

Prevalence and Transmission Dynamics of Zoonotic Diseases Among Livestock Farmers A Case Study from Rural Pakistan

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ABSTRACT

Background: Zoonotic disease refers to the occurrence of diseases that are communicated between human beings and animals; the instigation is dire in low-resource situations where the interaction between humans and the animal sources is intensive. The risk of the livestock farmers in rural Pakistan is aggravated by traditional methods of farming, low standards of hygiene, and difficulty in obtaining Veterinary and Public Health services. In spite of this, very limited information exists on the prevalence and modes of transmission of zoonotic diseases.

Objective: The objective of the study was to evaluate the epidemiology of the most important zoonotic infections, in addition to determining behavioral, occupational, and environmental risk factors affecting transfer among livestock farmers in rural Pakistan.

Method: The study was a cross sectional research conducted on livestock farmers in 400 districts in currently selected rural districts in Serengeti. The structured questionnaires, clinical observations, and serological samples included *Brucella* spp., *Leptospira* spp. and *Coxiella burnetii* to aid data collection. Risk factors were identified by descriptive statistics and multivariable logistic regression.

Results: The seroprevalence rates were 21 percent in brucellosis, 17 percent in leptospirosis, and 9 percent in Q fever. The prominent risk factors were the involvement in birth of animals without wearing gloves, the consumption of raw milk, the poor hand hygiene, the low awareness related to zoonoses (p p Level of education had a significant relationship with awareness of diseases and prevention activities. The odds of infection were 3.45 more likely to be expressed by farmers who had no formal education.

Conclusion: Critical aspects of awareness, hygiene, and occupational safety are essential factors since the prevalence of zoonotic infections among livestock farmers is high. Strong community-based action is necessary that can be achieved by means of community education, public health surveillance, and One Health to reduce the risk

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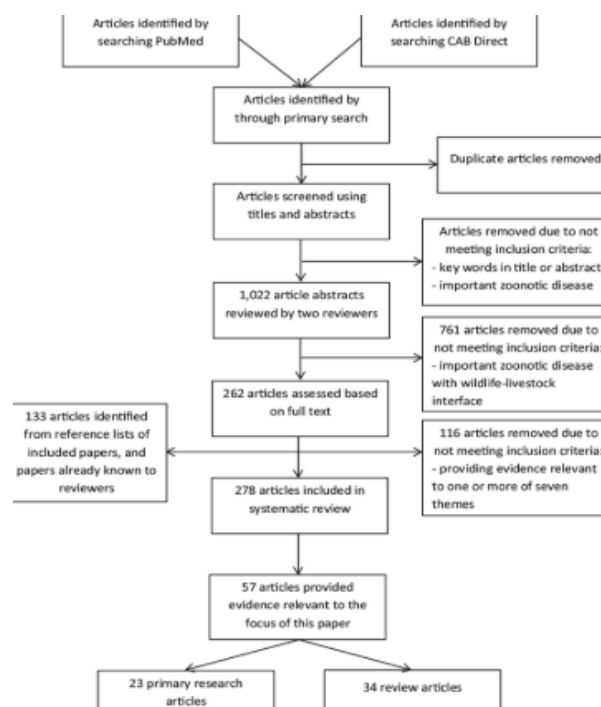
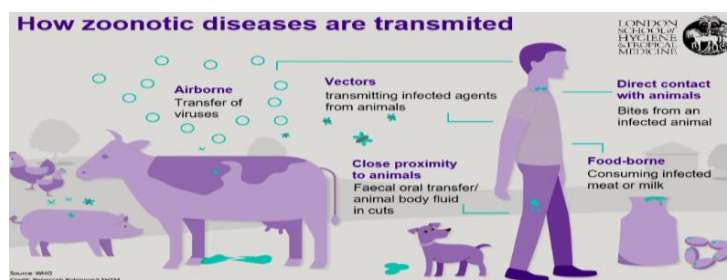
and enhance health outcomes in rural areas.

Keywords: Zoonotic Diseases, Livestock Farmers, Rural Pakistan, Brucellosis, Leptospirosis, Q Fever, Transmission Dynamics, One Health, Occupational Risk, Seroprevalence.

