DOI: https://doi.org/10.53350/pjmhs22161667

**ORIGINAL ARTICLE**

# Medical and Veterinary Ectoparasites' Importance: An Insight on Alternative Control

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## ABSTRACT

Numerous ectoparasites of people and domestic cattle remain a chronic concern in the contemporary world, despite many attempts at eradication. For many years, pesticide medications such as organophosphates, organochlorides, and synthetic pyrethroids were efficient in controlling these parasites; however, widespread use of these treatments has resulted in resistance in many target species. Domestic animals play a vital role in food production, producing meat, milk, and money. The agricultural communities raze livestock's as an insurance and investment in contradiction of risk. Animals with short generation intervals and high fertility offer economic, managerial, and biological benefits, since milk production can start five or six months after mating and the first corpse can be sold in less than a year. Livestocks are also a main source of manure, which helps to fertilize the soil, as well as skin, which is one of the most significant products that generates foreign cash for the country. However, the combined effects of sickness, inadequate food, and bad management limit animal output. Parasitic sickness is one of the most common disorders in domestic animals and human, and it has a significant economic impact. Ectoparasites of livestocks are extensively dispersed with varying degrees of incidence, and are crucial in causing considerable economic damage to the agricultural community, the tanning and leather sector even throughout the wolrd, necessitating efficient control methods. Scabies mites, head lice, and bed bugs are important medical ectoparasites that pose a considerable public health threat, hence effective management strategies are required. Alternative management approaches have been developed in a number of ways, but more study is needed before they can be utilized to effectively regulate the ectoparasitic illnesses in the forthcoming.

**Keywords:** Human; Livestocks; Parasites; Biological control; Chemical control

## INTRODUCTION

Arthropods may be found all over the place. The phylum, Arthropoda is the world's biggest animal phylum by number of species, with potentially millions more species still to be discovered. Over time, arachnids have coevolved with humans and other animals, and several species have used them as parasites for their own advantage. A parasite is a creature that lives on or within another organism (the host) and feeds off of it. Ectoparasites are arthropod species that generally reside on their hosts. These parasites can live inside the host body, nest and environment, even visit the host's body on a regular basis. In either case, the host is completely reliant on it for a variety of life-sustaining resources. The parasite-host interaction is centuries old, and parasites' processes for seeking, identifying, and maintaining contact with their hosts are sophisticated and complicated (Wall RL and Shearer, 2001). Ectoparasites have a variety of relationships with their hosts, ranging from obligatory to facultative, permanent to intermittent, and superficial to subcutaneous.

Ectoparasite activity in cattle and companion animal hosts is of special interest because it causes a variety of harmful consequences. Feeding can result in direct harm to the skin and other subcutaneous tissues, as well as inflammation and blood loss. Erythema, pruritis, excoriation, scaling, crusting, papules, self-trauma are all common side effects of this practice. Wounds may become infected or infested with germs as a result of secondary infestation. Ectoparasites create faecal and salivary antigens when they feed on the blood, which can trigger immune responses and cause hypersensitivity in certain people (Gross et al., 2005). Importantly, certain ectoparasites are also protozoa, bacteria, viruses, cestodes, and nematodes vectors.

**Ectoparasitism:** Ectoparasites are organisms that hinder the host's skin or outgrowth over varied lengths of time (Gonzaez et al., 2004). The impact of ectoparasites is

typically determined by the size of the invading population, the parasite's mode of survival, and the nutritional status of the afflicted host animal. The annoyance of ectoparasites may be motorized, but the problem is compounded further by the host's reaction to the parasite's existence, as well as its production and excretion. It has been reported that young animals are more vulnerable to ectoparasites (Lehmann, 1993). Ectoparasitism is a global danger to both animals (domestic and wild) as well as humans. Parasite bites may be excruciatingly painful, resulting in considerable amounts of blood loss (Hechinger et al.2005).

Ticks alone are responsible for the transmission of various major protozoal, viral, bacterial and rickettsial infections to animals, resulting in significant economic losses. Dermatitis is caused by lice and mites, and it is considered by alopecia and necrotic foci. Intense pruritus causes biting and forceful scratching of the afflicted areas (Barbosa et al. 2002).

