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Article

Enterobius Vermicularis: Biology, Transmission, and Control Strategies (Review)

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Abstract: *Enterobius vermicularis*, commonly known as pinworm or threadworm, is one of the most prevalent intestinal nematodes worldwide, infecting approximately one billion people across all socioeconomic groups, particularly children. This review aims to comprehensively describe the biology, life cycle, transmission routes, pathogenicity, diagnostic methods, and prevention strategies of *E. vermicularis*. The parasite exhibits a direct life cycle, with infection occurring mainly through ingestion or inhalation of embryonated eggs, facilitated by poor hygiene, overcrowded living conditions, and contaminated environments. Although many infections are asymptomatic, enterobiasis may cause significant clinical manifestations such as nocturnal perianal itching, sleep disturbances, gastrointestinal discomfort, secondary bacterial infections, and in severe cases, complications affecting the genitourinary and nervous systems. Diagnosis primarily relies on microscopic stool examination and the Scotch tape test, which remain the most effective and widely used techniques for detecting pinworm eggs. Control of enterobiasis is challenging due to frequent reinfection and the high transmissibility of eggs; therefore, preventive measures emphasize personal hygiene, environmental sanitation, health education, and periodic screening, particularly among school-aged children. This review highlights the public health importance of *E. vermicularis* infection and underscores the need for integrated control strategies to reduce its prevalence and associated health impacts, especially in developing regions.

Keywords: Roundworm, Oxyuridae, Common intestinal parasite, Nocturnal perianal itching

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1. Introduction

Pinworms are parasitic worms that infect approximately one billion people worldwide across all socioeconomic levels and are the most common parasitic worms (1). The oldest known pinworm eggs in human specimens are from carbolites (dried feces), found at Ducklin Oasis in Egypt and Danger Cave in Utah (2). Pinworm eggs have also been identified in dried feces approximately 1,000 years old and recovered from Mesa Verde, Colorado (3). (4) determined the threadworm as an example of an ancestral parasite, meaning it is a host-specific parasite with a long history of coevolution with early human ancestors dating to Africa. The organism once identified on the continent in 1758 by Karlinnaeus, name Oxyuyris vermicularis. It is generally restricted to humans, although related species can infect. Threadworms are a cause of numerous health and

psychological problems in children and adults of both sexes (5). The threadworm parasite is so named because of its long, pointed tail, which resembles a pin (6). Infection rates are as high as 40%, depending on age and ethnicity (7). Children are often affected at school or when they live in crowded conditions (8). In urban , children are particularly at risk for enterobiasis due to the ease of transmission in the eschool environment (9). Threadworms are most common in temperate climates, although they can affect almost all populations in a wide variety of climates. However, they thrive in temperate regions (10). Some individuals are asymptomatic, while others experience a variety of symptoms, nausea, diarrhea, insomnia, irritability, urinary tract infections, loss of appetite, anal itching, and malaise. It has also been reported that persistent infection with this parasite can affect children's mental development (11). Pinworms can also burrow into the colon wall and peritoneum. Live worms often wander in the vulva, causing vulvar itching and irritation associated with a scanty vaginal discharge (12). Persistent scratching of infected patients around the anal area may lead to a minor bacterial infection (13). Although the infection is silent in most adults, pinworms are a universally recognized worm and are difficult to control. They can be easily transmitted from person to person by contaminated hands. Direct contact between fingers and the anus is an easy route of transmission under favorable conditions of overcrowding, such as in primary schools, orphanages, refugee camps, and nurseries. Pinworm infections in the general population should never be ignored and need to be treated appropriately.

2. Materials and Methods

The case highlights the need for routine parasitological examinations to detect intestinal parasitic infections and to take all necessary therapeutic measures to eliminate the pinworm burden (5). High prevalence of enterobiasis can be detected in children with low socioeconomic status, and this infection affects the general health as well as the intelligence of affected children (14). Pinworm eggs are commonly detached from the perianal area and adhere to clothing, bedding, and other surfaces (15). The risk of E. vermicularis is attributed to a lack of awareness of environmental hygiene conditions,From a public health perspective, it is necessary to further study the risk factors for pinworm infection (16).