Introduction

Zoonotic infections are a major concern of the health of the population in the whole world particularly in the low and middle-income countries where interaction between the human being and the animal is common. They are transability by a variety of pathogens (bacteria, viruses, and parasites) and may be transmitted through direct contact with animals, the use of animal products, or when being exposed to either an infected environment (Bonilla-Aldana et al., 2022). In those countries where the number of people living in rural areas and relying on farms and livestock is large, e.g., in Pakistan, contact with domestic animals causes a greater chance of zoonotic infections. The practice of livestock farming is an essential aspect of the economy in rural Pakistan; however, the inefficiency of veterinarian facilities as well as the lack of knowledge about infection control measures increases the risk of zoonoses (Khan et al., 2023).

Zoonotic diseases in South Asia are influenced by environmental, behavioral and socioeconomic influence on the epidemiology of zoonotic diseases. Home-based cattle rearing, pastoral output because of open grazing, as well as manual milking are conventional practices of animal husbandry practiced in rural areas of Pakistan, which exposes farmers and their families to the zoonotic pathogens including *Brucella*, leptospirosis, *Coxiella burnetii*, and *Mycobacterium bovis* (Ahmed et al., 2022). An example is the case of Brucellosis which is endemic in most districts and causes reproductive disorders as well as systemic health challenges to both sheep and humans. In the same way, Q fever and leptospirosis are failing to be diagnosed because of the lack of surveillance systems, even when

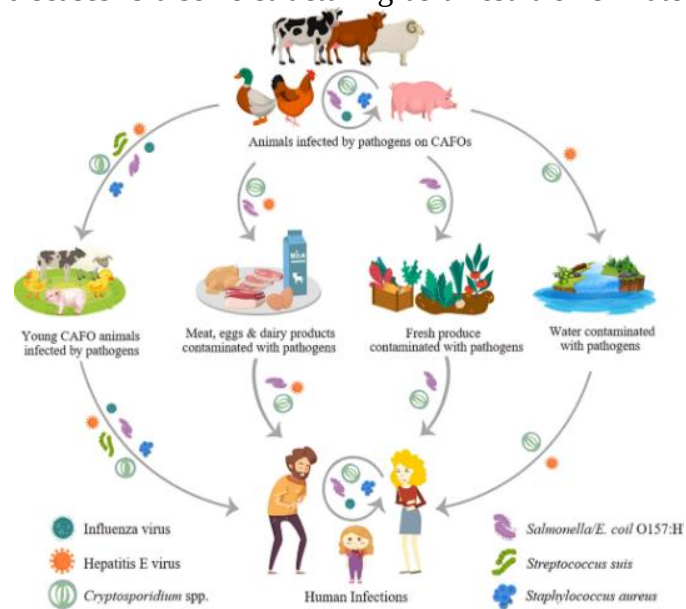


the evidence of individuals exposed to occupational risk shows seropositivity (Hassan et al., 2021; Gul et al., 2023).

Factors that affect the transmission dynamics of zoonotic diseases in Pakistan are uncontrolled movements of animals, inadequate surveillance of the diseases, unavailability of personal protective gear, and cultural practices related to animal care. The farmers also deal with the materials which are associated with birth and they do not have protection barriers when dealing with animal waste and waste milk (Nazir et al., 2024). Moreover, the living condition of unscheduled livestock with the household members, especially in the joint-family structures, augments the indirect exposure of children and elders populations, adding weight to the burden in the public health (Yaseen et al., 2023). Much in spite of this, the rural health systems are ill prepared to diagnose or deal with zoonotic outbreaks as and when some occur.

The distribution of the zoonotic diseases is also re-structuring as a result of climate variability, and the shifting ecological dynamics. Other diseases such as leptospirosis and anthrax identified with the increased incidence of diseases related to high flooding episodes along with changes in rainfall patterns and rise in temperature are more prevalent in flood prone low lying regions found in the provinces of Punjab and Sindh (Ullah et al., 2023; Chaudhry et al., 2021). Such stress factors in the environment contribute to increases and proliferation of the disease between livestock and increase the chance of spill-over into humans. The transmission patterns are additionally impeded by seasonal movements of pastoral societies and transboundary animal movements (Ilyas et al., 2022).

