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Pluralistic Epidemiology: What Indigenous Paradigms of Herd Immunity Offer to Non-Medical Pandemic Interventions

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Abstract

Modern epidemiological models define herd immunity almost exclusively as a biological threshold achieved via natural infection or synthetic vaccination. This conventional conceptualization often overlooks non-medical, socio-ecological systems of collective protection developed by indigenous communities. Indeed, the global response to the COVID-19 pandemic exposed the limitations of relying solely on centralized, biomedical frameworks to manage public health crises. This study investigates an undocumented traditional practice among pastoralist communities in India who employ a sophisticated form of variolation — combining *Napera* leaf extracts with infected viral serum — to manage pox outbreaks within their herds. Drawing on medical anthropology, ethnoveterinary studies, and the history of medicine, the paper examines how this indigenous protocol functions as a localized, non-medical intervention that parallels historical human variolation practices used prior to modern vaccinology. Rather than treating this empirical practice as a mere precursor to modern immunology, the study analyses it through the lens of *"pluralistic epidemiology"*. It also demonstrates how community-based traditional knowledge, health management, and controlled exposure operate together as socio-cultural mechanisms of herd defence. The biochemical mitigation of viral mutation within this traditional protocol reflects a nuanced, observational science embedded within community governance. By humanising the metrics of disease transmission, this paper argues that modern public health governance must expand beyond biomedical determinism. Integrating indigenous epistemologies into mainstream epidemiological planning provides valuable frameworks for community-led prevention and holistic pandemic preparedness. Ultimately, recognizing these historical and socio-ecological practices not only enriches global health policy, but also offers modern medicine novel approaches to vaccine development and a more pluralistic understanding of herd immunity in an era of emerging viral threats.

1. Introduction

With the onset of the Coronavirus (COVID-19) pandemic, non-pharmaceutical interventions (NPIs) such as mask-wearing, hand hygiene, social distancing, and self-quarantine have become routine practices intended to safeguard public health (Fricke et al. 2021; Butty et al. 2022; Böhler et al. 2026). While these measures proved effective in curbing the initial viral transmission (Lison et al. 2023; Björk et al. 2026), their standalone capacity to resolve the global health crises was constrained by socio-economic disparities, uneven enforcement, and the emergence of hyper-transmissible variants (Vokó et al. 2020; Dong et al. 2021; Shi et al. 2021). Consequently, epidemiologists and public health scholars increasingly returned to *"herd immunity"* as a central paradigm for population-level protection (Morens et al. 2022; Suryawanshi and Biswas 2023; Reiter et al. 2026), even as its operational definition, ethical boundaries, and practical execution generated sustained debate across scientific and policy communities (Robertson 2025; Davis et al. 2026).

Critically the term *"herd"* originates from the Germanic word '*Herde*' which classically denotes a flock of animals rather than an aggregation of human beings (Benthien et al. 2016; Rowland and Murphy 2025). Had the concept of *"herd immunity"* developed natively with the human healthcare, it might have

plausibly been more named *"community immunity"* or *"group immunity."* Instead, it entered into biomedical discourse through veterinary management of infectious diseases in livestock – principally sheep, goat, cattle and horses – where population-level thresholds of immunity were observed to interrupt the transmission chains within a herd. This lineage is not incidental. Reconsidering *"herd immunity*" on genealogical grounds requires moving beyond the narrow confines of the modern biomedical science to interrogate the concept's etymological roots, historical evolution, empirical application and broader implications for how collectives – human and animals – are imaged to protect another.

1.1. The limits of containment: from quarantine and population immunity

The practice of quarantine long predates modern epidemiology. The term *"quarantine"* itself derives from the Romanian-Venetian language '*quarantena'* [meaning "forty days"] (Peng 2025), designating the isolation period imposed on incoming ships and crew during the Black Death plague of the 14-15th century CE (Mattioli et al. 2020; Khan 2022; Vianello et al. 2026). Institutional isolation, however, extends into further antiquity: the Book of Leviticus (composed around the 7th – 6th century BCE) records early isolation protocols for segregating the individuals with contagious diseases under the Mosaic Law (Bassareo et al. 2020; Aljoudi 2022; Jamela and Ndebele 2025). In 706 CE, the sixth Umayyad Caliph Al-Walid established the first documented hospital in Damascus (Ragab 2015; Rezaei 2025), mandating the segregation of leprosy patients (Hasnain et al. 2020; Basciano 2026), - a practice of institutionalized containment that persisted through the Ottoman period, exemplified by the construction of Edirne Leprosarium in 1413 CE (Ayalon 2014; Aljoudi 2022).