Classification of Enterobius vermicularis

The pinworm was classified by Linnaeus in 1758 and based on (17)

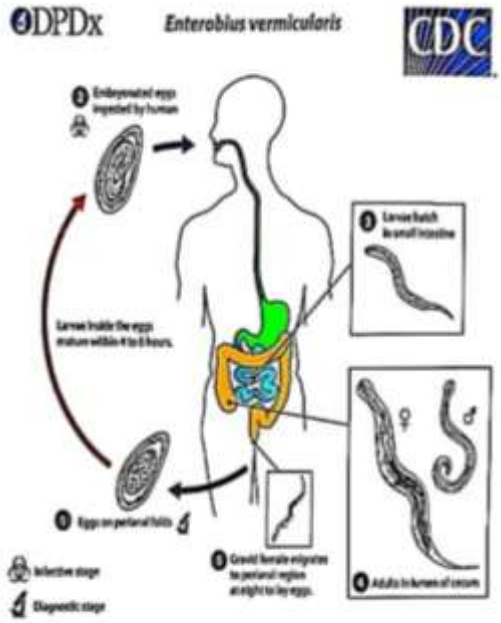
Kingdom : Animalia
Phylum: Nematoda
Class: Rhabditea
Order: Oxyurata
Family: Oxyuridae
Genus :Enterobius
Species: vermicularis

The life cycle of the pinworm parasite begins with ingested eggs. These eggs are laid at night by the gravid female. The eggs are ingested by person-to-person contact with contaminated surfaces such as clothing, bedding, curtains, carpets, etc., or by inhaling or swallowing the eggs. Self-infection can also occur if the eggs are transferred to the mouth by fingers that have scratched the perianal area (19). After ingestion, the larvae hatch from the eggs in the duodenum (the first part of the small intestine) and grow rapidly to a size of 140–150 micrometers in length. They migrate through the small intestine toward the colon (20). During this migration, the worm undergoes two moults to become adults (21). Females take for 5–13 weeks, while males live for about 7 weeks. Male pinworms mate with females in the distal small intestine. The male pinworm usually dies after mating and is excreted from the host in the feces (22). Female pinworms reside in the intestinal lumen, such as the cecum (the beginning of the large intestine), appendix, and ascending colon, where the larvae attach or fix themselves with mucus and ingest the colonic contents (23). The time interval from ingestion of the worm egg to oviposition by the adult female is

about one month. The average adult lifespan is about two months. Estimates of the number of eggs in pinworms range from 11,000 to 16,000 (21).

3. Results and Discussion

The pregnant female migrates at night to the rectum and crawls on the skin of the anal area to lay her eggs. The larvae develop within 4 to 6 hours under optimal conditions (19). The female pinworm has evolved a strategy to exit the anus by depositing eggs in the folds of the anal skin, a process known as ovipositing (24). Newly hatched larvae may migrate back to the anus, a process known as erosion. As they move along the skin near the anus, the worms lay their eggs either by contracting and shedding the eggs, dying and disintegrating, or being torn apart by the host (a scratch from the worm). After laying the eggs, the female becomes opaque (translucent) and dies. The reason for the female exiting the anus is to obtain the oxygen needed for the eggs to mature (20).



(CDC , 2019) *Enterobius vermicularis* دورة حياة طفيلي الشكل (1-2)

Morphological and anatomical characteristics of pinworms: The female is 8 mm to 13 mm long, white in color, and pointed at both ends. It features a long, thin, and elongated tail, giving it the appearance of a pin. The male is 2 mm to 5 mm long and features a strongly ventrally curved posterior end (25). The worm has a prominent tail supported by papillae, in addition to a single spine of 80 μm to 100 μm (26). The vulva opens between the first and second thirds of the body, and it has two inflated uteruses that fill almost the entire body when it contains thousands of eggs (27). The worm also has a specialized tubular excretory system with three ducts, arranged in an H-shape (28). The worm's body is cylindrical in shape and its cuticle consists of 3 main outer layers made of collagen and other mixtures surrounded by cuticle, The worm also has a slightly striated cuticle, visible to the naked eye as small pieces of white thread. The anterior oral end, or labial end, lacks a true buccal capsule but is equipped with three lips with a dorsoventral bladder-like epidermal growth (29). The cuticle layer on the worm is removed so that it can invade the digestive tract. The worms molt four times, the first two before hatching and then before adulthood (30). The reproductive system shows a T-shape in the act of segmentation, a characteristic of the eggs that can be seen inside the uterus (20).