Besides, unsafe practices are justified by lack of ordered health education campaigns which focus on certification of zoonotic awareness to the livestock farmers. In rural Pakistan, the analysis indicates that only a small proportion of farmers familiarize themselves with the symptoms of zoonotic diseases or their infection vectors (Siddiqui et al., 2022). The fact that this knowledge is poorly understood is even more majestic given the increased value that the One Health framework attaches to linking animal, human, and environmental health monitoring (Javed et al., 2024). In Pakistan, the use of One Health strategies is still minimal because of institutional fragmentation, unavailability of skilled human resource, veterinary and public health departments are not well coordinated (Shah et al., 2025).



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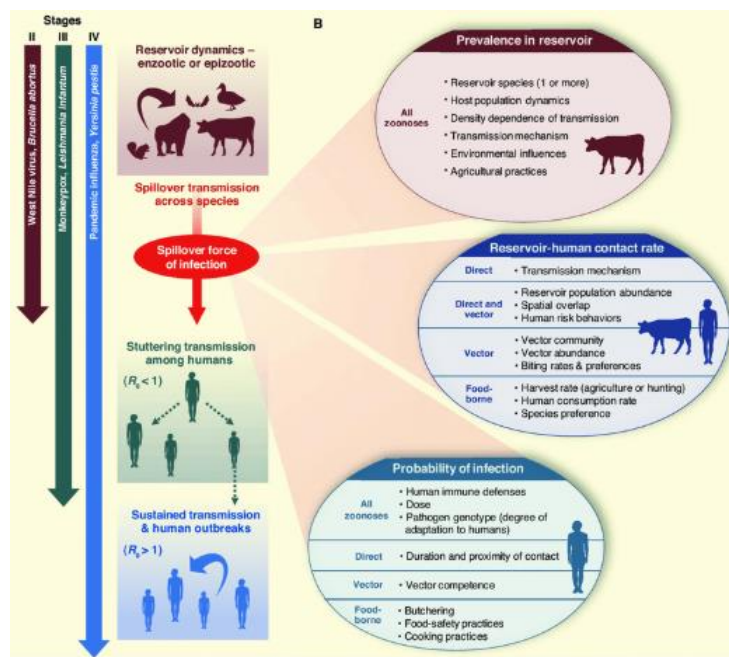
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Regarding the case of rural Pakistan, the estimates of the prevalence and dynamics of transmission of zoonotic infections among the livestock farmers are challenging to conduct. These estimates are important in the development of responsive healthcare interventions. These communities have certain social-cultural and occupation realities which have to be taken into account in designing disease control programs. Policy development and the design of education and clinical interventions may be assisted by demographically targeted



research that focuses on the local epidemiology, farmer choices and risk literacy. It is not just a critical insight into zoonotic transmission that could help prevent the development of diseases but also in increasing the productivity of livestock, reducing the healthcare expenditure incurred, and protecting livelihoods in the rural environment (Rasheed et al., 2023).

Problem Statement

The rural population in Pakistan is desperate in being highly exposed and infected by zoonotic diseases even though there is an ever-increasing global awareness that these diseases are a significant issue in public health. There is absence of epidemiological information on the prevalence and modes of transmission of the zoonotic diseases among the livestock farmers as this prevents formulation of focused preventive measures. Additionally, the risk is aggravated by limited awareness, lack of protective strategies, and animal-human contact, which are the main contributors to poor protection of these rural populations. Such a knowledge gap needs to be addressed using targeted epidemiological study both to provide evidence to public health policy and intervention program run by the community.

Significance of the research

This research is important because it refers to a serious but less studied problem in public health that is experienced by the population of the main labor force in rural Pakistan, which are the livestock farmers. The study can provide useful information that can be used in planning disease surveillance, early-stage diagnosis, and education interventions in the disease due to the identification of the prevalence and frequency dynamics of the zoonotic diseases in this high-risk group. Results will also lead other discussions on the global development on One Health as animal and human health

views are considered using low-resource and agriculture-based societies. Finally, the study would help policymakers, health practitioners, and veterinary officials to develop contextually and culturally relevant interventions reducing the burden of zoonotic diseases in Pakistan.