Quarantine interventions demonstrated measurable efficacy during the COVID-19 pandemic, owing to SARS-CoV-2's five-to-six days mean incubation period and its droplet-dominated transmission route (Jiang et al. 2020; Salzberger et al. 2020; Elias et al. 2021). Passive isolation, however, is fundamentally inadequate against orthopoxviruses, and particularly against *variola major* (smallpox) (Huang and Bashford 2024; Berche 2025). Smallpox transmits through respiratory aerosols and direct contact, with viral shedding commencing during the prodromal phase – prior to the appearance of diagnostic lesions (Sabhlok et al. 2024). With a basic reproduction of number (R_0) of five to seven and a case fatality rate of approximately 30%, passive quarantine could not contain smallpox; only active prophylactic immunization, applied at population scale, proved sufficient (Mühlhoff 2022; Ko et al. 2026; Schneider and Davenport 2026). Smallpox therefore, illustrates the structural ceiling of containment-based strategies and the historical necessity of population-level immunity as complementary – at times primary – line of defense.

1.2. Conceptual inconsistences in biomedical discourse

The inherent limitations of quarantine measures against highly transmissible airborne pathogens make population-level immunity a necessary object of inquiry in its own right (Grout et al. 2021; Sabhlok et al.

2024). Contemporary Western epidemiological frameworks conceptualize *"herd immunity"* through strict binary: immunity acquired *naturally* through widespread community infection, or immunity induced *artificially* systematic vaccination programmes (John and Samuel 2000; Pugh et al. 2022; Chen et al. 2024).

This bifurcated model, nevertheless, faces growing theoretical scrutiny on the grounds of terminological precision and conceptual coherence. Critics argue that population immunity accumulated through unmitigated collective or intentional sense, since it involves no coordinated protective action and typically extracts a sever tool in morbidity and mortality before any threshold is reached. The persistence of this loose usage – treating accidental mass infection and deliberate immunisation as two symmetrical routes to the same phenomenon – exposes epistemological inconsistences within established biomedical discourses and signals that the concept, as currently defined, has not been rigorously reconciled with its own etymological and historical premises.

1.3. (Re)thinking epidemiology through indigenous paradigm of collective defence

Indigenous Indian knowledge systems offer a divergent paradigm that departs fundamentally from Western binary. Rather than treating the population immunity as either an accidental by-product of disease exposure or a product of modern synthetic vaccinology, traditional Indian healthcare paradigms demonstrate how cultural, historical, and socio-ecological practices can construct deliberate, decentralised system of collective protection outside biomedical institution altogether.

For generations, pastoralist communities in India have practiced an undocumented ethnoveterinary from of variolation – combing leaf extracts with infected viral serum – to manage pox outbreaks with their herds. This empirical protocol integrates viral mitigation, controlled exposure, and spatial management, and functions as a localised socio-cultural tool of herd defence long before, and independent of, the biomedical vocabulary now used to describe such outcomes. Because this knowledge circulates primarily through oral transmission and embodied pastoral practice rather than through peer-reviewed literature, it remains largely invisible to the epidemiological mainstream – a gap this study treats as a subject of inquiry rather than as an absence of evidence.

Interrogating such alternative epistemologies through a pluralistic epidemiology framework does two things once. First, it exposes the culturally and historically contingent construction of biomedical terminology that is otherwise treated as neutral or universal. Second, it offers conceptual and practical tools for humanising public health governance and for expanding the repertoire of global pandemic preparedness beyond interventions authored solely with biomedical institutions.

1. **Research questions**:

1. How do contemporary Western biomedical frameworks and traditional Indian pluralistic epidemiological systems conceptualize *"herd immunity"* differently, and what epistemological

foundations underlie these divergent approaches to population-level disease protection?
2. What specific procedures and protocols underpin the indigenous *"herd immunity"* strategies, and how have these practices originated, evolved, and been transmitted across generations within their respective cultural contexts?
3. How and why have pluralistic epidemiological practices of inoculation, variolation and population-level protection been marginalized and what actionable insights can they offer for decentralised pandemic preparedness, community-led health governance, and to modern public health policy?

