghpat	20	102.7	NEGATIVE
Baghpat	21	135.72	POSITIVE
Baghpat	22	124.83	POSITIVE
Baghpat	23	104.73	NEGATIVE

Table 23 Contd...

Districts	Sample number	(S/P%) value	Result
Baghpat	24	116.6	NEGATIVE
Baghpat	25	106.3	NEGATIVE
Baghpat	26	37.62	NEGATIVE
Baghpat	27	92.32	NEGATIVE
Baghpat	28	116.34	POSITIVE
Baghpat	29	130.14	POSITIVE
Baghpat	30	120.49	POSITIVE
Baghpat	31	116.8	NEGATIVE
Baghpat	32	116.86	NEGATIVE
Baghpat	33	111.63	NEGATIVE
Baghpat	34	34.05	NEGATIVE
Baghpat	35	20.95	NEGATIVE

4.3.3 Overall Seropositivity in small ruminants brucellosis in small ruminant population of targeted districts of Western Uttar Pradesh

The overall seropositivity in small ruminant population of targeted districts of Western Uttar Pradesh was 43.01 per cent with 80 out of 186 samples positive for Brucella antibodies. The inter-district variation was more pronounced in goats than in sheep. The unusually high seropositivity in goat population of Bareilly (93.62%) is particularly noteworthy.

4.4 Seropositivity of Coxiellosis in Small Ruminants

Sheep and goats, the primary domestic reservoirs of *C. burnetii*, play a crucial role in the maintenance and dissemination of the pathogen, particularly in resource-limited, small holder farming systems. The absence of routine sero-monitoring and targeted control strategies in such settings significantly increases the risk of zoonotic spillover. To address this gap, the present study was undertaken with the objective of determining the seropositivity of coxiellosis among small ruminants raised by Scheduled Caste (SC) livestock farmers in three districts of western Uttar Pradesh including Agra, Bareilly, and Baghpat. These districts were purposively selected due to their dense small ruminant populations and epidemiological relevance for zoonotic disease surveillance. Serum samples were collected from both goats and sheep and were analyzed using the IDvet Coxiellosis Indirect Multi-Species ELISA Kit, a validated serological assay for the detection of *C. burnetii*-specific antibodies in ruminants.

4.4.1 Goat Seropositivity Patterns

The overall seropositivity of *Coxiella burnetii* among goats across the three surveyed districts was notably high, with 110 out of 151 goats (72.84%) testing seropositive, suggesting widespread exposure and a potentially significant role of goats in the transmission dynamics of Q fever. The details of goat samples screened for coxiellosis have been mentioned in (Table 24). District-wise, Bareilly recorded the highest seropositivity, where 44 out of 47 goats (93.62%) tested positive, indicating almost universal exposure in the sampled population (table25:fig20). In Agra, 41 of the 58 goats tested (70.69%) were seropositive, reflecting a similarly elevated risk. The seropositivity in Baghpat was comparatively lower, yet substantial with 25 out of 46 goats (54.35%) testing positive. The consistently high rates across all districts underline the importance of goats as key reservoirs of *Coxiella burnetii*, reinforcing the need for targeted surveillance, public health interventions, and risk communication in goat-rearing communities.

Table 24 : Details of goat samples screened for coxiellosis using IgG ELISA

Districts	Sample serial number	(S/P%) value	Result
Agra	1	57.07	POSITIVE
Agra	2	64.81	POSITIVE
Agra	3	40.90	POSITIVE
Agra	4	83.89	POSITIVE
Agra	5	71.28	POSITIVE
Agra	6	104.84	POSITIVE
Agra	7	60.58	POSITIVE
Agra	8	35.01	NEGATIVE
Agra	9	29.2	NEGATIVE
Agra	10	97.62	POSITIVE
Agra	11	33.01	NEGATIVE
Agra	12	114.4	POSITIVE
Agra	13	18.7	NEGATIVE
Agra	14	78.73	POSITIVE

Table 24 Contd...

Districts	Sample serial number	(S/P%) value	Result
Agra	15	107.55	POSITIVE
Agra	16	128.9	POSITIVE
Agra	17	36.52	NEGATIVE
Agra	18	53	POSITIVE
Agra	19	64.9	POSITIVE
Agra	20	70.3	POSITIVE
Agra	21	114.2	POSITIVE
Agra	22	85.89	POSITIVE
Agra	23	45.25	NEGATIVE
Agra	24	5.92	NEGATIVE
Agra	25	80.8	POSITIVE
Agra	26	117.2	POSITIVE
Agra	27	108.1	POSITIVE
Agra	28	102.3	POSITIVE
Agra	29	88.9	POSITIVE
Agra	30	<40	NEGATIVE
Agra	31	72.5	POSITIVE
Agra	32	86.3	POSITIVE
Agra	33	5.373	NEGATIVE
Agra	34	93.87	POSITIVE
Agra	35	137.1	POSITIVE
Agra	36	97.5	POSITIVE
Agra	37	76.44	POSITIVE
Agra	38	22.03	NEGATIVE
Agra	39	64.41	NEGATIVE
Agra	40	84.25	POSITIVE
Agra	41	40.45	NEGATIVE
Agra	42	67.67	POSITIVE
Agra	43	17.82	NEGATIVE
Agra	44	93.73	POSITIVE
Agra	45	166.52	POSITIVE
Agra	46	64.47	POSITIVE
Agra	47	91.08	POSITIVE
Agra	48	123.29	POSITIVE

Table 24 Contd...

Districts	Sample serial number	(S/P%) value	Result
Agra	49	61.16	POSITIVE
Agra	50	66.61	POSITIVE
Agra	51	22.18	POSITIVE
Agra	52	55.20	POSITIVE
Agra	53	37.35	NEGATIVE
Agra	54	24.29	NEGATIVE
Agra	55	44.34	POSITIVE
Agra	56	41.87	POSITIVE
Agra	57	45.51	POSITIVE
Agra	58	95.90	POSITIVE
Baghpat	59	88.22	POSITIVE
Baghpat	60	88.92	POSITIVE
Baghpat	61	94.19	POSITIVE
Baghpat	62	75.94	POSITIVE
Baghpat	63	44.28	POSITIVE
Baghpat	64	72.00	POSITIVE
Baghpat	65	21.70	NEGATIVE
Baghpat	66	8.75	NEGATIVE
Baghpat	67	3.42	NEGATIVE
Baghpat	68	6.30	NEGATIVE
Baghpat	69	5.58	NEGATIVE
Baghpat	70	8.89	NEGATIVE
Baghpat	71	23.67	POSITIVE
Baghpat	72	9.12	NEGATIVE
Baghpat	73	41.77	POSITIVE
Baghpat	74	11.79	NEGATIVE
Baghpat	75	26.22	NEGATIVE
Baghpat	76	10.30	NEGATIVE
Baghpat	77	110.1	POSITIVE
Baghpat	78	98	POSITIVE
Baghpat	79	76.1	POSITIVE
Baghpat	80	<40	NEGATIVE
Baghpat	81	105	POSITIVE
Baghpat	82	112.3	POSITIVE
Baghpat	83	63.6	POSITIVE

Table 24 Contd...

Districts	Sample serial number	(S/P%) value	Result
Baghpat	84	57.6	POSITIVE
Baghpat	85	16.5	NEGATIVE
Baghpat	86	62.8	POSITIVE
Baghpat	87	76	POSITIVE
Baghpat	88	34.7	NEGATIVE
Baghpat	89	35.6	NEGATIVE
Baghpat	90	108	POSITIVE
Baghpat	91	36.4	NEGATIVE
Baghpat	92	96.1	POSITIVE
Baghpat	93	131.2	POSITIVE
Baghpat	94	100.3	POSITIVE
Baghpat	95	100.3	POSITIVE
Baghpat	96	36.4	NEGATIVE
Baghpat	97	23	NEGATIVE
Baghpat	98	76.5	POSITIVE
Baghpat	99	34.5	NEGATIVE
Baghpat	100	92.9	POSITIVE
Baghpat	101	10	NEGATIVE
Baghpat	102	54.886	POSITIVE
Baghpat	103	17.524	NEGATIVE
Baghpat	104	39.788	NEGATIVE
Bareilly	105	86.76	POSITIVE
Bareilly	106	90.83	POSITIVE
Bareilly	107	140.24	POSITIVE
Bareilly	108	105.42	POSITIVE
Bareilly	109	112.32	POSITIVE
Bareilly	110	138.56	POSITIVE
Bareilly	111	133.7	POSITIVE
Bareilly	112	155.6	POSITIVE
Bareilly	113	100.84	POSITIVE
Bareilly	114	123.08	POSITIVE
Bareilly	115	97.8	POSITIVE
Bareilly	116	85.41	POSITIVE
Bareilly	117	94.74	POSITIVE
Bareilly	118	76.9	POSITIVE

Table 24 Contd...