Threadworms are oviparous parasitic worms, with a single worm laying approximately 4,600–16,000 eggs. Threadworms are oval-shaped and oblong on one side, 50–60 μm long and 20–30 μm wide. The egg has five layers: an inner layer, a lipid layer, three middle layers known as membranalucida, and an outer proteinaceous layer. This membrane of egg sticky and itchy, , important in the life cycle (30). The larvae differ in

that they are coiled (31). The female worm lays approximately 11,000 tiny eggs outside the anus or around the vagina and urethra at night when the child is asleep. The egg membrane is covered with an irritating mucus, which causes intense itching and scratching(32). The eggs are transferred to the hands and from there to the mouth for infection (25). The eggs are fully mature and susceptible to infection within a few hours, and due to their tough walls, they can survive in the harshest conditions for several days. Infection occurs by ingesting or inhaling the eggs (33). Males are rarely seen because they die after copulation and are discarded (34).

Sources of infection and / methods of transmission.

Pinworm infection occurs when infective eggs a contaminated environment (35). Infection occurs in one of four ways:

1. Retrograde infection, the larvae migrate to the large intestine after hatching.
2. Autoinfection, a patient is reinfected by hand-to-mouth transmission.
3. Cross-infection, infective eggs are ingested, contact with contaminated surfaces or body parts of infected humans.
4. Inhalation of airborne eggs via the nose and mouth (36). Due to the high level of cross-infection, these eggs may remain viable for 2-3 weeks on clothing and bedding, facilitating their easy spread among family members , children (37). Vegetables was a major role in the spread of infection, like lettuce, celery, leeks, and other vegetables that carry threadworms to humans (38).

Al-Naili (39) confirmed that insects, most notably houseflies, play an effective role in the spread of pinworm infections, as they isolate the external surfaces and digestive tract of flies, and high rat of parasite spread recorded places where waste is excreted. Researcher Al-Aredhi (40) also mentioned in a study he conducted in different areas of Diwaniyah Governorate, where he found ten types of parasites, representing 74.66% of the total, including pinworm eggs. The percentage of parasites transmitted by cockroaches was lower, 25.44%. This indicates that the spread of flies was greater in environments contaminated with pathogenic parasites. Abdullah (41) confirmed that mice found in homes are predisposed to infection with pinworms of human origin, and may have a hidden role in perpetuating pinworm infections in human society, especially those where pinworms and house mice are prevalent.

Pathogenicity

Pinworm infection occurs when infective eggs are by accident swallowed in infection the environment (35). morbidity is caused by gravid female worms that migrate at night to the anus to lay their eggs on the skin (ovipositor). The female releases all the eggs. This causes intense itching and a sensation of irritation, leading to scratching of the area (36). Symptoms of infection include hypersensitivity to the ovaries and the development of urticarial Acidosis associated with this infection, psychological disturbances, nervous symptoms, itching around the anus, irritation, fatigue, loss of sleep, its effect on the digestive system, abdominal pain, necrosis of the wall

Intestinal infections, appendicitis, colitis, and intestinal infections may lead to secondary bacterial infection, loss of appetite, anemia, mechanical obstruction of the intestine, and weight loss (42). They also cause severe anemia, iron deficiency, and decreased hemoglobin levels (43). Another pathological cause of pinworm infection is enuresis in children (25). Elevate levels of IgE antibodies are found infected with pinworms (44). The worms migrate to the carbohydrate-rich tissues of the intestinal wall and secrete hydrolytic enzymes (45).