2. Methodology

An Exploratory Research Design has been adopted for this investigation, as no considerable body of scholarship exist examining the comparative epistemological frameworks of Western biomedical and indigenous Indian conceptualizations of herd immunity. The rural areas of Telangana State, India were strategically selected as the primary research site. The region's unique geographical positioning between the Krishna and Godavari – two of peninsular India's major perennial rivers - historically limited extensive cultural assimilation across the intervening plateau, contributing to the relative preservation of indigenous health beliefs, herbal practices, and traditional healthcare systems in its closer to their original articulation than in more heavily colonised or transit-corridor regions. Ethnography serves as the primary methodological approach for understanding indigenous perspectives on healthcare practices, traditional immunization protocols, and herd immunity conceptualizations within their cultural contexts. Oral History methodology is employed as a secondary approach to access undocumented traditional knowledge that has been transmitted intergenerationally, with a particular attention to herbal vaccination practices and indigenous protocols for achieving community-level immunity. Additionally, Etymological Analysis is partially utilized to examine the linguistic origins and cultural meanings embedded in traditional vocabulary related to whole process of native vaccinology. Given the exploratory nature of this research design, the findings and results cannot be generalized beyond the specific study context. The investigation is geographically constrained to Telangana State, limiting broader applicability across diverse Indian indigenous communities. Most importantly, the herbs, their biochemical properties, and traditional procedures and protocols were not subjected to laboratory testing or clinical trials, meaning the efficacy and safety of these practices require scientific validation through future biomedical research.

3. Field observations and major findings

3.1 Pluralistic epidemiology in the lifeworlds of Indian shepherds

When the signs of an outbreak appear in their flock of sheep, shepherds not only anticipate the potential for rapid transmission but also recognize that exclusive reliance on *"herd quarantine"* and *"disease distance"*. Being believing that the pragmatic strategy of quarantine may be sufficient for some time but

not an ultimate solution for containing such contagious crises. As a result, the *Pedda Golla* — head of the herd and herders, — convenes an assembly with the fellow shepherds to organise the community's response. The authority of *Pedda Golla* in this context is not merely titular; it derives from a socio-political standing that the community accords him in recognition of his expertise in indigenous knowledge systems. He recalls and explains the age-old practices of disease-management followed by their ancestors which fundamentally laid on the premises of pluralistic epidemiology unlike the primarily natural progression of herd immunity described in modern scientific literature. In fact, this sort of knowledge is distinguishingly interventionalist and rooted in traditional practice of variolation. In this method, the virulence of a virus is intentionally diminished by applying leaf juice to the viral material, thereby weakening the virulence; this attenuated virus is subsequently introduced into healthy animals through direct inoculation/variolation, performed by the shepherds themselves. The modified virus typically results in a mild infection, since the biochemical compounds present in the specific leaf juice are believe curtail viral mutation, thus, the risk of severe disease is substantially minimized.

As a result of this controlled infection, the animals' natural immune systems are stimulated to produce antibodies, fostering immunity over time. While shepherds may not use scientific terminology such as *"virus,"* they possess a clear understanding of foreign agents capable of compromising herd health and have honed this indigenous method - popularly known as *"Potthi Kattu"* or *"Herd Immunity"* - as a mean to counteract viral mutations and spread. This time-tested approach reflects a sophisticated understanding unusually similar to contemporary medical protocols for immunization and disease prevention, and offers a strong point for developing formal protocols for herd immunity grounded in the pluralistic epidemiology.

3.2 *Potthi kattu*: a case of pluralistic epidemiological practice

Having secured the approval from the councils of herders, the *Pedda Golla* begins by conducting surveys across the local herds to determine the extent and distribution of infection. After gathering this information, he selects a sheep that has survived a severe infection as the source of viral material for the variolation process. Upon request or for payment, he brings this infected sheep to the healthy herd and simultaneously collects leaves from the *Napera* plant to extract *Pasaru* (leaf juice), which is collected in a *Doppa*, a cup fashioned from thick leaves. Using a *Gorukaalu* - a diamond-cutter-like metal blade - and a *Keelu Katti* - a set of traditional surgical instruments, he makes a small incision on the infected sheep's ear to collect serum. This serum is then mixed with the *Pasaru* in the *Doppa*, where the biochemical properties are understood locally to weaken or attenuate, the virus. The *Pedda Golla* scrapes a small incision on the ear of a healthy sheep and applies the attenuated serum-leaf juice mixture, completing the act of variolation process; this procedure is repeated individually across every animal in the herd.

