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Mini Review

Housefly: Common zoonotic diseases transmitted and control

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Summary
The Housefly (*Musca domestica* Linnaeus, 1758) lives in close proximity to humans, posing a variety of health risks. They are mechanical vectors capable of spreading an arraying of infections and annoy humans. More than 100 types of pathogens, including bacterial, viral, and protozoan, are transmitted by houseflies, and in this review, we describe 5 of them: Cholera, Anthrax, Shigella, ORF Virus, and Ascariasis. Cholera is a rigorous flux ailment initiated via the *Vibrio cholerae* bacteria contaminating the intestines. The ailment is often modest or does not present symptoms, but it can also be dangerous and lead to death, while anthrax is a harmful infective illness brought about by *Bacillus anthracis*. Shigellosis (Shigella infection) is a gastrointestinal ailment caused by *Shigella spp*. Bloody diarrhea is the most common sign of shigella infection. Houseflies are a severe health hazard for humans, causing discomfort, disease, and even death. Studies that assess the impact of Houseflies on humans were briefed. Articles on PubMed, Google Scholar, and other online reports, 50 in number, were reviewed.The genesis and life cycle of houseflies, their mode of disease transmission, commonly transmitted diseases are all discussed in this paper. Biological, chemical, and cultural control are some of the common control strategies discussed.
Keywords: Housefly, Cholera, Anthrax, Shigellosis, Control

Introduction

The Housefly is a worldwide Diptera species that can be found in a variety of human and animal settlements. Houseflies are responsible for the majority of the health of the general public (Howard, 2001), aspergillosis, typhoid fever, tuberculosis, poliomyelitis, cholera, ascariasis, dysentery, hepatitis are examples of illnesses in which the pathogens they carry causes (Graczyk et al., 2001; Graczyk et al., 2005). Flies readily transport bacteria on their carcass, hairs, or sticky pads on their foot to our meals resulting in digestive disorders, in addition to polluting food with eggs and maggots by releasing saliva and excrement, which may contain bacteria. Fly eggs or maggots are sometimes laid on the skin or wounded-opening of humans and faunas. Houseflies can preserve disease-causing organisms on their absorbent mouthpart, carcass, and the hairs of their legs, of which it is promptly conveyed to the subsequent exterior place, such as man foodstuff because they consume contaminated material such as man and animal waste, saliva and mucus, and wound' secretions (Manzon and Sanchez, 1997). Houseflies' habits, including walking and feeding on trash and excrement, make

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them ideal transporters of disease-causing organisms to man and animals. Many Diptera species complete their life cycle in animal wastes naturally. Anthrax, Shigellosis, Cholera, *Aspergillus* spp., *Penicillium* spp., Helminth eggs, and other diseases are known to be transmitted mechanically by houseflies. Humans and livestock are also subjected to psychological stress as a result of them. The aim of this paper is to discuss five common zoonotic diseases transmitted by houseflies and their control.

Life cycle of housefly

In the holometabolic development of the housefly (*Musca domestica.*), an adult emerges from the pupa in a process known as eclosion. There are distinct phases of development (Figure 1): egg, larval or maggot, pupa, and adult (Sacca, 1964). The housefly spends the winter as a larval or pupa under manure piles or other safe areas. The development is favored by warm summer temperatures and being able to finalize its life sequence within 7 to 10 days. Nevertheless, in less-than-ideal circumstances, the life cycle could take up to eight weeks. In temperate regions, 10 to 12 generations could exist per year, however in subtropical and humid regions; there may be more than 20 generations per year (Hussein and John, 2014). Males are ready to mate the day they emerge, but females do not mate until they are three days old; meanwhile, the adult houseflies have a lifespan of 15 to 30 days (Sacca, 1964).