Districts	Sample serial number	(S/P%) value	Result
Bareilly	119	66.4	POSITIVE
Bareilly	120	128.9	POSITIVE
Bareilly	121	132.68	POSITIVE
Bareilly	122	106.98	POSITIVE
Bareilly	123	104.73	POSITIVE
Bareilly	124	69.54	POSITIVE
Bareilly	125	87.22	POSITIVE
Bareilly	126	100.1	POSITIVE
Bareilly	127	122.52	POSITIVE
Bareilly	128	80.02	POSITIVE
Bareilly	129	103.42	POSITIVE
Bareilly	130	105.46	POSITIVE
Bareilly	131	60.586	POSITIVE
Bareilly	132	97.62	POSITIVE
Bareilly	133	114.48	POSITIVE
Bareilly	134	34.72	NEGATIVE
Bareilly	135	40	NEGATIVE
Bareilly	136	88.02	POSITIVE
Bareilly	137	123.4	POSITIVE
Bareilly	138	132.6	POSITIVE
Bareilly	139	63.26	POSITIVE
Bareilly	140	45.79	NEGATIVE
Bareilly	141	34.55	NEGATIVE
Bareilly	142	92.55	POSITIVE
Bareilly	143	33.85	NEGATIVE
Bareilly	144	68.85	POSITIVE
Bareilly	145	44.7	NEGATIVE
Bareilly	146	105.46	POSITIVE
Bareilly	147	139.45	POSITIVE
Bareilly	148	123.4	POSITIVE
Bareilly	149	55.5	POSITIVE
Bareilly	150	143.76	POSITIVE
Bareilly	151	77.52	POSITIVE

Table 25: Overall seropositivity of goat clinical samples for Coxiellosis in different districts of western Uttar Pradesh

District	Total sample	Positive sample	Seropositivity
Agra	58	41	70.69%
Bareilly	47	44	93.62%
Baghpat	46	25	54.35%
Total	**151**	**110**	**72.84%**

4.4.2 Sheep Seropositivity Patterns

The seropositivity of *Coxiella burnetii* in sheep was considerably lower, with only 5 out of 35 animals (14.29%) testing seropositive, suggesting a more limited role of sheep in Q fever transmission within the study area. The details of samples screened have been mentioned in (Table 26). In Agra, 3 out of 18 sheep (16.67%) were seropositive, while in Baghpat, only 2 out of 17 sheep (11.76%) tested positive. Although sheep appear to have lower exposure levels compared to goats, their involvement in the disease cycle cannot be entirely dismissed, especially considering their potential to shed the pathogen.

Table 26 : Details of sheep samples screened for coxiellosis using IgG ELISA

Districts	Sample serial number	Result	(S/P%) value
Agra	1	NEGATIVE	25.55
Agra	2	NEGATIVE	30.94
Agra	3	POSITIVE	67.98
Agra	4	NEGATIVE	24.20
Agra	5	NEGATIVE	28.43
Agra	6	NEGATIVE	21.51
Agra	7	POSITIVE	78.19
Agra	8	NEGATIVE	25.47
Agra	9	NEGATIVE	4.65
Agra	10	NEGATIVE	40.38
Agra	11	NEGATIVE	22.4
Agra	12	NEGATIVE	23.80

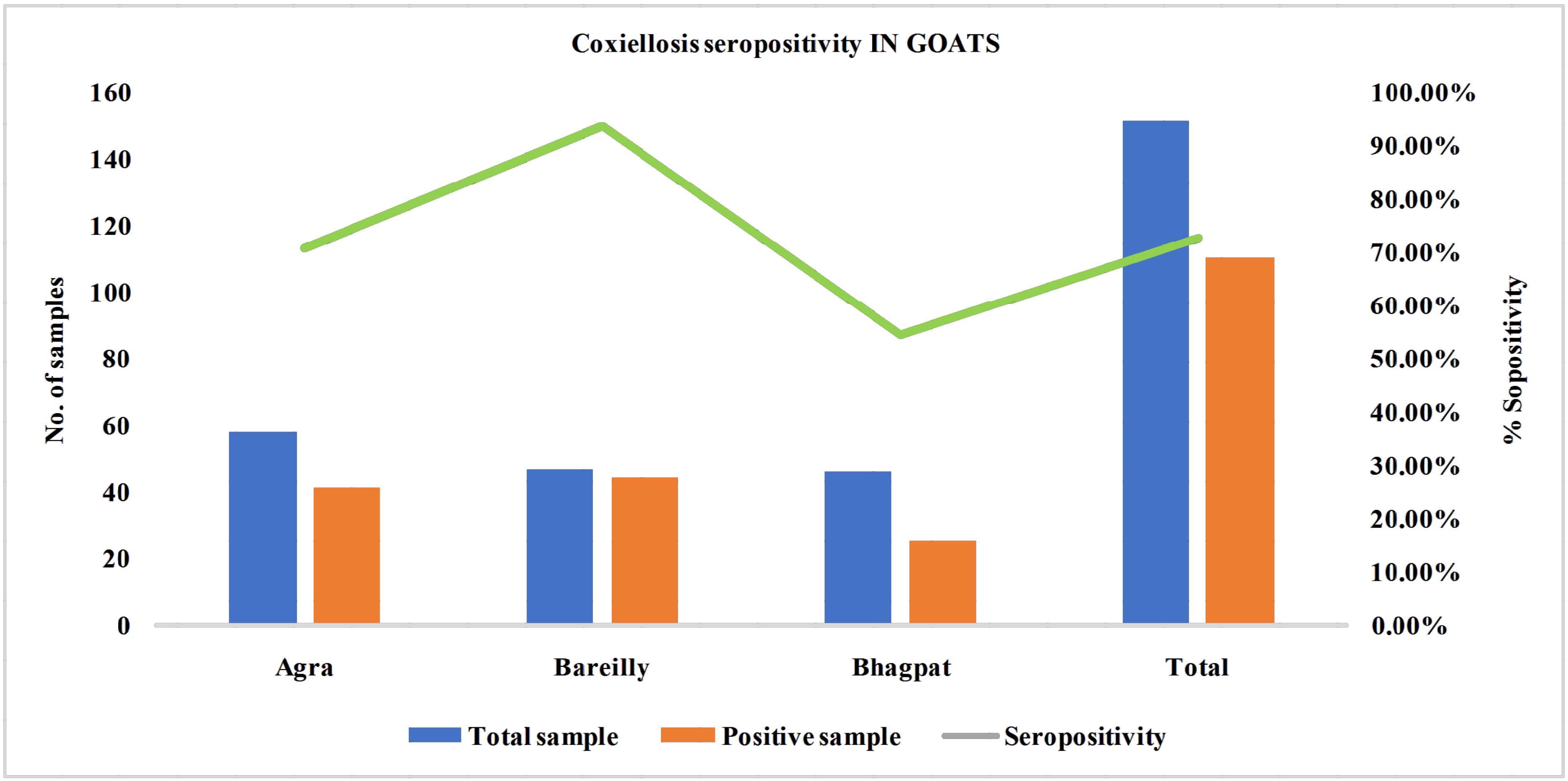

Fig. 20: District-wise seropositivity of Coxiellosis in goat population of targeted districts of western Uttar Pradesh

Table 26 Contd...

Districts	Sample serial number	Result	(S/P%) value
Agra	13	NEGATIVE	28.29
Agra	14	NEGATIVE	6.87
Agra	15	NEGATIVE	25.29
Agra	16	NEGATIVE	11.12
Agra	17	NEGATIVE	24.20
Agra	18	POSITIVE	89.91
Baghpat	19	NEGATIVE	26.50
Baghpat	20	NEGATIVE	8.80
Baghpat	21	POSITIVE	73.66
Baghpat	22	NEGATIVE	38.65
Baghpat	23	NEGATIVE	4.65
Baghpat	24	NEGATIVE	6.42
Baghpat	25	NEGATIVE	38.03
Baghpat	26	NEGATIVE	21.17
Baghpat	27	NEGATIVE	22.4
Baghpat	28	NEGATIVE	41.71
Baghpat	29	NEGATIVE	27.02
Baghpat	30	NEGATIVE	8.58
Baghpat	31	NEGATIVE	15.59
Baghpat	32	NEGATIVE	1.15
Baghpat	33	NEGATIVE	24.20
Baghpat	34	POSITIVE	87.51
Baghpat	35	POSITIVE	74.86

4.4.3 Overall Seropositivity of Coxiellosis in small ruminant population of targeted districts of Western Uttar Pradesh

The overall seropositivity of *Coxiella burnetii* among small ruminants across the three surveyed districts was 61.83 per cent, with 115 out of 186 animals testing seropositive. A marked species-wise difference was observed with goats exhibited a substantially higher seropositivity rate of 72.84 per cent (110/151) compared to 14.29 per cent (5/35) in sheep. Among goats, Bareilly recorded the highest seropositivity of 93.62% (44/47).

4.5 Comparative Analysis of *Brucella* and *Coxiella* Seropositivity in Small Ruminants

A comparison of serological findings revealed that *Coxiella burnetii* infection was more prevalent than *Brucella* spp. among the small ruminants sampled in the three districts of western Uttar Pradesh. The overall seropositivity of *Coxiella burnetii* was 61.83 per cent (115/186), considerably higher than that of *Brucella*, which was 43.01 per cent (80/186). Among goats, 72.84 per cent (110/151) tested positive for *Coxiella*, whereas 43.71 per cent (66/151) were positive for *Brucella*. While, sheep exhibited low seropositivity of 14.29 per cent (5/35) for *Coxiella* and comparatively high positivity of 40.00 per cent (14/35) for *Brucella*. Interestingly, while *Coxiella* seropositivity was highest in Bareilly (93.62% in goats), *Brucella* seropositivity peaked in Bareilly as well (93.62% in goats), suggesting overlapping hotspots of infection.