Following inoculation, both the herd and shepherds undergo a strict quarantine for a period of 15 days, during which each animal is closely monitored for signs of infection severity. This attenuated inoculum typically results in a mild infection, enabling the animals' natural immunity to suppress the disease and

recover, in marked contrast to the server course of infection would otherwise take if contracted naturally within the flock. The appearance of *Bobba* - peanut-sized blisters on the ears is treated as the diagnostic marker of successful variolation, signaling that herd immunity has been established. This indigenous healthcare practice, locally understood in terms of constant with the modern biomedical concept of *"Herd Immunity,"* exemplifies the depth of the shepherds' disease-management knowledge, and forms part of a wider repertoire of traditional healthcare systems that continue to operate within Indian pastoral communities today.

3.3 Pluralistic epidemiological practices for human health

In India, the pluralistic epidemiological practices of disease-management are not confined to animals and herds, but also prevalent among human health during ancient and medieval periods. When people are susceptible to epidemics such as measles, chickenpox, or smallpox, one such practice involves in preparation of *Pasaru*, obtained from the *Napera* plant, which is blended with serum or plasma drawn from a survivor of viral infection for the attenuation process. In the local understanding, the preparation is differentiated according to its intended recipient: material associated with human infection is understood to be used for humans, indicating an empirical distinction between human and animal health practices. The enfeebled preparation material is tapped into a small clay vessel known as *'Gurigi*,' which subsequently placed before the Pochamma temple.

Following the offering of prayers to the Deity Pochamma, the variolation procedure was performed by infusing the prepared attenuated viral material into the muscles of healthy people using a typical sewing needle. To minimize the possibility of transmitting subsequent infections, a fresh or sterilized needle was used for each person. The entire event takes place in front of Pochamma's temple, thereby situating the practice simultaneously within a therapeutic and ritual domain. The appearance of characteristic peanut-shaped blister at the injection infused place was interpretated as a sign of successful variolation and therapeutic execution (Pulikonda 2020). The procedure, however, require considerable precision and concentration on the part of indigenous healers, as an incorrectly placed injection could injure a nerve and produce a severe wound. Such complications were reportedly managed through the applications of medical herbs, further, describing the interconnectedness of variolation and indigenous therapeutic knowledge (Kochhar 2011). Likewise, each and every member of the community were expected to undergo variolation so that susceptibility within the group could drastically be reduced and achieve herd immunity.

4. From biomedical to pluralistic epidemiology: a paradigmatic shift

"Herd immunity," as a concept in modern biomedical immunology, is used to describe the confrontation of inherent biological endurance against the spread of a contagious disease within a population or herd (John and Samuel 2000; Al-Betar et al. 2021; Kumar 2021; Soumya and Deepa 2021), and is considered a benchmark to be achieved (Suneel and Narasimha Kumar 2020; Minh et al. 2025). It arises only when a sufficiently large proportion of the population develops immunity against the foreign disease in reducing

the likelihood of transmission between infected and susceptible individuals (Fine et al. 2011; Rashid et al. 2012; Ma et al. 2025).

With the modern framework, Topley and Wilson (1923) in their paper entitled *"The Spread of Bacterial Infection: The Problem of Herd Immunity"*, - the concept of 'herd immunity' was first adopted in experimental research in 1923 to denote the premunity/immunity of a given total population in order to examine the rate of disease fatality among mouse populations at various levels of immunity (Topley and Wilson 1923; Xia et al. 2020; Jones and Helmreich 2021), and the study recognized 'herd immunity' as a naturally occurring phenomenon (Hinman et al., 2004; Regalado, 2020). A.W. Hedrich's epidemiological study of measles in Baltimore in the mid-1930s discovered a substantial decrease in new infections after a large number of children had been conscientiously exposed to immune to measles (Hedrick 2017; Mina 2017; Fekadie Baye 2020). Natural herd immunity happens all the time (Jarrett 2020) or it can happen medically if those people are vaccinated and develop immunity as a result (Fontanet and Cauchemez 2020; Shretta et al. 2020; Cihan 2021; McDermott 2021). In light of this, mass vaccination has been invented to generate premunity among the population.