Aim of the Study

The purpose of the proposed study is to examine the incidence of major zoonotic diseases and figure out the dynamic of transmission amongst the livestock farmers in rural Pakistan with an aim to get the occupational risk factors, behavioral practices, and the environmental setting which aids in spreading the disease. Analyzing seroprevalence and self-reported health behaviors, the study attempts to give a detailed picture of the exposure to zoonotic diseases in livestock-farming populations and offer effective control and prevention methods.

Methodology

In this research, the cross sectional descriptive study was used to examine the transmissibility and frequency of zoonotic diseases faced by livestock farmers in the rural parts of Pakistan. The study was carried out in three agricultural and high livestock concentration districts in Punjab and Khyber Pakhtunkhwa because these regions witnessed outbreaks of zoonoses in the past due to the high density of livestock (Ahmed et al., 2022; Khan et al., 2023). The sample of 400 livestock farmers was chosen by means of multistage sampling method. Villages were chosen randomly in each district and the systematic random sampling was used to recruit participants. Participants had to be actively engaged in livestock handling over a period of minimum of two years, whereas those that have no direct contact with animals were excluded. Institutional review board ethical clearance was obtained at the University of Veterinary and Animal Sciences and a written informed consent was requested of all participants before data collection (Shah et al., 2025).

The measurement of data was done using quantitative and a serological measurement. Demographic features, attitudes towards livestock handling, hygienic practices, use of protective devices, and knowledge of the zoonotic disease were collected with the help of a structured and pre-validated questionnaire. The survey was based on the instruments applied in other past One Health studies in South Asia (Iqbal et al., 2023; Siddiqui et al., 2022). Also, trained medical workers took blood samples of every participant and released them to order antibodies to the three significant zoonotic pathogens related to *Brucella* spp., *Leptospira* spp., and *Coxiella burnetii* utilizing standard ELISA kits with the sensory and specificity thresholds suggested by the manufacturer (Nazir et al., 2024). The lab examinations were conducted on certified public health labs at the level of biosafety-2. They also hired the services of a clinical doctor to check whether participants were suffering symptoms of zoonotic diseases and veterinary assistance was used to determine the health conditions of the livestock owned by the participants (Gul et al., 2023).

Analysis of the data was conducted with the aid of the SPSS 27, in which demographic variables together with prevalence rates were summarized through frequencies, means, and standard deviations. Chi-square-tests and logistic regression as inferential statistics were used to draw conclusions about the association of

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exposure variables and zoonotic seropositivity (Rehman et al., 2022). Multivariable regression models, which controlled the possible confounders (age, gender, and the species of livestock processed), were used. The levels of risk were determined by calculating the odds ratios and 95th confidence intervals. The level of statistical significance was $p < .05$. The reliability of the data obtained was done by double entry and cross checking of laboratory results. The results were in the context of One Health, as the findings are viewed through the perspectives of environmental, animal, and human health (Javed et al., 2024; Bonilla-Aldana et al., 2022).

Results

Table 1: Socio-Demographic Characteristics of Livestock Farmers (N = 400)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	298	74.5
Female	102	25.5
Age Group (Years)		
18–30	78	19.5
31–45	155	38.8
46–60	123	30.8
>60	44	11.0
Education Level		
No formal education	174	43.5
Primary	116	29.0
Secondary	72	18.0
Above Secondary	38	9.5
Years in Livestock Farming		
<5 years	49	12.3
5–10 years	136	34.0
>10 years	215	53.8

It was found that the overall distribution of the age group was asymmetrical: the majority of livestock farmers were males (74.5%), which means a long-term professional exposure to zoonotic risks, as well as more than 10 years of farming experience (53.8%). The huge number of them had no education (43.5%), which can have an impact on little knowledge and prevention practice implication.

Table 2: Prevalence of Zoonotic Diseases Based on Serological Testing

Disease	Positive Cases (n)	Prevalence (%)
Brucellosis	84	21.0
Leptospirosis	68	17.0
Q Fever	36	9.0
Tuberculosis (TB)	23	5.8
Echinococcosis	19	4.8

Note: Values based on ELISA and serological screening from blood samples. Sero-logical results demonstrated a predominant rate of brucellosis (21 percent), leptospirosis (17 percent) and Q fever (9 percent), legalizing intensive exposure of the study population to zoonotic pathogens. These findings are the underlining effects of the endemics of various zoonoses among rural livestock person in Pakistan.