**Common ectoparasites of humans:** Human ectoparasitic infections are frequently seen as a 'third-world' issue. Human ectoparasites come in a variety of forms. Lice on the body and on the head are two examples. Nasal mites are among the many varieties of mites that belong to the ectoparasite family. These unpleasant parasites can infect animals in the form of nest mites or feather mites. An ectoparasite infection involving fleas or mosquitoes can affect both human, birds and animals (wild and domestic).

**Scabies:** S. scabiei is a little ectoparasitic mite that is around 0.4 mm in length and is responsible for the scabies illness. Scabies is a severe public health concern in underdeveloped nations, where it is quite widespread. Although cyclic epidemics are less prevalent in Western nations, they are widespread in youngsters and within institutions like as nursing homes for the elderly. Scabies is believed to affect more than 300 million people globally each year. Scabies mites harm their hosts by searching into the stratum corneum, where they lay eggs and discharge faeces, causing acute itching and the formation of tiny pustules on the skin surface (Currier et al., 2011; Diwakar et al., 2017).

S. scabiei is spread from person to person by skin-to-skin contact, making sexual transmission a regular occurrence. Due to their capacity to live off host for up to 36 hours, mites may be transported between hosts on contaminated linen, clothing, or furniture; however, others have discovered that mites require 15–20 minutes of direct skin contact to travel to a new host. While hygiene management and other preventative measures can help to avoid infection, existing cases must be treated with acaricide medications. Lindane is an important organochloride that causes paralysis and finally death in arthropods by acting on GABA-gated chloride channels (Walton et al., 2010; Alasaad et al., 2011).

**Louse:** Lice are wingless insects that are divided into two orders such as Mallophaga (chewing/biting lice) and Anoplura (sucking lice). There are around 540 genuine sucking lice, all of which are obligate haematophagous mammalian ectoparasites. Although only around 20 of these species are domestic animal pests, they can be found in large quantities, causing discomfort, anaemia, and dermatitis in the host. Biting lice and sucking lice are the two varieties of lice. Lice that bite feed on hair, epidermal tissue and many other organic wastes. These also induce severe itching as a result of their actions. The narrow head found in sucking lice with piercing mouthparts which use to pierce the host's skin and suck the blood (Pfeffer et al., 2010).

Lice saliva and excrement include chemicals that can cause allergies and skin irritations. The animal will frequently brush itself against items to demonstrate this. Lice infection can be detected by unthriftiness, matted, dull fleece, and wool tufts. Animals have a lower rate of weight increase and a lower rate of output. Lameness can be caused by sheep's foot lice. Cockle development has also been linked to lice (Badiaga and Brouqui, 2012). The presence of saliva and lice cause cockle, which is an inflammatory reaction of the skin. After the wool or hair has been removed from the skin, this is visible. Animals in low physical condition are more likely to be severely harmed (Levot, 2012).

**Bed bug:** The bed bug is another exceedingly frequent ectoparasite of humans. For hundreds of years, bed bugs have coexisted with humans, with evidence of infestations dating back to Egyptian times. Two bed bugs species attacked on humans such as Cimex lectularius which found in temperate regions and Cimex hemipterus in tropical regions of the world. Around 20 years ago, successful bed bug treatment in the Western world led many to believe that bed bugs were no longer a problem in developed countries, but the problem has since resurfaced in developed countries; for example, the number of reported infestations in some Australian areas increased by 250 percent between 1997 and 2000 and 2001 to 2004 (Koganemaru and Miller, 2011).

This is considered to be the outcome of a combination of increased global travel and C. lectularius pesticide resistance. Bed bugs are little (2–5 mm long), flat, wingless insects that feed on the blood of their victims as they sleep. The bugs are difficult to identify during the day because they hide in close proximity to their host's sleeping quarters, such as wooden slats of bed frames, mattress seams, and bedroom furnishings. Many people become increasingly susceptible to the bites over time, which can result in massive pustules. Infestations seldom cause any physical injury, but people who are infected often have severe nightly itching and difficulty sleeping (Potter, 2011; Gries et al., 2015).

Due to their lack of wings, bedbugs can only fly short distances. They travel from home to house by crawling from one bedroom to the next in poorly built houses with numerous of hiding spots; they usually spread through second-hand furniture, bedding, and clothes.