On May 14, 1796, Edward Jenner (1749–1823), a distinguished British surgeon and physician from Gloucestershire, England, pioneered the world's first vaccination against smallpox. He inoculated an 8-year-old boy, James Phipps, with material taken from cowpox lesions of a milkmaid named Sarah Nelms. Remarkably, Phipps did not develop smallpox, leading Jenner to conclude that exposure to cowpox conferred immunity against the far more deadly smallpox (Winkelstein 1992; Bennett 2020; Flemming 2020). Jenner's groundbreaking discovery established that cowpox infection provided superior protection against smallpox, laying the foundation for immunization (Persson 2010; Raja and Jothy 2024; Wilson 2025). Although Jenner's approach faced ethical and religious objections due to the use of animal-derived materials in human treatment, it marked a pivotal moment in medical history. The practice of vaccination — named from the Latin word *Vacca* meaning "*cow*," and *vaccinia* referring to *"cowpox"* — emerged from this discovery (Kotar and Gessler 2013; Meyer et al. 2020); Jenner's inspiration came from the common folk wisdom of a dairymaid who confidently claimed, *"I shall never have smallpox for I have had cowpox. I shall never have an ugly pockmarked face"* (Riedel 2005; Louten 2016). But it is important to critically examine the historical narrative that the spread of smallpox was wholly halted through the natural protection conferred by the cowpox vaccine. While Jenner's discovery was revolutionary, it is difficult to accept that smallpox transmission ceased solely due to vaccination, especially considering that many milkmaids in England did contract smallpox during that period. Moreover, survivors of smallpox often bore the characteristic pockmarked scars that the vaccine was supposed to prevent. Moreover, vaccine exists prior to Jenner's discovery both in England and Asia (Riedel 2005a; Martini et al. 2022; Raja and Jothy 2024) .

In contrast to the modern biomedical framework, the first documented written evidence to variation in China appears in Wan Quan's *Douzhen Xinfa* [Essential knowledge and secrets of pox diseases], published in 1549 (Needham et al. 2000; Sivin 2005; Hwang 2022). The reference to inoculation in the Ayurvedic works *Sacteya Grantham* was reported in the *journal dictionaire des sciences médicales* by the

French scholar Henri Marie Husson (Korsman et al. 2012; Berche 2022). Although the genesis of the concept of inoculation in India has been disputed, the method of inoculation is mentioned in various ancient Sanskrit medical books (Selin 2008). In 1767, John Zephaniah Holwell, a British surgeon and East India Company official, produced a seminal report that constituted one of the earliest Western acknowledgments of India's advanced indigenous immunization practices predating European contact by centuries (Desai 2025). In need, inoculation, variolation, scaring, and surgeries could abundantly be seen in India (Lahariya 2014) and have been existing from Harappan times (Brimnes 2004).

In the west, prior to Edward Jenner's pioneering discovery of vaccination, the practice of inoculation, or variolation, was already established in Europe during the 18th century as a preventive measure against smallpox. A seminal figure in the introduction and promotion of variolation in Western medicine was Lady Mary Wortley Montagu, an aristocrat who had personally endured smallpox, suffering significant facial scarring following her recovery in 1715. During her sojourn in the Ottoman Empire, she witnessed the local practice of inoculation — referred to as *"ingrafting"* — within the female quarters (zenanas) of society (Fara 2021). Enthralled by its reported efficacy, she documented the procedure extensively in correspondence, notably in her *"Letter to a Friend"* dated April 1, 1717 (Dinc and Ulman 2007). In March 1718, Lady Mary, wanting to protect her children from disease, arranged for her almost five-year-old son Edward to receive inoculation. The procedure was performed by Charles Maitland, who served as the Embassy surgeon (Montagu et al. 2012). Edward became the first English person to undergo this medical procedure. In a letter to a friend in England, Montagu described the inoculation practice she observed, writing:

There is a set of old women [here], who make it their business to perform the operation, every autumn...when then great heat is abated...thousands undergo this operation... [and there] is not one example of anyone that has died in it (Lindemann 2010).

Following her son's inoculation, she reported to her husband on Edward's condition:

The Boy was engrafted last Tuesday, and is at this time singing and playing, and very impatient for his supper. I pray God my next may give as good an account of him (Copeland and Halsband 1967; Schama 2023).

Despite her efforts, the introduction of inoculation encountered substantial resistance from the medical establishment of that time, largely due to its origins in folk practice. Nevertheless, Lady Mary's advocacy was influential; during the smallpox epidemic of 1721, she publicized the successful inoculation of her daughter (Evered and Evered 2020) and persuaded Caroline of Ansbach, the Princess of Wales, to adopt the practice. Amelia and Caroline, two daughters of the Princess, were successfully inoculated in April 1722 by French-born surgeon Claudius Amyand (Ward 2022). Further endorsements followed, including the inoculation of seven condemned prisoners at Newgate Prison, all of whom survived and were subsequently pardoned (Grundy 1999). This royal patronage facilitated broader acceptance, and by the mid-18th century, inoculation had been embraced by other European courts, including that of Catherine the Great of Russia in 1768 (Lindemann 2010).