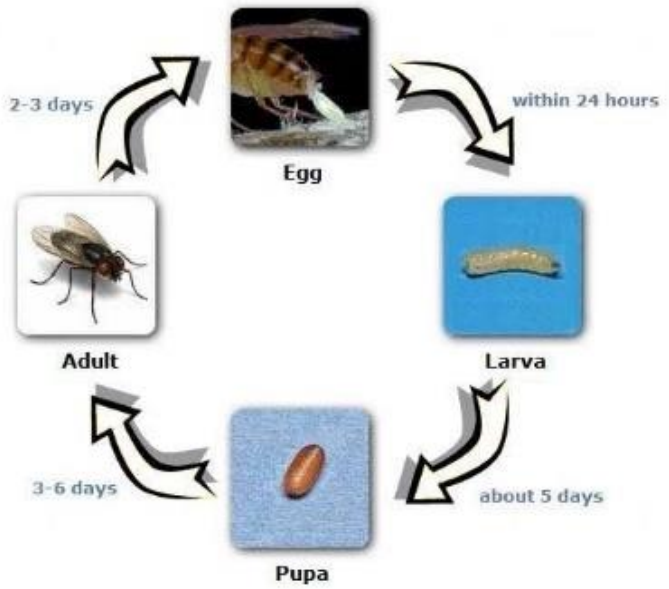

Fig. 1. Life cycle of housefly (Alan and Hui Meng, 2009).

A lone couple of membranous wings, multifaceted ruddy eyes, finely segmented tarsi, and four dim tiles on the thorax characterize the adult housefly. Its mouthparts are spongy, allowing it to take up fluid. Housefly will be able to eat solid food after converting it to a molten form thru spattering saliva or retching on it and allowing salivary gland discharges to break it down. They eat twice or three times per day (Sacca, 1964). Feces, animal dung, flesh, and further decomposing biological waste are common food sources for house flies. Pathogens adhere to their body surfaces during eating, which they then transport back to residential homes and farmhouses, in which they reside and finish their life processes (Takken and Knols, 2007).

Occurrence

Houseflies prefer unclean food and garbage as breeding grounds (Ahmadu et al., 2016). Water is an essential aspect of its nutrition because it cannot survive for longer than 48 hours without it. Milk,

syrup, beef broth, and a variety of other items found in human settlement zones are all sources of food for houseflies (Iqbal et al., 2014). The confines, blind and the aloft cables of structures, the plants, several kinds of alfresco cables, are places described as nocturnal relaxing spots for the flies. Outdoor flies' aggregations in chicken ranches are mostly found in the branches and shrubs at night, but practically the entirety of inhabitants inside poultry buildings congregate in its confines (Hussein and John, 2014). According to the findings of a research project in Texas, the best cohabiting sites for houseflies were horse muck, man filth, cow dung, fermented vegetal, and human waste. In addition, houseflies can be found in large numbers in places where people congregate, like clinics, marketplaces, slaughterhouses, restaurants, farmsteads, and poultry pens, are examples of places in which they annoy humans and domesticated animals, as well as possible disease carriers (Awache and Farouk, 2016).

Why are they attracted to humans?

Maneka Gandhi wrote a paper that was recently published four years ago.

Here are some of the reasons they come into contact with humans:

- They are drawn to carbon dioxide, which is exhaled by humans.
- Flies are drawn to the heat of a heated body, additionally as sweat and salt, and therefore the more an individual sweats, the more the flies they attract.
- Flies eat dead cells and open wounds, and oil is a significant source of nutrition for them.
- To liquefy solid food, a fly vomits on it. House flies use their feet to style things thus if there is food on the skin and enough house to liquefy it, they're going to land there.

Mode of disease transmission

The majority of disease-causing germs are transmitted mechanically by houseflies. Mechanical transmission occurs when the vector comes into direct touch with the vertebrate host. During the process, the disease-causing bacterium does not develop in the vector. Their ability to transport infections is attributed to their hairy body structure and sticky jointed appendages pad (Khamesipour et al., 2018). Even when breeding sites are numerous, and conditions are favorable, they migrate a few miles in a couple of days (Ebenezer et al., 2020; Nazni et al., 2005; Winpisinger et al., 2005). Unlike biological transmission, the mechanical transmission does not result in pathogen proliferation in the host. The fly, on the other hand, has been shown to carry enough germs on its body surface to generate an illness (Hindle and Merriman, 1914). The number of disease-causing organisms found inside the stomach is frequently greater than the number found on the body's surfaces, implying that excreta and vomitus could be a primary route of pathogen transmission (De Jesús et al., 2004; Pava-Ripoll et al., 2012). Houseflies are intimately connected with microorganisms at all stages of life (larvae, pupae, and adults) (Service, 2008).