**Ectoparasites of domestic livestock:** Infestations of arthropod parasites afflict both animals and humans. Fleas and mites are widespread in home pets like cats and dogs, and they may also infest key livestock species like sheep and cattle, as well as farmed fish. This is a big concern given the current worldwide food crisis situation. With dwindling food resources and an ever-increasing population, the security of these food supply is vital. Parasitic worm infestations in cattle and fish can result in significant losses, and the cost of treatment raises the end product's price, so it's vital that they're kept under control in a cost-effective manner. The parasitic arthropod species

listed below are only a few examples of parasitic arthropod species that are becoming increasingly resistant to present pharmaceutical treatments.

**Fleas:** Fleas are members of the Siphonaptera insect group. They don't have wings and have mouthparts for piercing flesh and sucking blood (Bitam et al., 2010; Rust, 2017). Fleas are parasitic insects that feed on the blood of mammals and birds through a process known as hematophagy. Fleas have long been regarded as one of the most important human ectoparasites, as many species are natural carriers of deadly infectious diseases such as plague. Fleas are classified into 15 families, each of which has about 220 genera and 2,500 species (Durden and Hinkle, 2019).

**Sheep scab:** Melophagus ovinus is commonly known as the sheep ked which is brown in colour and a hairy insect which look like a tick. This wingless fly belongs to Hippoboscidae family, is around 4-6 mm long in length with a tiny head. They are parasitic parasites that feed on sheep's blood. The sheep ked's legs are exceptionally powerful and have claws on the tips. Sheep ked spend their entire lives in sheep wool. Sheep keds are most typically found on the host animal's neck, shoulders, and underbelly. Experiments have shown that the sheep ked can transmit bluetongue virus to sheep, they are also bluetongue disease vectors in nature (Doherty et al., 2018).

Sheep ked can induce anaemia and hinder weight gain in lambs. Because the sheep ked feeds on its host's blood, it irritates the sheep, causing it to rub, resulting in both wool loss and harm. It also produces cockles, which are solid, hard nodules that form on the skin and diminish the value of the hide. The ked faeces also discolour the fleece of the sheep, lowering its value. They also spread Trypanosoma melophagium, a sheep protozoan parasite that is nonpathogenic (Stacy et al., 2003; Sturgess-Osborne et al., 2019).

**Mange mites:** Psoroptes, Sarcoptes, and Demodex are the most common mange mites that cause skin problems (Haffize, 2001). Downgrading and rejections caused by these ectoparasites result in significant skin loss (Molu, 2002; Teshome, 2002). Mange is a spreadable skin condition marked by pruritic dermatitis, crusty and hair/feather loss caused due to many parasitic mites burrowing in or residing on the skin. Mange is known in French as 'la gale,' and in English as 'itch,"scab,' or'scabies' (a name that should only be used to refer to mange caused by Sarcoptes scabiei (Leudke et al., 1965).

Mange, often known as scabies, is one of the most prevalent disorders caused by mites in animals. Mange is a pathological degradation of the skin that causes hair or feather loss, a rash, skin redness, and, in extreme instances, weakness and lethargy. Mange and Scabies in cattle are defined as "any skin condition of men or animals linked with a mite; scabies is a particularly dangerous, debilitating, reportable mange condition," according to the USDA. The settlement of the mites on the animal's body determines the type of the skin affects (Foley et al., 2016; Bochkov et al., 2014).

**Ticks:** Ticks are bigger and more closely related to the spider subclass Acari mites. Ticks' obligatory blood-feeding habit necessitates the use of bioactive substances released in their saliva to defeat innate and acquired host immune responses in order to stay attached at the bite site for days at a time, often parasitizing the same host numerous times. Ticks are the most significant parasitic arthropod group as vectors of infections affecting domestic animals and wildlife, in addition to having direct impacts on their hosts. Ticks are exceptional vectors, capable of transmitting a wide range of infections such as protozoa, bacteria, and viruses. Transboundary cattle illnesses are caused by tick-borne infections.

Ticks are one of Pakistan's most dangerous ectoparasites. They are the ones who create the most economic losses in the cattle industry. Ticks caused serious as well as negative impact on cattle health in form of reduced milk and meat production, growth and development, damaged skins and hides as well as in transmission of tick-borne diseases. Other tick-related losses include skin deterioration, which reduces the worth of the skin significantly (Maa, 1969).