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Discussion

5 DISCUSSION

5.1 KAP on zoonotic diseases amongst livestock farmers

Livestock farmers constitute a crucial occupational group in rural India, playing a significant role in the food system, rural economy, and the livelihoods of millions of households. However, their work environment exposes them to a wide array of zoonotic pathogens due to frequent and close contact with livestock, animal products, manure, soil, and contaminated water sources. This risk is especially pronounced among smallholder and traditional husbandry systems, particularly those belonging to Scheduled Caste communities, where limited biosecurity measures, close proximity of human dwellings to animal shelters, and inadequate veterinary supervision are common. In these settings, farmers often depend on traditional knowledge and community practices for animal health management, which may not effectively mitigate the risks of zoonotic disease transmission. The present study assessed the knowledge, attitudes, and practices (KAP) related to zoonotic diseases among Scheduled Caste livestock farmers across seven districts in western Uttar Pradesh including Agra, Baghpat, Bareilly, Bijnor, Firozabad, Mathura and Meerut . These districts were selected to capture a broad range of socio-economic conditions, enabling an in-depth examination of how local community factors influence farmers' awareness and behaviours concerning zoonotic disease risks. By exploring these settings, the study provides a detailed understanding of the occupational health challenges faced by livestock farmers in the region. This approach offers valuable insights for developing targeted and effective strategies to prevent zoonotic diseases in livestock farming communities.

5.1.1 Knowledge of Zoonotic Diseases

The findings from the knowledge assessment reveal a mixed and concerning picture regarding the awareness of zoonotic diseases among Scheduled Caste livestock farmers in western Uttar Pradesh. Despite their direct exposure to animals and related occupational hazards, only a small prportion (8.05%) of participants were familiar with the technical term "zoonosis." However, a relatively larger proportion (32.36%) recognized that diseases can be transmitted from animals to humans, indicating a basic but incomplete understanding of zoonotic concepts. This discrepancy suggests that while the community may intuitively grasp that some illnesses pass from animals to people, formal awareness and terminology related to zoonotic diseases remain limited. Awareness of animal reservoirs associated with zoonotic transmission was uneven. Respondents most frequently identified dogs (74.14%) and cattle (61.30%) as sources of zoonoses, reflecting the cultural and occupational prominence of these species. Recognition of other potential reservoirs such as poultry, buffaloes, rodents, pigs, cats, sheep, and goats was significantly lower, with less than 30% identifying these animals. This limited understanding of the full spectrum of animal hosts potentially hampers comprehensive zoonotic disease prevention efforts, as many of these species are known carriers of pathogens relevant to human health.

In terms of specific zoonotic diseases, the study observed high awareness of COVID-19 (97.26%) and rabies (94.01%), likely driven by recent pandemic experiences and sustained public health initiatives targeting rabies control. Moderate awareness was noted for tuberculosis (57.71%) and brucellosis (21.75%), both endemic in rural India but often underdiagnosed and underreported. This high awareness of rabies mirrors findings from Haryana, India, where over 90% of participants were knowledgeable about rabies transmission among urbanised population (Kumar *et al*.,2022). Internationally, similar patterns of limited zoonotic disease knowledge among livestock farmers have been documented. For instance, Lindahl *et al*. (2015), found that 85% of livestock farmers in Tajikistan were unaware of brucellosis, placing them at increased infection risk. In Turkey, only 2% of farmers demonstrated sufficient knowledge of zoonoses (Cakmur *et al*., 2015). While all livestock keepers in Jordan were aware of brucellosis, most lacked understanding of its transmission routes, which limits effective prevention

(Musallam *et al*., 2015). Similarly, moderate knowledge of brucellosis was reported among Ugandan farmers (Kansiime *et al*., 2014). Awareness of other zoonoses varied across regions with reported awareness levels of rabies, anthrax, and brucellosis at 9%, 72%, and 21% respectively among Zimbabwean farmers (Chikerema *et al*. 2013). Furthermore, our study revealed almost negligible awareness of diseases such as leptospirosis (0.86%), avian influenza (5.14%), and cysticercosis (0%), underscoring critical gaps in recognition of less-publicized but epidemiologically significant zoonoses. Similar findings were reported by Arbiol *et al*. (2016), who reported low prevention practice scores for leptospirosis among agricultural workers in the Philippines, emphasizing the need for greater education on these neglected infections.

Vector-borne and environmentally transmitted zoonoses showed uneven recognition. Mosquito-borne diseases such as chikungunya, dengue, and Japanese encephalitis were relatively well-known, reflecting their endemicity and prominence in public health messaging. However, awareness of emerging or less common vector-borne diseases, including Zika virus and tick-borne infections like Crimean-Congo hemorrhagic fever and Lyme disease, was virtually absent. Only 2.91% of respondents identified ticks as vectors, and none could name specific tick-borne diseases, highlighting a significant knowledge gap.

Rodent-borne diseases such as plague and leptospirosis were similarly poorly understood. Recognition of fungal zoonoses was skewed; while superficial infections like ringworm were commonly known, systemic fungal infections such as aspergillosis and cryptococcosis were unfamiliar. Foodborne zoonotic transmission was another area with limited understanding. Only 25% of respondents recognized raw milk consumption as a risk factor, mainly linking it to tuberculosis and brucellosis. This finding aligns with a study from Egypt, which reported poor awareness of milk-borne zoonoses among Egyptian farmers despite prevalent raw milk consumption (El-Tras *et al*., 2015). Awareness of other milk-borne pathogens, including toxoplasmosis and coxiellosis, was completely absent, underscoring the urgent need for focused education on food safety and the zoonotic risks associated with dairy products.

The knowledge scoring system classified respondents into good (7.19%), moderate (54.97%), and poor (37.84%) knowledge groups. The relatively low proportion of farmers with good knowledge highlights the urgent need to strengthen educational interventions. While the majority possessed some understanding of common zoonoses and basic preventive measures, substantial gaps remain, particularly concerning less recognized diseases and complex transmission pathways. District-wise analysis revealed significant regional disparities in knowledge levels about zoonotic diseases among livestock farmers. Agra, Bareilly, Bijnor, and Firozabad reported higher proportions of farmers with good knowledge, which may reflect better access to veterinary services, extension activities, or targeted awareness campaigns in these areas. In contrast, Meerut and Mathura exhibited alarmingly high levels of poor knowledge, with over two-thirds of farmers demonstrating limited understanding. This highlights critical gaps and identified these districts as priority areas for intensified outreach and training efforts. Overall, the knowledge assessment revealed a imbalance, while awareness of well-publicized diseases was widespread, understanding of neglected zoonoses and their diverse transmission routes remained minimal. The marked differences in knowledge across districts underscore the need for prevention and education programs tailored to the specific contexts and challenges of each region, rather than adopting a uniform approach. This notion aligns with findings from other multi-district KAP studies in India (Singh *et al*., 2019), which emphasize that locally adapted interventions are essential for achieving better outcomes. Such limited and uneven knowledge compromises farmers' ability to adopt comprehensive protective measures, thereby increasing their vulnerability to occupational infections. To bridge these gaps, it is imperative to develop culturally appropriate, accessible, and sustained education programs that effectively enhance zoonotic disease prevention among livestock farmers in western Uttar Pradesh.

5.1.2 Attitudinal Assessment Towards Zoonotic Disease Prevention

The attitudinal evaluation of livestock farmers in western Uttar Pradesh reveals a generally favorable perception toward zoonotic disease prevention and occupational health safety however, considerable heterogeneity and critical gaps persist. A predominant proportion (73.97%) of respondents strongly endorsed the necessity for comprehensive awareness of zoonotic diseases among all farmers, reflecting widespread acknowledgment of the importance of knowledge dissemination within this demographic. Furthermore, over half of the participants recognized zoonoses as a significant public health threat (57.53%) and expressed personal concern regarding their susceptibility to these infections (54.97%), which are fundamental components for the initiation of protective health behaviours. Despite this encouraging baseline, several deficiencies were identified in relation to specific preventive interventions. Approximately half of the respondents acknowledged the efficacy of farm hygiene (52.74%), and glove utilization (51.88%), and proper carcass disposal (50.68%) as integral measures to mitigate zoonotic transmission. Notably, the study uncovered a pronounced reluctance toward the vaccination of livestock, with only 46.75% expressing willingness to immunize their animals against zoonotic pathogens. This vaccination hesitancy constitutes a significant impediment, considering that immunization remains a cornerstone in controlling zoonotic infections at the animal-human interface. This reluctance may be attributable to multifactorial causes, including economic constraints, limited veterinary infrastructure, scepticism regarding vaccine efficacy, and inadequate comprehension of vaccination benefits for both animal and human health. Additionally, just over half of respondents (50.51%) acknowledged the zoonotic risk associated with animal waste handling, indicating gaps in understanding common transmission pathways. These findings highlight a partial acceptance of preventive strategies, with evident deficits in interventions necessitating proactive implementation, such as vaccination.

Scoring of attitudes further elucidated this pattern with only 7.88% of farmers exhibited a robust and proactive attitude characterized by consistent recognition of zoonotic risks and adherence to protective behaviours including vaccination and the use of personal protective equipment (PPE). The majority (55.31%) demonstrated a moderate attitude, reflecting awareness of preventive measures but inconsistent application in routine practices. Alarmingly, a substantial fraction (36.81%) exhibited poor attitudes, characterized by minimal concern for occupational hazards, reluctance to employ PPE, and deficient engagement with biosecurity protocols, thereby perpetuating vulnerability to zoonotic infections.