It is imperative to contextualize Jenner's later discovery within this continuum of medical knowledge: variolation was not merely an obscure folk custom but a well-documented, cross-cultural intervention with demonstrated potential for smallpox prophylaxis. Moreover, the recognition of protective immunity arising from exposure to animal diseases is not unprecedented in Western medicine; analogous beliefs and practices are evident in indigenous knowledge systems, such as those of Indian shepherds and cowherds, who long held that contact with certain animal infections could confer resistance to human diseases. Such parallels underscore the importance of integrating historical and cultural perspectives in understanding the evolution of immunological science from pluralistic epistemologies and epidemiologies.

5. Humanising pluralistic epidemiology: negotiating health across human and herd

It goes without saying that all the world's civilizations had been evolved and had a deeper connection with sheepherding not only as a profession but as high spiritual regard too (Duran and Naden 1996; Tan 2019). Amos (Harman 2021), Moses (Meeks 2017), Jesus (Bailey 2014), Mohammad (Cafferky 2013), and Krishna too (Tyagi 2009), were/are idealized with a pastoral sense of protectors both realistically and metaphorically. This is why, shepherds are to be *"Et in Arcadia ego,"* (Morris 1975; Steefel 1975; Orvell 2020) which may be translated as *"Even in Arcadia, there am I"* (Ware 2003; Shalloway 2018), implying that shepherds can detect a person's death by measuring the shadow of one of their comrades on the grave (Reuterswärd 1987; Keith 2009). It explicates that a shepherd's observation differs greatly from that of ordinary men because he consistently encounters and experiences a wide range of geographies (lands, rivers), life sciences (fauna and flora), philosophies (nature of nature, herds, and his fellow-herders), sociologies (cultures, traditions, people), psychologies (animal behaviours, weather trends) and so forth. Moreover, Indian pastoral shepherds and cowherds developed and conserved unique breeds including the deep-red, prominent-browed *Gir* cattle and powerful *Gir* oxen, high-yielding *Sahiwal* and Red *Sindhi* cattle and bulls, massive, heavy-duty *Ongole* bullocks, and miniature *Punganur* cattle, the rich, high-fat-milk-producing *Gawli* buffalo and meat-quality Deccani sheep. These hybridiation and cross-breeding are exemplifying their sophisticated traditional biological knowledge. A parallel case is also found in local breeding practice: although shepherds do not frame their knowledge in the language of modern genetics, their preference for selected rams from distant flocks echoes an intuitive grasp of the value of genetic diversity, a practice aimed at producing healthier, stronger and more disease-resistant offspring that converges with genetic principles now advanced within contemporary breeding science. Their indigenous woolen blankets, known as *"Gongadi,"* also exhibit remarkable functionality similar to contemporary nanotechnology: they offer protection from the sun, rain, and cold without the need for washing (Bheenaveni 2023). These pastoralists are also credited with inventing "*ghee"*, a clarified butter product that Westerners have historically imported from India, along with the term *"ghee"* itself entering the English language from Sanskrit-Hindi roots (Amith Kumar 2016; Oko 2019). Even in contemporary India, treatments for snake-bites, bone fractures, and certain infectious diseases remain embodied within the knowledge systems of indigenous healers, many of whom emerge from shepherding, pastoral,

artisanal, and tribal communities. These communities have historically cultivated a close attentiveness to nature, animal husbandry and ecological processes, enabling the development of distinctive therapic practices involving in medicinal plants, bone-setting, surgical intervention and other forms of embodied expertise. This knowledge is not simply a remnant of the past; it represents accumulated repertoire of empirical observation, experimentation, and intergenerational transmission. Anyways, the idiosyncratic value of shepherds' knowledge and rich therapeutic traditions of their communities may have a capacity to provide practical responses to illness, disease outbreaks, and other forms of collective crisis.