Methods of diagnosis

1. Microscopic tests

The microscope is used to diagnose some protozoa and eggs of parasitic worms in the intestine after collecting stool samples and observing their appearance, color, and consistency—solid, semi-solid, soft, or liquid. Blood cells may also be present (45). The soft sample contains the feeding stages of protozoa, which are easier to observe than the cystic stages, which may not be present in fully formed samples but can sometimes be diagnosed in fully formed samples (46). Microscopic diagnosis is based on ,Three techniques, the first of which is the direct wet vet smear, which is the easiest and involves

mixing a quantity of feces with a drop of normal saline on a glass slide, then examining it under a microscope. Iodine stain may be used.

Concentrations , which includes sedimentation and flotation. As a result of the difference in the density of the cysts with the density of the solution, they settle at the bottom of the tube when they settle, while the eggs float to the surface of the suspension when they float, also due to the difference in density between the eggs and the solution. The third technique of microscopic examination is the fixed smear, in which the samples are permanently stained. Preservatives such as 5% and 10% formalin are used for this purpose. Examples of these stains are Iron-hematoxylin stain (47). It is preferable to examine stool samples within 30-60 minutes after they arrive at the laboratory. It is recommended to examine 3 samples within 10 days by the CDC, as it increases the sensitivity of microscopic examination from 85-95%. There are a number of factors that affect the samples, such as delaying their delivery to the laboratory, which causes the decomposition of active phases or contamination of samples with water and urine, which leads to difficulty in diagnosis (48).

2. Scotch Tape

The most common method for detecting eggs is to use a piece of it , then attached to a slide and examine. Preparing a clear cellulose tape is the most used procedure for detecting pinworm infection. The first use of this tape was in 1997. Procedure by Graham (49), where a 10 cm strip of cellophane is cut, placed over the anus by pressing it 3-4 times and glued onto a glass slide for microscopic examination This test is successful if performed in morning for several days, as 90% of cases are detected, as females do not lay eggs daily (18).

Clinical singe

enterobiasis may take weeks , months to become notice before ingesting the eggs (21). While some individuals develop symptoms, others are nonspecific (50). The adult have large numbers of eggs in the area surrounding the rectum. Itching is a typical symptom, , which lead to scratching and bacterial infections (51). In, the host has some clinical signs of the disease, but no evidence of the it can be documented through test despite efforts to locate it. This is called "cryptic worm infection" (52). In females, pinworm infections can spread and cause itching or vaginal discharge (vaginitis). Other singe include abdominal discomfort, appendicitis, and inflammation of the colon and reproductive tract (53). Several clinical findings, such as nighttime teeth grinding, weight loss, and urinary incontinence, linked to pinworm infections (54).

Prevention and Control

Preventive treatment relies primarily on personal hygiene, cleanliness of living areas, and sanitation (55). Frequent bathing and washing the rectum with hot water and soap are recommended in cases of infection or rectal oocysts. Changing underwear, blankets, and bedding can help prevent reinfection., the infection is common and easily acquired. Nail biting is the most effective route of infection, so nails should be kept short. Reinfection should be prevented by careful hand washing after and before meals (36)., bedsheets, nightclothes, (27). Infection affects human health in general, but especially children, and plays a major role in the causes of urinary incontinence. (25).

Intestinal parasite infection is a major health problem worldwide. According to the World Health Organization, it is estimated that more than 24% of people worldwide are infected with intestinal parasites, with a high prevalence in developing countries (56). Norman (57) also confirmed that the uncontrolled food and animal products may contribute to the spread of infections with various types of parasites, especially worms. Among the materials that cause parasite transmission are vegetables, which often transmit the cystic stages of primary parasites as well as worm eggs (11). Intestinal infections caused by the threadworm E. vermicularis are widespread worldwide (58). Shahdoust (25) reported that climatic and important role in the transmission of intestinal parasites , and migration and travel contribute to the emergence of some parasites in countries where they were not previously endemic. As such, nematodes subject of studies on their epidemiological, pathological, diagnostic, and preventive strategies (59). Enterobiasis is a parasitic infection that affects approximately one billion people across all socioeconomic