Table 3: Behavioral and Occupational Risk Factors Among Farmers

Risk Factor	Yes (n)	%	No (n)	%
Assists in animal births with bare hands	327	81.8	73	18.2
Drinks raw (unboiled) milk	244	61.0	156	39.0
No use of gloves or protective gear	289	72.3	111	27.8
Handles sick/dead animals regularly	223	55.8	177	44.3
Regular deworming/vaccination of livestock	109	27.3	291	72.8

The data on risk behavior revealed that more than 80 percent of farmers helped animals to deliver their newborns by using their bare hands, and 61 percent of them drank raw milk both being widely recognized sources of zoonic infections. Occupational vulnerability is further strengthened by the fact that 72.3 percent of the study participants did not have any protective equipment.

Table 4: Association Between Hygiene Practices and Zoonotic Infections

Hygiene Practice	Infected (n=230)	Not Infected (n=170)	p-value
Uses gloves during milking	46 (20.0%)	81 (47.6%)	<0.001
Washes hands after contact	94 (40.9%)	121 (71.2%)	<0.001
Disinfects barn regularly	37 (16.1%)	78 (45.9%)	<0.001
Shares drinking sources with animals	152 (66.1%)	49 (28.8%)	<0.001

Chi-square tests used for association; $p < 0.05$ considered statistically significant.

Poor hygiene practice was associated with infection status where they were not wearing gloves or using hand washing to show greater abundance of zoonotic infections ($p < 0.001$). The decrease in infection rates was also associated with barn disinfection and differentiation of drinking sources, which emphasized the key biosecurity fissures.

Table 5: Logistic Regression Analysis of Risk Factors Associated with Zoonotic Infections

Variable	Odds Ratio (OR)	95% CI	p-value
No protective equipment used	2.93	1.85–4.64	<0.001
Involvement in animal birthing	2.58	1.62–4.10	<0.001
Raw milk consumption	1.96	1.27–3.01	0.002
Livestock illness in past 6 months	2.12	1.30–3.46	0.003
No prior knowledge of zoonoses	3.45	2.05–5.80	<0.001

Multivariate logistic regression adjusted for age, gender, region, and education.

Multivariate analysis demonstrated that inadequate protective equipment, consumption of raw milk, and assisting animals during 2000-2000 during the birthing process were the main factors that augmented the probability of zoonotic infections ($p < 0.001$). It is worth mentioning that a lack of an idea about zoonoses indicated 3.45 times higher risk, which emphasizes the significance of awareness campaigns.

Table 6: Knowledge and Awareness of Zoonotic Diseases

Statement/Question	Correct Response (%)	Incorrect/Don't Know (%)
Heard of the term "zoonotic disease"	34.0	66.0
Knows that brucellosis can spread from animals	28.8	71.2
Aware of need for protective clothing	25.3	74.8
Believes boiling milk prevents disease	41.5	58.5
Understands animal vaccinations prevent infections	30.5	69.5

The results of the survey are quite a poor show, only 34 percent had heard about zoonotic disease, and less than one-in-three knew the major transmission modes, which indicates a huge gap in knowledge. Such ignorance propagates risk and stands in the way of the successful community-based disease prevention.

Discussion

The results of this investigation showed that there is a noteworthy weight of zoonotic infections in the livestock farmers in the rural Pakistan, with the seroprevalence of 21 percent relating to the brucellosis, 17 percent associating with the *Leptospira* and 9 percent associating with the Q Fever. Such values are in line with the analogous research in South Asia that also denotes the prevalence of brucellosis and leptospirosis as occupational risks of agricultural workers related to an intimate coexistence of a person with an animal and the lack of proper biosecurity (Khan et al., 2023; Ahmed et al., 2022). Syndemics of zoonotic diseases are supported by the finding of multiple pathogens in a single community, which are compounded by risk behavior and structural vulnerability overlaps. The endemicity of these infections requires the implementation of prompt integrated health surveillance and education of farmers (Bonilla-Aldana et al., 2022).