Since Harappan times, a plethora of deities was evolved in India, and offering and worshiping around their shrines have become normal practices in everyday life. But, in point of fact, they are not primarily Gods or Goddesses but rather inventors of different healing systems, technologies, and of course, martyrs sometimes (Bheenaveni 2011). The finding of herd immunity for several poxes is exemplified by Deity Pochamma in Telangana State (Bheenaveni 2020). As a basis, one can perceive her as the inventor of this inoculation or variolation for different poxes, but people were/are made to believe her as a Goddess in seeking protection from smallpox. Consequently, people still must go to her temple to offer when someone in their family is infected (Lashkar 2013; Kancha 2019; Basu 2020). She is being called with region-specific names like Sitala Mata across North India (Desai 2025; Rede and Redij 2025), Pochamma in Karnataka and Telangana States (Polu 2016), Muthyalamma in Andhra Pradesh (Padma 2011), Vasoorimala (Bini 2016), and Muthumariamman (Rangarajan 2013) in Tamil Nadu and Kerala respectively. Similarly, Deity Chaudalamma is revered as the protector of diseases among the cattle herders. Deity Balamma is known for her midwifery, pre-natal and post-natal healthcare. Atalamma, Muthyalamma, Saragamma, Maremma, Edamma, Nukalamma, and so forth are being worshiped in honour of their contributions to curtailing the outbreaks of epidemics and pandemics.

Regrettably, the so-called mainstreamed traditions did not recognize the skills and talents of indigenous deities who often indulge in and promulgate - production, protection, and procreation as essential human activities, and further treated them inferior by labeling '*Kshudra devatas*' – demon gods/goddesses (Bheenaveni 2011). Surprisingly, the Brahmin priests belonging to the Hindu's great tradition did not worship even a single indigenous deity throughout Indian history (Kancha 2019). Every religion projected its respective God(s) as more powerful, respectful, and beautiful too, although they did know neither production nor innovation. Because of the purposeful exclusion and marginalization of little traditions by politico-spiritual hegemony, the (hi)stories of great tradition have persisted as pulsating chronicles and magnificent narratives. More often than not, the great traditions have devoured the little traditions, either directly or in guise, resulting in the overlapping of Indian history. Thus, the histories of indigenous deities from Harappa to Beerappa have not been unmasked from an alternative point of view, and people tend to believe them to be Gods rather than scientific inventors, however, their legacy has been continuing in the form of indigenous knowledge systems, and their medical treatment has still been enduring as age-old traditions, oral histories, folklore, and a distinct set of practices around their shrines and temples.

6. Pluralistic epidemiology: present context and future prospects

During the early days of the COVID-19 eruption, Michael Ryan - the Executive Director of WHO, - made an important observation that "*India has a tremendous capacity to deal with the coronavirus outbreak as it has the experience of eradicating the smallpox and polio through targeted public intervention. Countries like India must lead the way to show the world what can be done*" (The Economic Times 2020). By that time, the WHO was not sure about what kind of measures India takes but hoped that India would be a torchbearer in finding a solution to COVID-19. India indeed played a unique role in each of these pandemics, although it paid very prices in certain outbreaks (Arnold 2020). Since the Indian civilization is well-versed in pluralistic epidemiology as part of culture and tradition, the indigenous treatments, home remedies, herbal usages, and, in particular, immune-induced kitchen and dietary habits protected its people naturally from the attack of coronavirus. Ayurveda and indigenous medical systems also played a substantial role in combating the pandemic (Golechha 2020; Mishra et al. 2020; Alam et al. 2021; Singh et al. 2021; Umesh et al. 2021; Joseph et al. 2021; Rastogi et al. 2022).

In China, on other hand, the combination of traditional medicine with Western medicine revealed the potential usefulness of herbal products in the treatment of COVID-19 (Luo et al. 2020). Several herbal medicines have greater safety margins and potential antiviral actions (Demeke et al. 2021) than reference drugs. There is enough evidence about the potential use of herbs as adjuvants in the treatment of COVID-19 (Islam et al. 2020; Luo et al. 2020; Nugraha et al. 2020; Shankar et al. 2020; Xu and Zhang 2020). Despite the implementation of strategies generally recommended by the classical school of public health, namely tracking and tracing of aggressive contact, isolation, and quarantine of the infected, practice of social distancing, and sensitizing the public about disease control and suppression, as well as having more advanced science and sophisticated technology, the world was forced to shut-down for an extended period of time due to COVID-19. Therefore, WHO and the general public throughout the world branded it *"Public Enemy No. 1,"* (Dahl 2020; Liu et al. 2020; Marshall 2020; Varon et al. 2020) and it was also regarded as one of the deadliest health disasters in human history ever since (Baldi and Savastano 2021; Pandey 2021). The entire humankind, irrespective of nationality, race, gender, income and age, has suffered an inconceivable loss in all regards owing to its unpreparedness and underestimation of pandemic risk (Smitham and Glassman 2021). The functional absence of integrated management in mitigating the pandemic and producing the coronavirus vaccine also contributed significantly to the enormous loss (Yayehrad et al. 2021), yet, the globe has reached a level of natural or vaccine-induced herd immunity in certain ways. The present new corona calamity looks to be over, but there will be major pandemic threats in the future. In case, herd immunity is created with vaccinations, it will be far safer and more accurate than natural immunity. Thus, indigenous healers and shepherds, as well as contemporary doctors, prefer variolation or vaccination to achieve herd immunity without fail. The combination of indigenous practices and current scientific episteme may likewise produce useful outcomes. This is why, reclaiming the past traditions and experiences of indigenous healing systems, as well as retrieving their intrinsic properties of treatments from oral histories, folklore, and all other sorts of knowledge systems, will undoubtedly pave the way for finding new solutions for not only coronavirus, but also for any other virus-causing diseases, epidemics, and pandemics.