Common diseases distributed

M. domestica is thought to hold a variety of microorganisms, including *viruses, fungi,* and *bacteria* (Nayduch and Burrus, 2017). The housefly has been found as an active vector of contagions like *Shigella* spp. and *Campylobacter* spp. (Bahrndorff et al., 2013; Greenberg, 1973; Holt et al., 2007), as well as a bacteria carrier like *Campylobacter jejuni* (Cohen et al., 1991), *Salmonella spp.* (Förster et al., 2009), *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterococcus,* and other bacteria. The housefly's intimate relationship with bacteria, as well as its involvement in pathogen transmission, makes it a paradigm model organism for studying the relevance and diversity of vector species' microbiota (Cohen et al., 1991). The diseases transmitted by houseflies include Epidemic Cholera, ORF Virus, Anthrax, dysentery, intestinal flu, Ascariasis, Tuberculosis, Bacillary Dysentery. Here's a quick rundown of some of the most common diseases spread by the insect:

Anthrax

Anthrax is a worldwide disease that affects nearly all household animals and humans. *Bacillus anthracis* is a gram-positive, non-motile, spore-producing rod that causes anthrax (Carlson et al., 2018). Although spores are unlikely to grow in an enclosed carcass, spore production happens when organisms are expelled from a diseased animal's body. The housefly family is responsible for mechanical transmission (Fasanella et al., 2010). These flies land on a carcass with open wounds, saliva, feces, or blood leaked. Thus, the flies could have anthrax bacilli or spores on their legs and bodies, as well as in their crop and intestines, after picking them up from the carcass. Flies are naturally drawn to injuries and skin abrasions and hence potentially spread anthrax bacilli or spores by touching the cut with their legs or bodies or by vomiting or excreting anthrax bacilli or spores into the cut. As a result, the sickness might be passed from man to man (WHO, 2003). Control measures are geared toward breaking the cycle of infection. These measures include:

- Cut off infection supply.
- Dispose of anthrax carcasses properly.
- Correctly clean, clean, and lose contaminated materials.
- Vaccinate exposed vulnerable animals and, wherever doable, humans in at-risk occupations (WHO, 2003).

Cholera

Cholera is a waterborne gastrointestinal disease characterized by critical, damp diarrhea caused by the bacterium *V.cholerae* (a gram-negative rod). It can progress to life-threatening diarrhea with retch and watery diarrhea. People can lose considerable amounts of fluid and salts if they are not treated quickly, leading to severe dehydration and death within hours. Human food is a commonplace where flies feed, crawl, and deposit eggs (Fotedar, 2001; Morris et al., 1995; Sasaki et al., 2000). By functioning as mechanical vectors of the bacteria *V.cholerae*, houseflies may aid in the spread of cholera (De Jesús et al., 2004). Cholera is transmitted through the fecal-to-oral channel, which can be transmitted directly from one individual to another or conversely through contaminated liquids from a long-standing ecological ditch, foodstuff, and possibly flies and contaminated non-living objects (Farhana et al., 2016). Cholera can be simply and successfully cured by substituting the body fluid and salts expelled due to diarrhea. Oral rehydration solution (ORS) is a ready mix of sugar and salts that is conjoined with 1L of water and drunk in bulky amounts to address cases. Intravenous fluid replacement is frequently required in extreme cases. Antibiotics can assist in shortening the extent and brutality of an illness, but they are not as important as rehydration. Those suffering from harsh diarrhea and retching in nations where cholera is present should seek medical care as soon as possible. Check to determine if there have been any recent cases of the disease in the region you wish to visit. Control measures include:

- Only drink water that has been bottled, boiled, alternatively, chemically treated beverages, as well as bottled or canned beverages.
- Rinse your hands frequently with water and soap, particularly before the consumption or making food, as well as after spending time in the toilet.
- Use bottled, boiled, or chemically treated water to wash dishes, brush teeth, prepare meals, and make ice.
- Put away dung in a hygienic manner to prevent environmental pollution (CDC, 2020).