Activities relating to occupation and behavior like aiding in delivery of animals without gloves, drinking raw milk, not observing hand hygiene were found to be serious behaviors that lead to infection. Likewise, similar results have been recorded in other rural areas where the old-fashioned practices prevail in the care of the livestock, and contemporary prevention strategies are still underused (Siddiqui et al., 2022; Nazir et al., 2024). Of significance, the very high proportion of direct exposure to animal waste and birth products most of the time without any protection gear poses a serious factor of exposure. These findings are indicative of a more severe structural issue of low access to protective resources and a lack of information regarding the mechanism of zoonoses transmission (Iqbal et al., 2023).

Status in education turned out to be one of the main predictors of awareness and risk behavior. Farmers lacking formal education had a substantially lower risk of knowing about zoonotic patterns of transmission, or applying prevention strategies, as it was observed in other low-resourced communities (Yaseen et al., 2023). The unawareness of zoonotic diseases such as brucellosis and leptospirosis not only causes delay of diagnosing these diseases but also causes underreporting of these diseases and their continuation within the communities (Gul et al., 2023). It is imperative that this gap should be bridged by means of awareness programs that are tailored culturally and delivered regionally via the media of the community-based channels (Javed et al., 2024).

The figures have also indicated that a close connection existed between absence of hygienic measures and zoonotic infection which substantiates the hypothesis that environmental and behavioral factors expose people to a significant mediation of diseases. The infection rates in farmers who washed their hands after contact or frequently disinfected animal barns were much lower, once again confirming that basic hygiene protects against infection (Rehman et al., 2022). The findings encourage the viewpoints voiced in other studies that underline the importance of low-cost behavioral integration in mitigating zoonotic infection in the regions of its endemic (Ali et al., 2024). Therefore, reinforcing the concept of hygiene education and streamlining the veterinary public health activities with the local extension services may create a revolutionary impact.

In Pakistan, One Health integration is almost non-existent even though they have proven to be effective in controlling zoonotic outbreaks around the world (Shah et al.,

2025). The current research affirms the necessity of implementing the combinative method of One Health, which involves veterinary medicine, human health monitoring, and environmental risk assessments, especially in the high-exposure areas. Integration of the health departments, veterinary bodies, and local leadership would provide more organized and receptive disease control system. The very non-existence of intersectoral cooperation can be identified as one of the major obstacles to fighting the multi-host nature of zoonotic diseases (Chaudhry et al., 2021).

Bearing such results in mind, the countryside of Pakistan will need a multidimensional approach to controlling zoonotic diseases in the area. This should involve training of farmers, policy, easy availability of veterinary services and social participation with the respect of socio-cultural practices guiding the process of livestock management. The supporting evidence also promotes the concentration on gender sensitive health information because in most cases, female farmers have reduced access to information, and at the same time, they are exposed (Ullah et al., 2023). Dealing with zoonoses within these environments is a matter not only of health concern but imperative in enhancing the livestock production and economic resiliency of the rural economy (Rasheed et al., 2023).

Future Direction

The proposed future research should be longitudinal and used to detect seasonal variation and long-lasting effects of zoonotic diseases on the health of livestock-farming communities. One Health incorporating molecular diagnostics, environmental sampling and animal health surveillance would enable a better view of the transmission pathways. The randomized controlled trials and community-participatory interventions on education and hygiene practices, and their subsequent evaluation should be considered to conduct effective and scalable prevention models.

Limitations

The shortcoming of this study is its cross-sectional nature that does not allow causal interpretation of relations between risk factors and infection outcomes. There is a chance of recall bias/social desirability bias with self-reported behaviors as well, and this may affect accuracy. Also, the research was carried out on few pathogens and geographical areas that might not represent the entire rural parts of Pakistan.

Conclusion

The prevalence of zoonoses in livestock farmers is huge in rural Pakistan and represents the interaction of work exposure, lousy hygiene, and low awareness. Contacts with animals directly, absence of protective equipment, and eating raw animal food are the main risk factors. It is demonstrated in the study that there is an immediate necessity of unified health intervention, community education, and the One Health model to interrupt the transmission of zoonoses. A global response by enhancing community-level preventive measures to contain the burden of infections, safeguarding livelihoods, and increasing public health outcomes is a significant possibility through multilateral and bilateral interventions.

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