Inter-district comparisons revealed marked disparities; districts such as Bijnor and Meerut recorded higher proportions of farmers with positive attitudes (22.60% and 21.62%, respectively). Conversely, Bareilly, Mathura, and Baghpat exhibited elevated prevalence of poor attitudes (exceeding 45%), suggesting systemic challenges including resource limitations, insufficient veterinary outreach, and socio-cultural barriers contributing to vaccine hesitancy and suboptimal preventive behaviors. These consistent findings underscore a pervasive challenge across rural livestock-rearing populations in India, where economic factors, cultural perceptions, and knowledge deficits hinder the uptake of essential zoonotic disease control measures. A baseline level of zoonotic disease awareness and concern exists among livestock farmers in western Uttar Pradesh, significant attitudinal impediments most notably vaccination hesitancy persist. Addressing these challenges necessitates culturally contextualized, accessible educational interventions designed to enhance knowledge, build trust, and foster behavioural change. Furthermore, strengthening veterinary infrastructure and ensuring affordable, accessible vaccination services are imperative to elevate preventive practice adoption and mitigate zoonotic disease transmission effectively.

5.1.3 Occupational Practices

The practice assessment among livestock farmers in western Uttar Pradesh reveals critical gaps in the consistent adoption of recommended preventive measures against zoonotic diseases. Although many respondents reported engaging in certain biosecurity behaviours, such as daily cleaning and disinfection of animal enclosures (94.35%), several high-risk practices persist, potentially undermining overall disease control efforts. A key finding is the limited use of personal protective equipment (PPE) during high-risk activities like assisting with animal births or handling aborted materials with only 27.40% reported using protective gear when managing sick animals, which is particularly concerning given the presence of pathogens like *Brucella* spp. and *Coxiella burnetii* in the region that are shed in large quantities during parturition. This low PPE adoption parallels findings in other low-resource agricultural settings, where economic constraints, lack of availability, and inadequate risk perception contribute to poor personal protection (Dhakal *et al*., 2016).The disposal of animal waste and biological materials shows mixed adherence to safe practices. While the majority of farmers properly buried aborted fetuses (82.19%) and carcasses (82.02%), a significant minority resorted to superficial burial or unsafe methods such as dumping in open fields or leaving materials accessible to scavengers. Such practices not only contaminate the environment but also increase zoonotic transmission risks by facilitating pathogen persistence and spread through vectors and wildlife scavengers. The limited use of biogas systems (6.85%) and composting (40.75%) for manure management highlights opportunities for promoting environmentally sound waste treatment technologies that also reduce occupational hazards.

The management of dog bite incidents further illustrates persistent gaps in practice. Although nearly half of the respondents sought formal medical care (48.29%) and practiced wound hygiene with phenolic soap (46.23%), only 21.06% combined both recommended actions, while 17% relied on traditional remedies or unlicensed practitioners. This underscores ongoing challenges in accessing and trusting formal healthcare services, a pattern documented in rural communities worldwide. Routine veterinary health monitoring was markedly inadequate, with only 2.05% conducting regular animal health checks and 75.86% seeking veterinary advice only when animals appeared visibly ill. This reactive approach hampers early detection and management of zoonotic diseases, allowing infection cycles to persist unnoticed. Encouragingly, moderate compliance was seen for parasite control measures, with 40.41% practicing regular deworming and ectoparasite management, yet inconsistent application remains a barrier to optimal disease prevention.

The overall practice scoring highlights a severe implementation gap with only 0.17% of farmers consistently adhered to all recommended preventive behaviours, while 77.40% demonstrated moderate but inconsistent practices, and 22.43% exhibited poor adherence. This disconnect between knowledge and practice is common in zoonotic disease prevention literature and reflects multifactorial challenges including economic constraints, limited access to resources, cultural norms, and insufficient training (Lindahl *et al*., 2015). District-level variation further emphasizes the need for tailored interventions. For instance, Meerut recorded the highest poor practice rate (36.49%), indicating that contextual factors such as local infrastructure, veterinary service availability, and community engagement may significantly influence behaviour. Conversely, districts like Agra and Mathura showed higher moderate practice levels, suggesting relatively better uptake of preventive measures. Understanding these spatial differences can inform targeted, context-specific strategies that address local barriers and leverage existing strengths. Comparatively, similar practice gaps have been documented in other countries with comparable livestock farming systems. For example, a study (found suboptimal waste disposal practices among livestock farmers in Pakistan (Ahmed *et al*. 2020). Such parallels underscore that zoonotic disease prevention challenges transcend geographic boundaries, often rooted in socioeconomic and systemic issues. Our present study highlights significant weaknesses in the translation of knowledge and attitudes into consistent, effective practices among livestock farmers in western Uttar Pradesh. Addressing these gaps requires multifaceted interventions that not only improve awareness but also enhance resource availability, provide culturally appropriate training, strengthen veterinary services, and promote sustainable waste management technologies. Strengthening these areas is crucial to reducing occupational and community exposure to zoonotic pathogens and improving overall public health outcomes in rural agricultural settings.

5.1.4 Determinants of Knowledge, Attitudes, and Practices Among Livestock Farmers

In this study, univariable analysis was initially conducted to assess the influence of age, district of residence, farming type, and years of livestock farming experience on KAP scores, focusing on factors that could independently or jointly affect livestock farmers' knowledge, attitudes, and practices regarding zoonotic diseases. Age emerged as a significant determinant, with farmers aged 54–72 years scoring significantly higher than the youngest group (18–35 years). This association remained significant in the multivariable regression model, where farmers in the 54–72 age group scored significantly higher after adjusting for farming type and district, suggesting that older farmers possess greater awareness and demonstrate better preventive practices due to accumulated practical experience, repeated exposure to livestock-related health challenges, and heightened perception of risk over time. This finding is consistent with a study from Greece, where older ruminant livestock farmers exhibited higher awareness and adherence to preventive measures for zoonotic diseases (Kontogianni *et al*., 2022).

District of residence also strongly influenced KAP scores, with farmers from Bareilly, Bhagpat, Mathura, and Meerut having significantly lower scores, whereas those from Bijnor scored higher. Multivariable regression confirmed that district-level factors independently affected KAP scores even after adjusting for age and farming type, reflecting differences in access to veterinary services, public health education, community engagement, and livestock extension programs. Similar geographic variability has been observed in Rwanda, where smallholder livestock farmers in Bugesera district demonstrated lower KAP levels compared to other districts, highlighting the importance of region-specific interventions to improve knowledge and preventive behaviors (Tadesse *et al*., 2023).

Farming type was another significant predictor; farmers engaged in livestock rearing scored significantly higher than those involved in other agricultural activities in univariable analysis and this effect persisted in the multivariable model ($\beta = 1.463$, $p < 0.05$), emphasizing that direct, regular contact with animals enhances awareness and safe practices. Comparable results were reported in China, where direct contact with livestock was positively associated with improved knowledge and preventive behaviors regarding zoonotic diseases (Li *et al*., 2021). In contrast, socio-demographic factors such as gender, education level, and annual income did not show significant associations with KAP scores, suggesting that practical experience and daily engagement in livestock management outweigh formal education or income in determining KAP. This contrasts with findings from Ethiopia, where higher educational attainment was associated with better KAP regarding zoonotic diseases among government employees (Gebremedhin *et al*., 2020). Years of livestock farming experience did not significantly influence KAP scores in the present study suggesting that experience alone may not suffice to improve knowledge and preventive behaviors without access to veterinary guidance or community-level training programs, whereas research from Nepal indicated that longer farming experience was linked to higher KAP scores (Shrestha *et al*., 2021).

Overall, the multivariable regression model explained approximately 13.3% of the variability in KAP scores, indicating that age, district, and farming type are important determinants, but other unmeasured factors such as participation in community health programs, individual motivation, exposure to veterinary services, and peer-to-peer knowledge sharing likely also influence KAP. These findings emphasize the need for targeted, context-specific interventions that address district-level disparities, utilize experienced livestock farmers as peer educators, and integrate age-specific strategies, alongside strengthening veterinary extension services and structured community education programs to improve zoonotic disease awareness and preventive practices across diverse farming populations.

5.2 KAP on zoonotic diseases amongst sanitation workers

The findings under this section are significant in the broader context of occupational health, as sanitation workers are both frontline protectors of community hygiene and potential source for disease transmission if adequate preventive measures are not observed. Their occupational tasks expose them to a range of zoonotic pathogens, including bacteria, viruses, fungi, and parasites, many of which are under-recognized in public health programs. This study assessed the knowledge, attitudes, and practices (KAP) related to zoonotic diseases among 492 sanitation workers from seven districts of western Uttar Pradesh including Agra, Bareilly, Mathura, Meerut, Baghpat, Firozabad, and Bijnor belonging to Scheduled Caste communities, these workers are engaged in high-risk activities such as street sweeping, drain cleaning, waste collection, and carcass disposal. Such tasks routinely bring them into close contact to infections that may not be widely known but are highly relevant to their occupational setting.