Shigellosis

Shigella organisms are spread by mechanical vectors like houseflies. Seasons when both the insect and occurrences of diarrhea are common frequently coincide. Houseflies have an affinity for human feces, and the bacteriologic culture of held flies has shown that they become infected with Shigella organisms after coming into contact with infected human feces (Levine and Levine, 1991). Shigella contaminations are a public health

concern in developing and transitional countries due to their relative ease of transmission, the relentlessness of scientific illnesses, extensive medicine opposition, and absence of an approved injection. Whereas *Shigellae* is thought to be transferred largely by uninterrupted fecal-to-oral exchange and fewer of times through contaminated food and water, the fly *M.domestica's* role as a mechanical vector of transmission is sparingly well understood (Sack et al., 2004). During World War 1, Dudgeon detected a jump in housefly concentration in the fourth to the fifth month, followed by a rise in *Shigella* rate in British Army field hospitals one month later in Macedonia (Farag et al., 2013). From July 1916 to December 1918, Ledingham observed an increase in fly population, which was followed by an upsurge in the occurrence of dysentery two-four weeks later (Dudgeon and Yorke, 1919). Efforts to manage flies as a public health necessity have not been well adopted by the general community. Our understanding suggests that this is chiefly due to an absence of knowledge in the involvement of houseflies in the spread of *Shigella* (probably, other enteric diseases) and of enticed fly traps as an active, economical, and eco-friendly method of reducing housefly population (Ledingham, 1920). The long term solution for the reduction in infection rate is an incorporated tactic that comprises:

- Improvement in the quality of water
- Cleanliness
- Optimized nourishment
- Paying better attention to the medical need of the populace

ORF virus

The ORF virus (Poxviridae) is the cause of contagious ecthyma (sore mouth), a disease that mostly affects animals around the world, but also humans who come into contact with diseased animals. When ORFV infection occurs, house flies have been observed aggregating on the same body areas that have been found to be impacted by skin lesions (Cafiero, 2014; Galante et al., 2019). The findings show for the first time that *M. domestica* can mechanically carry ORFV (DNA) and mechanically transmit it. The dipteran can also excrete the ORFV genome via oro-fecal pathways (vomit/feces) and store it in the crops (Raele et al., 2021). As at the time that this paper was written, there was no approved treatment for this illness.

Ascariasis

Ascaris lumbricoides Linnaeus, 1758 is a parasitic worm belonging to the *Ascarididae* family that causes human Ascariasis diseases. In humans, it is the most common parasitic worm. Hosts become infected with Ascaris through a fecal-oral path. When infective eggs are consumed and hatch, Ascaris larvae develop in the parenteral tissues of the host (Dold and Holland, 2011). It is generally known that house flies play a role in the transfer of helminth eggs, such as *A. lumbricoides*. The most prevalent roundworm infection is Ascariaris (Emmanuel et al., 2016). Control measures include:

- Avoid swallowing soil that has been treated with human or pig excrement.
- Before handling food, clean your hands with soap and water.
- All raw fruits and vegetables should be washed, peeled, or cooked before consumption (WHO, 2012).

Control measures

Houseflies can be controlled using a range of techniques; a few of them are mentioned below:

Biological control

Predators, parasitoids, diseases, and herbivores are examples of natural pest enemies used in biological management. Humans and animals are not harmed when parasitic wasps are used. They hunt down and kill immature houseflies, but they can't eradicate entire housefly populations. As a result, using wasps in conjunction with other strategies to reduce house flies is recommended (Oghale et al., 2013). Natural enemies of houseflies, like endosymbiotic fungi and nematodes, fire ants, beetles, mites, opportunistic wasps (non-

detrimental to humans), birds, and flies will be accustomed to curb their populations (Hogsette et al., 2002). Hydrotae (Ophyra) larvae have been found to be facultative predators for controlling the population of houseflies (Geden and Hogsette, 2006). For decades, a pteromalid parasitoid that consumes houseflies at the pupa stage has been implemented as a further operational BCA of the housefly populace (Lietze et al., 2011). The MdSGHV virus belongs to the Hytrosaviridae family, which was recently discovered. Adult forms of houseflies and other flies are known to be susceptible to the family. Infected flies have a shorter lifespan and a lower rate of successful mating than healthy flies (Miller et al., 1971). Housefly maggots can be managed by feeding *Bacillus thuringiensis* to chickens and cattle, then conveying the germs to their breeding places in compost (Iqbal et al., 2014).