levels (60). E. vermicularis, commonly referred to as the threadworm or seatworm, belongs to the phylum Nematoda and has the greatest geographical distribution of any parasitic worm (61) They are creamy white, filamentous parasites. Males are 2-5 mm long and females 8-13 mm long. They are found mainly in the ileal region of the intestine, but are commonly found throughout the gastrointestinal tract, from the stomach to the rectum. The female threadworm parasite, laden with eggs, migrates to the anus at night to lay sticky eggs on the skin there. The eggs on the anal skin develop into the infective stage (implanted eggs) within a few hours at body temperature, The eggs, once detached from the skin, can survive for two to three weeks in a moist environment. Often, the eggs are transferred from the anus to the hand of the infected person and then to their mouth or to the mouth of another person, They are also carried by house dust. Further human infection occurs through ingestion of these eggs, which are common mainly in children (62)In some cases where the incidence is low, most adults are asymptomatic. However, children with hyperinfection with enterobiasis may exhibit symptoms including nervousness, delayed growth, insomnia, irritability, as well as weight and appetite loss (63). Common infections cause relatively mild symptoms, usually severe itching in the perianal area covering the entire skin. Diagnosis can be made by detecting and identifying eggs attached to the skin around the anus, which is achieved by placing cellophane tape (Scotch tape) over the areaOn the anal area early in the morning before defecation or bathing (18). In physiology, female pinworms may sometimes lose their way back to the anus and enter the vagina and urethra closest to the anus and then ascend the reproductive system and even reach the peritoneal cavity along the fallopian tubes. After the pinworms have entered the female reproductive system, they may cause vaginitis, vulvar irritation, endometritis, and pelvic inflammatory disease (PID) (64). It is usually endemic in crowded settings such as kindergartens and elementary schools, due to easy transmission between infected and uninfected children (65). Although effective treatment has been established for decades, control of enterobiasis is difficult due to re-infection, incomplete treatment, and easy transmission (66). More than half of the cases are asymptomatic, and reports indicate that enteric infections in adults are uncommon, with a few available reports of enteric infections and associated symptoms such as chronic diarrhea, appendicitis, urinary tract infections, vulvar pruritus, postmenopausal bleeding, nocturnal enuresis, anaphylaxis, and perianal abscess. Occasionally, the infection is discovered incidentally during colonoscopy or during surgery (67).

4. Conclusion

Conclusions

From the study results, the following conclusions were reached:

a) The study results showed a high incidence of pinworm infection among children, based on several factors, such as geographic distribution, gender, age group, economic status (standard of living), family size, and parental education level.
b) Microscopic stool examinations and Scotch tape are the optimal method for testing for pinworm parasites.
c) The most prevalent worm among other intestinal parasitic worms.
d) The highest incidence of pinworm infection was recorded among children aged 4-9 years.
e) School-age children are the age group most susceptible to infection.
f) The results showed that males are more susceptible to infection than females.

Recommendation

a) Health education plays an important role in supporting the control program by explaining the parasite's life cycle, infection methods, and disease prevention methods, as well as cooperation between state educational, health, and agricultural institutions.
b) Adopt microscopic examinations to diagnose threadworms, such as stool and tape samples, to provide faster results and determine prevalence rates among hospital and health center visitors.

c) Examine and monitor food workers, provide preventive supplies, monitor imported food, and monitor transportation, preservation, and storage methods.
d) Conduct periodic examinations of children, especially those of school age, in cooperation with health authorities to diagnose threadworm infections through microscopic examination of stool or tape, and treat the disease as quickly as possible.
e) Expand the scope of sanitation services to keep pace with population growth, especially in rural areas, and develop an appropriate control strategy. Improve the economic situation of the population and provide essential life supplies, healthcare centers, and medical detachments throughout the country.
f) Conducting subsequent studies on how to combat pinworm eggs by using disinfectants and household cleaners.

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