7. Conclusion

The study concludes that, grounded in extensive and intimate interactions with nature, livestock herds, and human societies over generations of pastoral and nomadic life, Indian shepherds and cowherds developed empirical practices of variolation using *Napire* leaf-juice to attenuate viral virulence and promote what they understood as *"Potthi Kattu,"* or herd immunity; these practices were subsequently extended to humans for protection against smallpox and are preserved in oral traditions through the veneration of *Deity Pochamma* as the originator of the vaccination practice. Such indigenous practices of immunization appear to have preceded and contributed to wider traditions of inoculation and *"ingrafting"* in China and Europe respectively, predating Jenner's development of modern vaccination, and therefore invite a broader historical understanding of vaccinology beyond its conventional biomedical framework.

The COVID-19 pandemic, despite extensive non-pharmaceutical interventions, exposed the severe vulnerability of global health systems and looked for the *"herd immunity"* without going into its origin and evolution, however, the Western science recognized two avenues to population-level immunity: *"natural infection"* and *"artificial vaccination*". Whereas the pluralistic epidemiology has always valued managed variolation as the best methods for achieving herd immunity against various poxes. Although purposeful inoculation predates Western vaccination, these learned strategies have naively been unheeded or lost in contemporary public health discourse. Nevertheless, modern research can gain valuable insights from the pluralistic epidemiological approaches that underlies contemporary vaccination theory.

By bringing together the lifeworlds, oral histories, folklore, and other indigenous knowledge systems of pastoral communities with contemporary biomedical perspectives, this study seeks to bridge the epistemological and epidemiological gaps between Western biomedical and Indian pluralistic healthcare traditions; thereby envisaging a critical, evidence-based reconciliation of these systems as a pathways toward more inclusive, historically informed, and resilient strategies for future pandemic preparedness.

Declarations

Ethical Approval:

The study was carried-out at Osmania University, Hyderabad, India. As Osmania University does not have a central Institutional Review Board (IRB), ethical approval for the study was obtained from the Research Ethics Committee (REC), Department of Sociology, Osmania University, Hyderabad–500007, India Vide Ref. No. 2/REC/Socio/OU, dated 4 June 2024. The study merely employed a qualitative, non-interventional research design based on ethnographic engagement, oral-history sources, and etymological analysis. No clinical trials, medical interventions, or experimental procedures involving human participants or animals were conducted as part of this study. The research was conducted in accordance with the applicable ethical principles and requirements for research involving human participants.

Informed Consent:

Informed consent was obtained from all participants prior to their participation in the ethnographic and oral-history components of the study. Participants were informed about the purpose and nature of the research, the intended academic use of the information provided, and the voluntary nature of their participation. Appropriate measures were taken to protect participants' privacy and confidentiality, including the responsible handling of community-specific and culturally sensitive information.

Author Contribution

Ram Shepherd Bheenaveni (RSB) is the sole author and was responsible for all aspects of the study, including conceptualisation, methodology, analysis, interpretation, and writing, reviewing, and editing of the manuscript.

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Data Availability

The data presented in this study is merely qualitative by nature, and was collected by the author through ethnographic engagement and oral-history interactions with traditional shepherds living in Telangana State, India. The data materials include ethnographic field observations, oral-history accounts, and etymological analysis. The study did not generate any conventional quantitative dataset, survey dataset, or statist code(s). Relevant evidence from the ethnographic, oral-history and etymological materials has been incorporated into the manuscript in anonymised and appropriately contextualised form.

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