5.2.1 Knowledge of Zoonotic Diseases

The present study revealed that just over half of the sanitation workers surveyed (54.07%) had heard the term *zoonosis*, while fewer than half (48.78%) were aware of the concept of occupational health hazards. This relatively low baseline awareness is a serious concern given the nature of sanitation work, which involves regular contact with potentially contaminated environments and materials. Without a clear understanding of the meaning of zoonoses or the health hazards associated with their work, sanitation workers may fail to recognize risky situations, underestimate their personal vulnerability, and neglect preventive measures that could protect their health. A notable pattern emerged in the comparison of awareness levels for different zoonotic diseases. Recognition was almost universal for COVID-19 (100%) and rabies (95.33%), which can be attributed to widespread public health campaigns, extensive media coverage, and in some cases, direct personal or community experience with these diseases. About 93.7% of the participants in Haryana had good knowledge about

COVID-19 (Kumar *et al*., 2022). COVID-19 awareness was amplified by the global pandemic, widespread government campaigns, and community-level interventions. Similarly, rabies is well-known due to its fatal nature, the visibility of stray dog populations, and long-standing vaccination drives. However, awareness levels dropped considerably for other zoonoses. Brucellosis (59.55%), and typhoid (52.64%) were moderately recognized, reflecting some general knowledge but suggesting gaps in understanding occupationally relevant pathogens beyond the most common or high-profile diseases. Even lower awareness was reported for avian influenza (49.80%), plague (42.07%), and Japanese encephalitis (44.92%), which have significant public health importance but may be perceived as less immediate threats due to their sporadic outbreaks or lower perceived prevalence in these communities.

The most alarming finding was the near-total lack of awareness about certain neglected zoonoses that are directly relevant to the sanitation work environment. Only 0.20% of respondents had heard of leptospirosis, and none recognized neurocysticercosis, cryptosporidiosis, or amoebiasis. This is especially concerning because sanitation workers are routinely exposed to wet, contaminated environments, rodent-infested areas, and faecal matter all of which are conducive to the transmission of these diseases. The absence of awareness in these areas suggests that current occupational health education programs, where they exist, may be too generic and fail to address the specific disease risks inherent in sanitation work. Understanding of zoonotic disease transmission pathways showed similar inconsistencies. While 53.46% of respondents were aware that zoonotic diseases could be transmitted through direct or indirect contact with animals and their waste, awareness of specific examples was uneven. Salmonellosis was moderately recognized (51.42%), but hepatitis E, an important pathogen linked to contaminated water and poor sanitation was acknowledged by only 17.48% of respondents. This gap is significant given that sanitation workers handle wastewater and sewage, where hepatitis E virus can be present.

Knowledge of vector-borne disease transmission was comparatively stronger, with 78.46% aware of mosquitoes as disease vectors. Within this group, malaria (89.02%) and dengue (85.59%) were the most widely recognized, reflecting their high community prevalence and the success of public health awareness programs targeting these diseases. Chikungunya

(50.20%) and Japanese encephalitis(44.92%),were moderately recognized, indicating that although these diseases are mosquito-borne and present in India, they may not be emphasized equally in awareness campaigns, possibly due to lower incidence rates in the specific districts studied. In contrast, rodent-borne diseases were less recognized overall, with only 46.75% acknowledging rodents as a source of zoonotic infection. Among these, plague (43.70%) was the most frequently identified, possibly due to historical references or school-level education. However, awareness of scrub typhus (11.41%) and leptospirosis (0.20%) was extremely low, despite their well-established association with rodent infestations and contaminated environments both of which are common in sanitation work. Awareness of zoonotic fungal diseases was moderate (68.29%), with ringworm (56.71%) being the most recognized. This is likely because ringworm presents with visible, easily identifiable symptoms and may be familiar from personal or community experience. However, none of the respondents recognized aspergillosis, candidiasis, or cryptococcosis, indicating that fungal infections without obvious skin manifestations remain a blind spot in worker awareness.

Waste management knowledge emerged as a relative strength among respondents. All sanitation workers (100%) correctly identified different waste categories biomedical, organic, agricultural, dry, and wet waste indicating exposure to at least some form of basic occupational training or awareness material. A large majority (82.11%) were familiar with color-coded disposal systems, and 76.46% could name at least one waste management method such as dumping, burial, or composting.

Scoring analysis categorized 16.06% of sanitation workers as having good knowledge, 65.65% as moderate, and 18.29% as poor. District-level comparisons revealed notable differences with Firozabad having the highest proportion of good knowledge (30%), followed by Agra (28.41%) and Mathura (27.94%). In contrast, Baghpat recorded the lowest proportion (20%), suggesting possible variations in training initiatives, municipal engagement, and access to health education resources across districts. Overall, the knowledge assessment paints a clear picture that sanitation workers demonstrate reasonable awareness of certain high-profile diseases and general waste management concepts, their understanding of many occupationally relevant zoonoses remains severely limited. This knowledge gap particularly in relation to neglected diseases and transmission routes is a critical barrier to effective disease prevention and must be addressed through targeted, occupation-specific health education programs.

5.2.2 Attitudes Toward Occupational Safety and Disease Prevention

The present study revealed that sanitation workers demonstrated a moderate but incomplete commitment to occupational safety and disease prevention. While a little over half of respondents (52.44%) expressed willingness to adopt new technologies in sanitation work, and 54.47% recognized that proper sanitation could help reduce disease risk, these figures also indicate that a substantial proportion of workers either lacked interest in modernizing work processes or failed to fully connect sanitation practices with health outcomes. Willingness to report workplace hazards to supervisors was observed in 56.10% of respondents, suggesting a degree of proactive engagement with occupational safety, y*et al*so highlighting that nearly half remain hesitant to raise safety concerns possibly due to fear of reprisal, lack of trust in management, or a belief that reporting would not result in meaningful changes. Similarly, 54.88% of sanitation workers considered their occupation to be very important for public health, reflecting some awareness of the broader societal value of their work. However, this still leaves a significant number who do not strongly associate their role with community health outcomes, which can reduce motivation to follow stringent safety measures. Concern about contracting zoonotic diseases was expressed by only 50.61% of respondents, and just 48.58% emphasized taking personal precautions such as consistent PPE use and adherence to hygiene protocols. Preventive measures like wearing masks for respiratory protection were acknowledged by 51.83% of workers, indicating that even when certain risks are recognized, adoption of relevant protective strategies is far from universal.

The overall pattern reveals a disconnect between knowledge, recognition of risks, and consistent application of preventive actions as one of the key challenges in occupational health promotion. These findings are consistent with broader trends in sanitation and occupational safety research. A study conducted among solid waste handlers in Nigeria revealed that 75.5% were aware of the hazardous nature of their work, and 76.1% recognized the importance of PPE; yet only 66.7% reported consistent PPE use, and less than half had received pre-employment training (Stanley *et al.*, 2023).

The scoring analysis of attitudes toward occupational safety and disease prevention revealed notable weaknesses among sanitation workers. Only 4.67% demonstrated a good attitude, reflecting consistent adherence to safe work practices, a strong sense of responsibility for their own health, and recognition of their role in protecting public health. The majority 50.41% fell into the moderate category, indicating partial acceptance of safety measures and preventive behaviours but with inconsistent application in daily work. Alarmingly, 44.92% were classified as having a poor attitude, suggesting low concern for occupational hazards, minimal use of personal protective measures, and limited participation in health monitoring or training activities. Such attitudinal patterns highlight the challenge of translating awareness into habitual safety-oriented behaviour. District-wise variations further underline the complexity of the issue. Firozabad performed best, with 8% of workers exhibiting a good attitude, possibly reflecting stronger municipal support, better training opportunities, or more effective supervision. Agra (6.82%) and Mathura (5.88%) also performed relatively better, though their figures still indicate that over 90% of workers require improvement. At the other extreme, Baghpat had no workers in the good attitude category and the highest proportion of poor attitudes (56%), followed closely by Meerut (48.61%). These differences may stem from disparities in local governance, access to safety resources, and the presence (or absence) of targeted occupational health interventions. The findings emphasize the urgent need for district-specific strategies, including behaviour change communication, consistent PPE provision, supervisory reinforcement, and integration of safety training into routine operations, to cultivate a workplace culture that prioritizes occupational health and personal responsibility.

5.2.3 Occupational Practices

The assessment of occupational practices among sanitation workers revealed considerable gaps in compliance with recommended safety and hygiene protocols. Only 47.36% of respondents reported consistently wearing personal protective equipment (PPE) while cleaning high-risk areas, despite acknowledging its protective benefits. This indicates that awareness of PPE importance does not necessarily translate into habitual use, likely due to factors such as discomfort during work, limited availability, lack of enforcement, or underestimation of occupational risks. Hand hygiene compliance was comparatively better, with 71.75% of workers using phenolic soap after cleaning tasks. However, the fact that 28.25% did not follow this basic practice is troubling, as handwashing is one of the most effective ways to interrupt pathogen transmission. Bathing immediately after work was reported by 55.69%, suggesting that nearly half the workforce could be carrying contaminants from their workplace into their homes. Furthermore, 46.75% admitted to walking barefoot at work, exposing themselves to sharp objects, chemical residues, and pathogenic agents, behaviours that could result in injuries or infections. Other hygiene-related behaviours also reflected inconsistencies. Only 50.20% reported using disinfectants during cleaning, suggesting that many workers relied solely on water or less effective cleaning agents. Waste segregation was followed by 57.93% of workers, despite universal awareness of waste categories, indicating a clear gap between theoretical knowledge and practical implementation. Cleaning of mops one of the most frequently used cleaning tools was done daily by 79.90% of respondents, which is commendable, but the remaining 20.1% either cleaned mops weekly (15.59%) or monthly (4.51%), falling far short of hygiene standards necessary for controlling microbial growth. Waste disposal methods varied considerably with 39.08% used waste trucks, 31.85% relied on incineration, 10.96% dumped waste in open dunghills, and 18.11% had no structured disposal method, reflecting significant environmental and public health hazards associated with improper waste management.