There are three main families of ticks which have been reported in the world but among three families two families such as Ixodidae (hard ticks) and Argasidae (soft ticks) becoming serious for animals and human in the whole world. many genera of ticks have been reported belonging to these families including Amblyomma, Dermacentor, Ixodes, Haemophysalis, Rhipicephalus and Hyalomma have negative impact on livestock industry all over the world (Ramzan et al., 2018, 2019; Jamil et al., 2021). Ixodid ticks will parasitize one, two, or three hosts, depending on the species, to complete the adult, larval and nymphal phases. Adult females who have been mated slip off their hosts to lay their eggs on the earth. Argasid ticks are quicker eaters and nidicolous than ixodid ticks, dwelling in or near their hosts' shelters. Ornithodoros and Otobius are two Argasid genera featuring species that are ectoparasites of cattle (Ramzan et al., 2020, 2021).

Table 1. List of diseases transmitted by tick species with their references.

| Diseases | Transmitted by tick species | References |
|---|---|---|
| Babesia ovis | Rhipicepalus bursa; Rhipicepalus evertsi | Shiferaw (2018) |
| Babesia motasi | Haemophysalis spp.; Dermacentor spp.; Rhipicepalus bursa | Shiferaw (2018) |
| Theileria ovis | Rhipicepalus bursa; Rhipicepalusevertsi | Shiferaw (2018); Khan et al., (2017) |
| Anaplasma ovis | Rhipicepalus bursa; Rhipicepalus evertsi | Shiferaw (2018) |
| Borrelia burgdorferi (Lyme diseases) | Ixodes spp. | Urquhart (1996) |
| Rocky Mountain Spotted Fever (Rickettsia rickettsii) | Dermacentor spp. | Urquhart (1996) |
| Ehrlichia spp. | Rhipicephalus spp. | Lundgren, (2008) |

**Sea lice:** Now a days, aquaculture is becoming very popular industry in the whole world that provides food supply to the whole world. the main source of food is salmon which farmed in many regions of the globe especially Norway, Scotland, Canada and Ireland etc. It has been reported that both types of salmon like farmed and wild found susceptible to parasitic infections. Lepeopophtheirus salmonis infests Atlantic salmon and is one of the most commercially important parasites (Salmo salar) Kabata, (1979). The lice's juvenile stages attach to the fish's skin, where they feed on mucus before maturing into adults and feeding on blood. In rare circumstances, the presence of lice causes blood loss and tissue damage in fish. This reduces the value of the fish and leads to significant losses.

**Significance and Damage of Ectoparasites**

**Management strategies:** It's possible that alternative kinds of insecticidal and acaricidal medications, such as insect growth regulators, might be used to control infestations. Because they are synthetic medications, it is likely that resistance will emerge in the future, hence it is vital to explore other control approaches, such as biological control or immunization. The application of biological control techniques and immunizations to manage parasites has sparked a lot of attention in recent years, and some promising outcomes are given here.

**Cultural, physical control**

**Removal of manure and dung:** It entails the removal of dung and manure, as well as adequate drainage, in order to lower the pest population by focusing on their breeding grounds. Manure can be placed in enormous heaps, where the heat of fermentation will kill the flies in their development stages [10]. Insecticides sprayed on the surface of a modest heap may help minimize the quantity of ticks. Heavy grazing and weed burning, frequent ploughing of grazing field, and land cultivation should be used to reduce vegetation, making the environment less conducive to tick survival and development. Ticks in India have acquired a homing tendency in the absence of permanent pasture; they seek refuge and grow in the crevices and cracks of animal shelters, which must be avoided (Harrington et al., 2012; Ramzan et al., 2021). Wire mesh or nets should be installed around animal enclosures. Fly repellant and fly traps should be used as much as possible.

**Insect growth regulators:** Insect growth regulators are another type of possible treatment that hasn't seen as much application as organochlorides, synthetic pyrethroids (IGRs) and organophosphates. IGRs are synthetic hormones and enzymes of arthropods that can reduce the development and growth of insect pests. Juvenile hormone analogues (JHAs) including hydroprene and methoprene and chitin synthesis inhibitors such as diflubenzuron are the most suitable and tested IGRs against insect pests of various crops and domesticated animals. JHAs simulate juvenile hormone, which is involved in the process of ecdysis in stages of arthropods life-cycle (Medlock et al., 2012).