Cultural control

Cultural control entails manipulating the environment to prevent pests from gaining access to vital resources. The most effective cultural strategy is to properly dispose of garbage or any other organic debris that can serve as a breeding ground for eggs of houseflies. It is a reality that roughly half of all houseflies in municipal regions occur as a result of poor waste management in households, hospitals, and markets. Garbage should be disposed of on a regular basis, and waste bins should have adequate lids. Wastes should be cleaned up on a weekly basis at the very least (Hussein and John, 2014). In any fly-control program, sanitation should be the first step to be taken. Materials that the houseflies will deposit eggs on should be detached, demolished as a breeding spot, or segregated from the adult capable of depositing eggs (Lazarus et al., 1989). Because houseflies are capable of accomplishing the entirety of their cycle of reproduction within a week, better dung elimination procedures, like the suggested a week (or more frequent) disposal, can be critical in disrupting housefly's life cycle. The above-mentioned strategy has proven to be a cost-effective way to reduce housefly populations (Bennett, 2008). Reducing the number of exposed garbage clearance facilities or choosing sealed/shielded sites reduces the origin of houseflies. Relocating disposal sites away from residential areas can be a cost-effective way to reduce pollution sources (Das et al., 2018).

Chemical control

Pesticides or flies catcher, or both, can be used indoor and outdoor of establishments to keep flies at bay (Issa, 2019). Certain considerations, such as resistance and tolerance of houseflies to pesticides, rising insecticide costs, and insecticide toxicity for creatures other than houseflies, make the use of insecticides less successful (Iqbal et al., 2014). Essential oils have been shown to have fumigant insecticide effects due to acetyl cholinesterase obstruction and octopaminergic activity (Isman, 2000). Botanical oils usage has been shown to alter the performance of houseflies in terms of their ability to draw, repel, and poisonous state when they come into contact with flies at various developmental stages (Koul et al., 2008). For the purpose of curbing houseflies, the study created and tested mycoinsecticide bait compositions. The findings showed that mycoinsecticide baits might achieve similar levels of mortality as a chemical insecticide product and that fly visits to mycoinsecticide bait formulations can be boosted with the inclusion of constituents having appealing or arrested qualities. In places where insecticide spraying is prohibited, mycoinsecticides in bait formulations provide an alternate to the customary chemical insecticides for the control of houseflies (Baker et al., 2020).

Discussion

The study by Emmanuel et al. (2016) revealed that Houseflies carry parasites on their bodies, including *A. lumbricoides*, and confirmed that the Housefly is a vector that transmits parasites to humans. Due to poor sanitation, it primarily affects populations in poorer countries in the tropics and subtropics (CDC, 2010).

According to Fasanella et al. (2010), the findings confirmed the role of insects in anthrax infection

transmission. Given the enormous magnitude of fly populations frequently linked with anthrax outbreaks in domestic animals, this contribution, albeit minor, cannot be overlooked from an epidemiological standpoint and suggests that fly control should be considered as part of anthrax control initiatives.

According to Farag et al. (2013), a significant increase in Shigella dysentery cases occurs simultaneously with or shortly after the yearly seasonal increase in housefly density.

Raele et al. (2021) found that homogenized ovine ORFV (DNA)-positive crusts are suitable for infecting houseflies; this situation is very similar to what might occur in nature during an ORFV outbreak, where fresh scabs of infected animals could be a major source of the virus for synanthropic flies like *M. domestica*. To avoid the spread of this disease, further research should be undertaken.

The findings of Ali et al. (2015) show that the cholera burden remains high. Efforts for an integrated strategy to cholera control are critical for preventing the disease's spread and reducing the disease's mortality and morbidity. The lack of statistical analysis for the many disorders described is a key limitation in this study.

Conclusion

In this paper, the common diseases transmitted by houseflies were explained and the impact that they have on humans. They have the ability to transmit diseases that are harmful to humans' health. Because they graze freely on both human food and unclean waste, houseflies spread diseases. Maintaining adequate cleanliness would help to keep their population in check. It is suggested that more research be conducted on *M. domestica* Linnaeus.

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Conflict of interests

No conflict of interests.

Ethical approval

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