Scoring analysis showed that only 9.15% of sanitation workers demonstrated good practices, consistently following safety protocols and hygiene measures. The majority (69.72%) exhibited moderate practices, following some guidelines but inconsistently or partially, while 21.14% fell into the poor practice category, showing minimal adherence to safety and hygiene measures. District-wise data revealed that Mathura (27.94%) and Firozabad (26.00%) had the highest proportion of good practices, suggesting stronger local management or training initiatives, whereas Baghpat had the lowest at just 0.89%. Bijnor recorded the highest proportion of poor practices (35.19%), highlighting urgent needs for intervention in these areas. These results are consistent with findings from other KAP studies on sanitation workers, which repeatedly highlight a persistent gap between occupational health awareness and the actual adoption of safe practices. In Tamil Nadu, for example, 65% of sanitation workers were aware of the importance of PPE, but only 41.7% used it consistently, and hand hygiene adherence remained inconsistent due to limited access to soap, inadequate washing facilities, and high work pressure (Ramasamy *et al*., 2021). In Haryana, only 69.7% sanitation workers reported that they washed hands frequently using water and soap (Kumar *et al* 2022). Similar patterns emerged in Nigeria, where 66.7% of waste handlers admitted to inconsistent PPE use despite acknowledging its importance, and only 38% practiced proper waste segregation an essential step in preventing cross-contamination and environmental contamination (Oluwatosi *et al*., 2022). In Bangladesh, less than half of waste collectors reported bathing after work, with many citing the absence of bathing facilities, time constraints, or a belief that bathing was unnecessary unless visibly soiled (Haque *et al*., 2020). These examples from different regions reinforce the idea that knowledge alone is insufficient; structural and systemic constraints such as resource limitations, poor infrastructure, and weak enforcement of safety protocols heavily influence actual behaviour.

5.2.4 Determinants of Knowledge, Attitudes, and Practices (KAP) Among Sanitation Workers

Univariable and multivariable regression analyses conducted in this study identified the primary determinants of knowledge, attitudes, and practices (KAP) regarding occupational hygiene and zoonotic disease prevention among sanitation workers. In the univariable analysis, district of residence and workplace type emerged as significant predictors, while age, gender, education level, annual income, vaccination status, occupational exposures (such as contact with human or animal faecal matter and body fluids), and history of workplace injuries did not demonstrate statistically significant associations with KAP scores. Specifically, sanitation workers from Firozabad and Mathura had significantly higher KAP scores compared to the reference district, whereas workers from Bhagpat showed a trend toward lower scores. This indicates that regional differences, potentially reflecting variations in access to formal training programs, availability of hygiene resources, and institutional support, play a critical role in shaping workers' knowledge and preventive behaviours. Workplace type also influenced KAP outcomes with those working in public spaces had significantly lower scores compared to workers in human hospitals, veterinary dispensaries and animal farms, suggesting that the work environment and the level of exposure to structured training or safety protocols can substantially affect hygiene practices. Interestingly, direct occupational exposures, such as contact with animal or human body fluids, and history of workplace injuries, did not significantly correlate with KAP scores, highlighting that experience or exposure alone does not necessarily translate into higher awareness or safer practices. These results align with findings from another study of India and other low- and middle-income countries, where sanitation workers' knowledge and preventive practices were strongly influenced by institutional support, workplace conditions, and access to training, rather than socio-demographic characteristics or exposure history (Sarkar *et al*., 2019; Kumari *et al*., 2021).

Multivariable regression analysis further confirmed that district of residence was independent predictor of KAP scores, with adjusted $R^2 = 0.0607$, indicating that this factor explained approximately 6.1% of the variation in KAP scores. Taken together, these findings underscore the need for targeted, context-specific interventions, including district-focused educational initiatives, workplace-based training programs, and improved access to hygiene resources, to enhance occupational safety and prevent zoonotic disease transmission among sanitation workers. Strengthening institutional support, monitoring adherence to hygiene protocols, and implementing continuous refresher training could further improve knowledge, attitudes, and consistent practice of preventive measures across this vulnerable occupational group.

5.3 Seropositivity of brucellosis and coxiellosis in small ruminant population

The present study assessed the seropositivity of two major zoonotic pathogens *Brucella* spp. and *Coxiella burnetii* in small ruminants (goats and sheep) populations managed by Scheduled Caste livestock farmers across three districts in western Uttar Pradesh which is Agra, Bareilly, and Baghpat. The overall seropositivity was found to be 43.01% for brucellosis and 61.83% for coxiellosis in the sampled population, indicating widespread exposure to these pathogens in the region. Goats exhibited substantially higher seropositivity than sheep for both infections. Among districts, Bareilly showed alarmingly high seropositivity rates above 90% for both pathogens in goats suggesting a hyperendemic situation. Agra and Baghpat showed moderate to high seropositivity, but lower than Bareilly. Sheep generally showing lower seropositivity, still had significant rates for brucellosis (40%) and a lower but relevant rate for coxiellosis (14.29%). Among districts, Bareilly emerged as a hotspot with an alarmingly high goat seropositivity of 93.62%, nearly three times higher than Agra (31.03%) and more than tenfold higher than Baghpat (8.70%).While sheep showed a brucellosis seropositivity (40%), with Agra reporting a higher prevalence (50%) compared to Baghpat (29.41%). Though the sample size for sheep was smaller than for goats, the relatively high seropositivity suggests that brucellosis is a significant issue in ovine populations as well. The elevated prevalence in Agra sheep might indicate sustained transmission within smaller flocks or different management practices compared to goats. Interestingly, both infections showed overlapping geographic hotspots, with Bareilly exhibiting the highest seropositivity for both pathogens. This overlap may indicate shared risk factors such as similar husbandry practices, and environmental conditions favouring pathogen survival.

The high seropositivity observed, particularly in goats, suggests these animals are likely major reservoirs maintaining and transmitting these zoonoses within small-scale farming systems. The elevated *Brucella* antibody presence reflects chronic and possibly uncontrolled infection cycles, given the persistent nature of brucellosis in livestock and the lack of widespread vaccination or control programs in these regions. The seropositivity for Coxiella, notably higher than for *Brucella*, is indicative of environmental contamination and intense circulation of the pathogen, which aligns with the recognized difficulty in controlling Q fever due to its ability to persist in the environment and infect a wide range of hosts. District-wise differences likely arise from varying husbandry practices, animal density, awareness levels, and access to veterinary care. For instance, Bareilly's extremely high rates may be a consequence of intensive small ruminant farming with minimal biosecurity and possibly favorable climatic conditions for pathogen persistence. These factors combined elevate the risk for farmers, particularly those in Scheduled Caste communities who may lack resources for adequate preventive measures. The observed difference in seropositivity between goats and sheep aligns with established epidemiological trends, as goats are known to shed *Coxiella burnetii* and *Brucella* spp. more extensively, thereby increasing environmental contamination and enhancing the risk of pathogen transmission.

Several studies across India demonstrate varying seroprevalence of brucellosis in sheep and goats, reflecting regional differences in disease burden. For example, in Karnataka, seroprevalence was reported as 30.9% in sheep and 22% in goats, while Andhra Pradesh showed a similar pattern with 30.9% in sheep compared to 22% in goats. In a nationwide study, Shome *et al*. (2021) reported a higher brucellosis seroprevalence in sheep (11.55%) than goats (5.37%). Additionally, they noted that more than 5% seroprevalence was recorded in both sheep and goats across multiple states indicating the endemic nature of the disease countrywide. Similarly, Sundar (2020) found 19.25% brucellosis in sheep versus 5.88% in goats in Tamil Nadu. Contrasting these findings, our study observed an overall seropositivity of 43.01% among 186 small ruminants tested, with goats showing a slightly higher positivity (43.71%) compared to sheep (40%). These variations underscore the complex and regionally variable epidemiology of brucellosis in small ruminants across India, influenced by husbandry practices, environmental factors, and diagnostic approaches.

The seroprevalence of *Coxiella burnetii* in Odisha was considerably higher for both goats and sheep, 22% and 11.5%, respectively compared to Assam, where prevalence rates were 9.8% in goats and 1.6% in sheep (Leahy *et al*., 2020). Notably, the seroprevalence observed in our study significantly surpasses many previous regional reports, which typically documented rates below 50%. This discrepancy could indicate either underreporting in earlier studies or a recent expansion of *Coxiella burnetii* circulation in western Uttar Pradesh. The findings of present study reveal a pronounced species-specific difference in seropositivity with goats showed high positivity of 72.84%, while sheep had a lower rate of 14.29%. These results highlight global evidence that goats are the primary domestic reservoirs and key amplifiers of Q fever, especially within rural livestock systems. Studies from other developing countries highlight the neglected status of Q fever and the lack of systematic surveillance in smallholder systems (Angelakis and Raoult, 2010).