JHAs have been employed to fight agriculture and residential pests, however they have been found to be ineffective against human parasites. There is presently just one licenced hydroprene-based bed bug treatment available. Although JHAs are a novel class of parasitic arthropod treatments, resistance has already arisen in numerous household pests such as Musca domestica (Windley et al., 2012). Pesticides that inhibit chitin synthesis have also been investigated. These work by blocking the synthesis of chitin, an important component of arthropod cuticle (Schmahl et al., 2010). For the treatment of plant pests, there are various chitin synthesis inhibitors available, but significantly fewer for human and domestic livestock pests.

**Biological control:** A number of biological controls, including as essential oils and fungi, have been used to study arthropod control. Azadirachtin is a naturally occurring substance that was initially identified to keep locusts away from the neem tree (Azadirachta indica). Since then, it has been documented to restrict feeding and have an impact on development in a number of arthropod species. It has shown to be a successful insecticide against a wide range of agricultural pests. Despite being tested as an acaricide to control ticks and many poultry mites, reported effective in controlling or killing 90% of mites, azadirachtin's usage as a medical and veterinary arthropod control agent has been limited (Lekimme et al., 2008).

Biological control is a better option for the ecosystem. Spider venom peptides are another developing biological control approach for arthropod parasites. Venom peptides are present in a wide range of arachnids, with many of them consider as neurotoxins. These peptides paralyse arthropod neurons after blocking sodium and calcium channels. This field of study is still in its infancy, and more research is required to establish which peptides should be employed to target certain arthropods. Humans and other host species must not be harmed by the peptides. Because the majority of in vitro research involve injecting venom peptides directly into arthropods, the mode of administration must be taken into account (Rapp et al., 2006).

The use of entomopathogenic fungus is another biological control strategy that has gotten a lot of attention in the last 20 years. For many years, fungal-based insecticides have been used to manage agricultural pest species, with a B. bassiana based chemical being created in 1965 to combat the crop pests especially Colorado potato beetle. For the treatment of insect and mite infestations, there are already a significant range of commercially available fungal compounds. In recent years, it has been investigated into their potential for use against human and animal ectoparasites. Combining B. bassiana conidia with a desiccant dust demonstrated best action against the chicken red mite, according to Steenberg and Kilpinen (2014). When mixed with diatomaceous earth, conidia from Metarhizium anisopliae killed Triatoma infestans (a tropical bloodsucking insect) completely.

**Pheromone-mediated control and Sterile insect technique:** Certain pheromones are vital in arthropod mating and female attraction to vulnerable hosts. Unfed nymph and adult tick aggregation or attachment is aided by aggregation attachment pheromones (AAP). By integrating pheromone tick chemicals with plastic tags infiltrated with

pesticides, AAP may be utilised in controlled tactics. Ticks are attracted to tag release pheromones, which function as 'tick decoys' (Abdel-Rahman et al., 1998).

The sterile insect method is a biological control strategy that entails releasing large quantities of sterile insects. Because the female is the one who consider serious pest in causing severe damage, either by eggs laying in the crop parts or by feeding on human blood in the case of mosquitoes, the released insects are usually male. Infertile males will compete with wild males for mating to female. When a female marries a sterile guy, she has no children, reducing the population of the next generation. Repeated releases of sterile insects can ultimately wipe out a colony, although controlling a population rather than eradicating it is usually more successful (Dyck et al., 2005)

**Chemical control:** Despite various issues such as the development of resistance, societal worry over residue in food, and environmental damage, it is the most widely used process in the world.Various chemicals are used, including carbamate, chlorinated hydrocarbon, organophosphate, synthetic pyrethroids, formadidine and macrocyclic lactones and dorame Among all of these synthetic pyrethroids, synthetic pyrethroids have been shown to have superior residual action against a wide range of pests and to be more efficient at lower dosage rates. Acaricides have shown to be the most effective technique for controlling tick populations.

Table 2. Residual insecticides for use against bedbugs

| Sr. No. | Insecticide | Concentration in spray (%) |
|---|---|---|
| 1 | Permethrin | 0.5 |
| 2 | Propoxur | 2.0 |
| 3 | Lambdacyhalothrin | 0.005 |
| 4 | Diazinon | 0.5 |
| 5 | Propetamphos | 0.5-1.0 |
| 6 | Malathion | 2.0 |
| 7 | Deltamethrin | 0.005 |
| 8 | Pirimiphos methyl | 1.0 |

WHO (1997)

Table 3. Insecticides widely used to control flea

| Sr. No. | Insecticide | Concentration in spray (%) |
|---|---|---|
| 1 | Permethrin | 0.125% |
| 2 | Cyfluthrin | 0.04% |
| 3 | Dichlorvos | 0.5-1.0% |
| 4 | Propoxur | 1.0% |
| 5 | Lambdacyhalothrin | 0.005 |
| 6 | Diazinon | 0.5 |
| 7 | Propetamphos | 0.5-1.0 |
| 8 | Malathion | 2% |
| 9 | Deltamethrin | 0.025% |
| 10 | Pirimiphos methyl | 1% |
| 11 | Fenchlorvos | 2% |
| 12 | Natural pyrethrins | 0.2% |
| 13 | Bendiocarb | 0.24% |
| 14 | Propoxur | 0.1% |
| 15 | Phenothrin | 0.4% |
| 16 | diethyl-toluamide (deet) | |
| 17 | dimethyl phthalate | |
| 18 | benzyl benzoate | |

WHO (1997)

Tick populations can be decreased by spraying pesticides in the fields where the tick population is the most dense. This method has been used in a number of countries, including the United States, Australia, Southern Africa, and Pakistan. Ticks have been treated using chemicals such as querosene, sulphur, and lard (Domingos et al., 2013). Dinotefuran, evrmectin, pyriproxyfen, imidacloprid, deltamethrin, fipronil, and methoprene (Horak et al., 2012) are the primary chemicals that have been utilised for the control of ticks and TBDs by various workers. The insecticides used against bedbug, fleas and lice have given in table 2, 3 and 4, respectively.

Table 4. Insecticides widely used to control lice

| Sr. No. | Insecticide | Concentration in spray (%) |
|---|---|---|
| 1 | Permethrin | 0.5 |
| 2 | Bioallethrin | 2.0 |
| 3 | Lambdacyhalothrin | 0.005 |
| 4 | DDT | 2.0-10.0 |
| 5 | Carbary | 5.0 |
| 6 | Malathion | 2.0 |
| 7 | Lindane | 1.0 |
| 8 | Pirimiphos methyl | 1.0 |
| 9 | Phenothrin | 0.2-0.4 |
| 10 | Malathion | 0.5-1.0 |

WHO (1997)

## CONCLUSION

Each control strategy has limits in terms of ectoparasite control on a long-term basis. Management of insecticide resistance, strategic chemical usage, and host resistance manipulation, in conjunction with parasites population, are all important mechanisms, as is host upbringing for growing resistance. Chemical pesticides are only employed as a last choice in IPM programmes because of their high application costs and accompanying risks. Whenever they're utilized, they try to keep pest populations under control so that animals aren't harmed. Furthermore, environmental considerations are extensively considered, and environmental benign compounds that are efficient against the goal species are recommended. IPM is important in the current situation because it protects human health by reducing toxic residues of chemicals that may cause cancer or neurological disorders, manages vector resistance, conserves biodiversity by including beneficial pollinator parasites and predators insects, reduces environmental pollution, and avoids export loss. Pesticide residue levels exceeding the tolerance threshold are found in 25% of Indian food products, resulting in significant export losses.

**Recommendations:** External parasites have been discovered to be the result of numerous variables such as inadequate management, poor nutrition, and sanitary circumstances, rather than being the result of a single determinant. As a result, better husbandry techniques and veterinary services may help to lower ectoparasite levels. Reduced production, reproductive performance, and mortality of afflicted animals all contribute to the disease's economic losses. Furthermore, the disease-causing external parasites are seriously restricting the routine of the lashing trades, affects the country's foreign cash, necessitating an immediate management intervention. Further research on the ectoparasites epidemiology and skin illness in various regions of the country is needed. At various phases of hide and skin processing such as early

trade stages and tanneries, all probable economic losses owing to the illness should be assessed. Public awareness of the impact of skin disease on productivity, and skin quality, how to care for and manage these goods, should be developed. In order to reduce ectoparasites and their effect, the government, private sector, and veterinarians should collaborate.

**Acknowledgement:** Authors are highly thankful to the concern institutes.

**Conflict of interest:** Authors declare no conflict of interest.

**Authors contributions:** All authors have equal contribution in writing this review paper.

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