The present study highlights the substantial and alarming positivity of brucellosis and coxiellosis among small ruminants raised by Scheduled Caste farmers in western Uttar Pradesh, with goats identified as key reservoirs. These findings underscore significant public health and veterinary challenges, emphasizing the urgent need for multisectoral, targeted interventions.

Strengthening disease surveillance, enhancing farmer awareness, and improving veterinary services are critical steps to mitigate the health risks and economic impacts of these zoonoses on vulnerable farming communities.

Summary and Conclusions

6 SUMMARY AND CONCLUSIONS

The present study comprehensively assessed the Knowledge, Attitude, and Practices (KAP) regarding zoonotic diseases among two occupationally vulnerable groups, livestock farmers and sanitation workers of western Uttar Pradesh alongside serological detection of *Brucella spp.* and *Coxiella burnetii* in small ruminants. The findings reveal both common and group-specific gaps, with important implications for targeted interventions. Among livestock farmers, awareness of certain high-profile diseases was almost universal, with 97.26% recognizing COVID-19 and 94.01% familiar with rabies. However, awareness sharply declined for other relevant zoonoses, with only 8% having heard of the term "zoonosis," 21.75% aware of brucellosis, and a mere 0.86% familiar with leptospirosis which is critical but under-recognized occupational hazard in livestock handling. Awareness of emerging or less common vector-borne diseases, including Zika virus and tick-borne infections like Crimean-Congo hemorrhagic fever was virtually absent with only 2.91% of respondents identified ticks as vectors. Further, only 25% of respondents recognized raw milk consumption as a risk factor for zoonotic diseases transmission. This pattern indicates that most knowledge is disease-specific and shaped largely by recent outbreaks and media coverage rather than by a broader conceptual understanding of zoonotic transmission. In contrast, sanitation workers demonstrated comparatively greater familiarity with the term "zoonosis" (54%), yet their knowledge of specific occupational diseases such as leptospirosis (0.20%), cryptosporidiosis (0%), and neurocysticercosis (0%) was minimal, despite the nature of their work bringing frequent exposure to contaminated waste, animal carcasses, and rodent-infested environments. The knowledge gaps in both groups, particularly concerning less-publicized zoonoses, represent a significant vulnerability as they limit the likelihood that workers will consistently recognize, prevent, and respond to zoonotic threats.

Attitudinal patterns revealed significant barriers to effective zoonotic disease prevention. Among livestock farmers, a notable concern was vaccination hesitancy, with many expressing doubts about vaccine safety, questioning the necessity for apparently healthy animals, or delaying vaccination due to cost, lack of access, or uncertainty about its benefits. Notably, the study uncovered a pronounced reluctance toward the vaccination of livestock, with only 46.75% expressing willingness to immunize their animals against zoonotic pathogens. Such reluctance not only reduces herd immunity against key livestock diseases such as brucellosis but also sustains the potential for zoonotic transmission to humans. Among sanitation workers, many respondents displayed a stoical acceptance of disease as an unavoidable occupational hazard. This mindset was often reinforced by economic constraints, which led them to prioritize earning a livelihood over adopting preventive measures, even when the risks were understood. Further, only 54.88% of sanitation workers considered their occupation to be important for public health, reflecting a significant number who do not associate their role with community health outcomes, which can reduce motivation to follow stringent safety measures. The aforementioned fact was reinforced while analysing the importance of mask wearing with only 51.83% of workers recognised the importance of mask in the health protection. These attitudes, shaped by socio-economic and cultural realities, present a major challenge to the success of awareness campaigns unless paired with systemic changes that make protective practices both accessible and practical.

The assessment of preventive practices showed that while some protective behaviours were in place, significant gaps persisted in both occupational groups. Livestock farmers widely adopted certain biosecurity measures, such as daily cleaning of animal enclosures, yet critical preventive behaviours were lacking. The use of personal protective equipment during high-risk tasks including assisting in animal births or handling aborted materials was infrequent with only 27.40% reported using protective gear. Veterinary services were typically sought only in cases of severe illness, missing opportunities for preventive care. Practices such as consuming raw milk (31.6%) and relying on traditional remedies or quacks (17%) in case of dog bites remained common, perpetuating exposure risks. For sanitation workers, PPE availability was inconsistent, with only 47.36% workers reported consistently wearing a PPE kit while cleaning contaminated or high risk areas and even when provided, its use was sporadic due to discomfort, inadequate supply, or lack of enforcement. Many of the workers (46.75%) admitted to walking barefoot at work place exposing them to several infectious agents. Waste segregation was often incomplete being followed by only 57.93% of workers and post-work hygiene measures were insufficient. Risk-prone practices were common, with 36.33% of respondents manually handling waste without gloves and 41.67% practicing open dumping, thereby sustaining high levels of exposure to zoonotic pathogens.

Descriptive statistics and a standardized scoring system were employed to quantify and summarize KAP levels .Among livestock farmers, categorization of KAP scores revealed that 7.19% had good, 54.97% moderate, and 37.84% poor knowledge levels. For attitudes, 7.88% of respondents demonstrated good scores, 55.31% moderate, and 36.81% poor. In terms of practices, only 0.17% of the farmers were categorized as good, while the majority (77.40%) fell into the moderate category and 22.43% exhibited poor practices. The mean KAP scores among livestock farmers were 9.24 for knowledge, 6.09 for attitudes, and 10.76 for practices, indicating an overall moderate level with notable deficiencies in the adoption of safe preventive practices. Multivariable regression analysis further revealed that age group (54–72 years), district of residence, and farming type were significantly associated with KAP scores, whereas gender, education, income, and farming experience did not show significant associations. Regression analysis also highlighted the importance of geographic variation farmers from Bareilly, Baghpat, Mathura, and Meerut recorded significantly lower scores, while those from Firozabad and Bijnor exhibited significantly higher KAP scores. These district-level differences may reflect variations in socio-economic conditions, access to veterinary services, and coverage of health education programs. The final model explained 13.3% of the variability in KAP among farmers. Among sanitation workers, categorization of scores showed 16.06%, 65.65% and 18.29% workers in good, moderate and poor knowledge, respectively. For attitudes, 4.67% of respondents demonstrated good scores, 50.41% moderate, and 44.92% poor. Regarding practices, 9.15% of sanitation workers were classified as good, 69.72% as moderate, and 21.14% as poor. The mean KAP scores among sanitation workers were in moderate category with 13.48 for knowledge, 4.73 for attitude and 5.60 for practices. Final multivariable regression analysis identified district of residence as significant predictor of KAP, while vaccination status, exposure type, and workplace injuries were not significantly associated. Similar to farmers, sanitation workers from Bareilly, Baghpat, Mathura, and Meerut demonstrated poorer KAP outcomes compared to other districts, underscoring the role of geography in shaping awareness and preventive behaviors. The final regression model explained 6.1% of the variability in KAP among sanitation workers. Overall, the study highlights marked occupational and regional disparities in zoonotic disease awareness and preventive practices. Livestock farmers demonstrated relatively better attitude and practice scores, whereas sanitation workers displayed higher knowledge scores. Despite these differences, both groups exhibited low proportions of good KAP, indicating substantial gaps in awareness, risk perception, and the adoption of safe behaviors. Regression analyses confirmed that socio-demographic particularly district of residence in both the occupation revealed significantly shaped KAP outcomes. These findings emphasize the urgent need for geographically focused interventions, including district-level public health campaigns for farmers and education-centered training programs for sanitation workers, to strengthen KAP and reduce the risk of zoonotic disease transmission in both occupational groups.

Serological evidence supported the epidemiological significance of good knowledge and practices gaps. Testing of small ruminants in the study area detected antibodies to *Brucella* spp. and *Coxiella burnetii*, confirming the presence of these pathogens in the local livestock population. The overall seropositivity of Brucellosis was 43.01%, with 43.71% in goats and 40% in sheep while overall seropositivity of coxiellosis was 61.83%, with 72.84% in goats and 14.29% in sheep in small ruminant population of Bareilly, Baghpat and Agra. Goats exhibited higher seropositivity than sheep, and importantly, several seropositive animals appeared clinically healthy, indicating that infected animals can remain silent carriers and a continuous source of infection. For livestock farmers, direct contact during routine animal husbandry and reproductive management poses an obvious risk, while for sanitation workers, exposure may occur indirectly through contaminated waste, soil, or water in the environment.

The findings demonstrate that both livestock farmers and sanitation workers face significant but distinct vulnerabilities to zoonotic diseases. For livestock farmers, the coexistence of low awareness on many zoonotic diseases and certain orthodox practices creates a persistent transmission pathway. Addressing these issues requires interventions that combine behavioural change strategies with structural improvements, such as improved access to veterinary preventive services, and the promotion of good animal husbandry practices. For sanitation workers, the combination of high exposure risk, limited disease-specific knowledge, and poor enforcement of safety protocols demands interventions that improve PPE availability and use, enhance hygiene infrastructure, and strengthen supervisory oversight. The geographic clustering of lower KAP scores in Bareilly, Baghpat, Mathura, and Meerut indicates that district-specific interventions are essential for both groups. Further, bridging the conceptual gap on zoonoses through awareness campaigns and addressing location-specific challenges *via* targeted training programs are likely to achieve sustained improvements in protective behaviours. Ultimately, a coordinated One Health approach integrating veterinary services, public health systems, and occupational safety frameworks is necessary to reduce zoonotic disease transmission risks and improve health outcomes for both livestock farmers and sanitation workers.

Mini Abstract

7 MINI ABSTRACT

Zoonotic diseases pose major risks to occupational groups with frequent contact with animals or waste, such as livestock farmers and sanitation workers. This study assessed the knowledge, attitudes, and practices (KAP) regarding zoonotic diseases among these two groups in western Uttar Pradesh, along with serological detection of *Brucella spp.* and *Coxiella burnetii* in small ruminants. Structured questionnaires assessed KAP, and univariable and multivariable linear regression analyses were applied to identify socio-demographic determinants. Concurrently, blood samples from goats and sheep were tested for antibodies against *Brucella* spp. and *C. burnetii* using standard serological assays. Descriptive statistics and a standardized scoring system were employed to quantify and summarize KAP levels. The survey included 589 Scheduled Caste livestock farmers and 492 sanitation workers from seven districts of western Uttar Pradesh. Awareness of zoonotic diseases among livestock farmers was limited with only 8.05% had heard the term zoonosis, and 32.36% recognized animal to human transmission. Disease-specific knowledge was also poor, with awareness of brucellosis at 21.75%, while none had heard of coxiellosis. Practices such as consuming raw milk (31.6%) and relying on traditional remedies or quacks (17%) in case of dog bites remained common, perpetuating exposure risks. Scores were categorized into three levels good, moderate, and poor for each section with mean of all sections (Knowledge, Attitude and Practices) were recorded in moderate category amongst farmers. Multivariable regression model indicated that age (54–72 years), district of residence, and farming type significantly influenced KAP scores, whereas gender, education, income, and farming experience were not associated. Among the sanitation workers more than half (54.07%) had heard of the term zoonosis, yet their knowledge of specific occupational diseases such as leptospirosis (0.20%) cryptosporidiosis (0%), and neurocysticercosis (0%) was negligible. Risk-prone practices were common, with 36.33% of respondents manually handling waste without gloves, 41.67% practicing open dumping, and 46.75% of workers admitted to walking barefoot at work place thereby sustaining high levels of exposure to zoonotic pathogens. The mean of all sections including knowledge, attitude and practices were recorded under moderate category amongst sanitation workers. Multivariable regression model identified district of residence as significant predictor of KAP, for sanitation workers also. Serological screening of 186 small ruminant sera revealed high exposure to zoonotic pathogens. Overall seropositivity of *Brucella* spp. was 43.01%, while *Coxiella burnetii* was detected in 61.83% of samples. The study highlights important occupational and regional disparities in zoonotic disease awareness and preventive practices. Regression analyses confirmed that socio-demographic factors significantly shape KAP. High seropositivity of *Brucella* and *Coxiella* in small ruminants further underscores the risk. Targeted interventions, including district-level public health campaigns are essential to improve KAP and reduce zoonotic disease transmission.

लघु सारांश

लघु सारांश

जन्तुजन्य रोग वे संक्रामक रोग है जो पशुओं से मनुष्यों में फैलते हैं और वैश्विक स्तर पर जनस्वास्थ्य के लिए गंभीर चुनौती उत्पन्न करते हैं। यह जोखिम विशेष रूप से उन व्यावसायिक समूहों में अधिक होता है जिनका पशुओं अथवा अपशिष्ट पदार्थों से प्रत्यक्ष या अप्रत्यक्ष रूप से नियमित संपर्क होता है। इनमें पशुपालक तथा सफाई कर्मचारी प्रमुख हैं। इस अध्ययन का उद्देश्य पश्चिमी उत्तर प्रदेश में इन दोनों समूहों के बीच जन्तुजन्य रोगों के प्रति ज्ञान, दृष्टिकोण और व्यवहार (के.ए.पी.) का मूल्यांकन करना तथा छोटे जुगाली करने वाले पशुओं में *ब्रुसेला* प्रजाति और *कॉक्सियेला बर्नेटीआई* की सिरोलॉजिकल उपस्थितित का आकलन करना था। अध्ययन में सात चयनित जिलों से 589 अनुसूचित जाति के पशुपालकों और 492 सफाई कर्मचारियों को सम्मिलित किया गया। आंकड़ों के संकलन हेतु संरचित प्रश्नावली का उपयोग किया गया, जिसके माध्यम से प्रतिभागियों के ज्ञान, दृष्टिकोण एवं व्यवहार का आकलन किया गया। डेटा विश्लेषण के लिए वर्णनात्मक सांख्यिकी के साथ–साथ एकविकलपी और बहुविकल्पी प्रतिगमन मॉडल का उपयोग किया गया, ताकि सामाजिक–जनसांख्यिकीय कारकों के प्रभाव का पता लगाया जा सके। इसके अतिरिक्त, बकरियों एवं भेड़ों से एकत्रित रक्त–नमूनों की सीरोलॉजिकल जाँच कर *ब्रुसेला* प्रजाति और *कॉक्सियेला बर्नेटीआई* के विरुद्ध एंटीबॉडी की उपस्थिति की पुष्टि की गई। परिणामों से यह स्पष्ट हुआ कि पशुपालकों में जन्तुजन्य रोगों के प्रति जागरुकता अत्यंत सीमित थी। केवल 8.05% प्रतिभागियों ने ''जूनोसिस'' शब्द सुना था और 32.36% को यह जानकारी थी कि कुछ रोग पशुओं से मनुष्यों में संचरित हो सकते हैं। रोग–विशिष्ट जानकारी भी अत्यंत कम रही। केवल 21.75% को ब्रुसेलोसिस के बारे में जानकारी थी, जबकि किसी भी प्रतिभागी को कॉक्सियेलोसिस के बारे में जानकारी नहीं थी। जोखिमपूर्ण प्रथाएं भी व्यापक रूप से प्रचलित थीं, जैसे कच्चा दूध पीना (31.6%) तथा कुत्ते के काटने पर झाड़–फूंक या नीम–हकीम पर निर्भर रहना (17%)। समग्र रूप से पशुपालकों का औसत के.ए.पी. स्कोर मध्यम स्तर पर पाया गया। प्रतिगमन विश्लेषण से ज्ञात हुआ कि आयु (विशेषकर 54–72 वर्ष), जिला और खेती का प्रकार के.ए.पी. स्कोर पर महत्वपूर्ण प्रभाव डालते हैं, जबकि लिंग, शिक्षा, आय एवं अनुभव का प्रभाव नगण्य था। सफाई कर्मचारियों में 54.07% प्रतिभागियों ने ''जूनोसिस'' शब्द सुना था, परंतु रोग–विशिष्ट जानकारी लगभग नगण्य थी। केवल 0.20% प्रतिभागियों को लेप्टोस्पाइरोसिस की जानकारी थी, जबकि क्रिप्टोस्पोरिडियोसिस और न्यूरोसिस्टिसर्कोसिस के बारे में किसी को जानकारी नहीं थी। व्यवहारिक दृष्टि से जोखिमपूर्ण प्रथाएं अत्यधिक प्रचलित थी, जैसे बिना दस्ताने कचरा संभालना (36.33%), खुले में कचरा डालना (41.67%) तथा नंगे पाँव कार्य करना (46.75%)। परिणामस्वरूप उनका संक्रमण जोखिम अत्यधिक बढ़ा हुआ पाया गया। इनका औसत के.ए.पी. स्कोर भी मध्यम श्रेणी में पाया गया। बहुविकल्पी प्रतिगमन विश्लेषण में जिला निवास को महत्वपूर्ण निर्धारक के रूप में पहचाना गया। अध्ययन के पशु–आधारित भाग में 186 छोटे जुगाली करने वाले पशुओं के रक्त–नमूनों की जाँच की गई, जिसमें *ब्रुसेला* प्रजाति की सिरोपॉजिटिविटी 43.01% तथा *कॉक्सियेला बर्नेटीआई* की 61.83% पाई गई। यह परिणाम पशु आबादी में इन रोगजनकों की उच्च उपस्थिति तथा मानव संक्रमण के गंभीर जोखिम की ओर संकेत करते हैं। निष्कर्षतः अध्ययन से यह सिद्ध हुआ कि व्यावसायिक समूहों में जन्तुजन्य रोगों के प्रति ज्ञान, दृष्टिकोण एवं व्यवहार में गंभीर कमियाँ मौजूद हैं। पशुपालक और सफाई कम्र्चारियों दोनों में जागरूकता और रोकथाम संबंधी प्रथाएँ अपर्याप्त पाई गई, वहीं छोटे जुगाली करने वाले पशुओं में उच्च सिरोपॉजिटिविटी ने यह दर्शाया कि संक्रमण का खतरा वास्तविक और गंभीर है। प्रतिगमन विश्लेषण ने यह भी स्पष्ट किया कि सामाजिक–जनसांख्यिकीय कारक के.ए.पी. स्तर को प्रभावित करते हैं। अतः इस क्षेत्र में जन्तुजन्य रोगों की रोकथाम एवं नियंत्रण हेतु लक्षित हस्तक्षेप आवश्यक है। जिला स्तर पर जनस्वास्थ्य अभियान, सामुदायिक प्रशिक्षण कार्यक्रम तथा व्यवहार परिवर्तन संचार रणनीतियों को अपनाना चाहिए, ताकि इन व्यावसायिक समूहों में जागरूकता और सुरक्षित व्यवहार को बढ़ावा देकर जन्तुजन्य रोगों के बोझ को कम किया जा सके।

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