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Blood Glucose Levels in Individuals Infected with Soil-Transmitted Helminths in Padang West Sumatera, Indonesia

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A B S T R A C T

Chronic infections in the human gut are most commonly caused by helminths spread through soil. Worms have been found to provide immunity to several illnesses, including inflammatory diseases and metabolic syndrome. This study aims to investigate adult members of scavenger families who have been exposed to soil-transmitted helminth infections in terms of their fasting blood glucose (FBG) levels. To check for soil-transmitted helminths, feces are examined using the direct method using iodine, and the Kato Katz method to count the number of eggs per gram of feces. The hexokinase enzymatic approach was used to test blood glucose levels during a fast. Infections with soil-transmitted helminths were categorized as mild in all study participants. When soil-transmitted helminth infections were compared to controls, there was a statistically significant drop in FBG levels ($p<0.05$). Thus, it may be said that soil-transmitted helminth infections spread through the soil can lower adult blood glucose levels.

Introduction

Around 1.5 billion individuals, or 24% of the global population, are thought to be afflicted with soil-transmitted helminth (STH) diseases, making it one of the most prevalent infections globally. In tropical and subtropical regions, these illnesses primarily affect the most impoverished and disadvantaged groups that have limited access to clean water, sanitation, and hygiene. The highest prevalence of these infections has been documented from sub-Saharan Africa, China, South America, and Asia. Their transmission occurs by eggs found in human feces, which pollute soil in unsanitary regions. The roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworms (*Necator americanus* and *Ancylostoma duodenal*) are the primary species that infect humans (WHO, 2023).

Soil-transmitted helminth infections are most frequent in individuals living in endemic areas, due to exposure at all times during their lives, starting immediately after birth until adulthood. The highest prevalence is in elementary school-aged children because they often play in the soil and the development of cellular immunity is not fully developed, but it can affect adults who are influenced by the environment and occupations such as farmers (Nurhayati, 2020; Nurhayati, 2021).

Worm infections can cause nutritional disorders, gastrointestinal disorders, and anemia (Sari, 2020), but

despite these negative effects, worm infections have a protective effect on several allergic diseases and metabolic syndrome (Arrais, 2022; Rennie, 2021). Worm infection has also been shown to have a protective effect against several autoimmune diseases such as multiple sclerosis (Renesteen, 2020), inflammatory bowel diseases (Atagozli, 2023), and rheumatoid arthritis (Langdon, 2019).

Chen, in his research in China, found that the prevalence of diabetes and metabolic syndrome was low in the elderly with a history of *Schistosoma mansoni* helminth infection, characterized by low levels of blood cholesterol, blood glucose, and all other components of metabolic syndrome, so it is assumed that helminth infection can provide a protective effect against metabolic syndrome and diabetes (Chen, 2013). Wiria (2015) found that soil-transmitted helminth infection can improve insulin sensitivity. The results of these studies open up new studies in dealing with the problem of diabetes mellitus, whose cases are increasing worldwide.

Low blood glucose levels in soil-transmitted helminth infections may be explained by the worms taking nutrients from the host, but the role of worms in modulating immune responses has been reported (Harris and Loke, 2017). Intestinal helminth infection can suppress pro-inflammatory responses and improve insulin sensitivity, leading to protective effects against metabolic dysregulation such as diabetes and dyslipidemia. The interaction of intestinal helminth infection with the host immune system dampens effector pathways that result in deviation of the inflammatory response (Shi, 2022).

In chronic infection, helminths trigger macrophage differentiation from classically activated macrophages (CAMs) to alternatively activated macrophages (AAMs) characterized by the production of anti-inflammatory cytokines. The anti-inflammatory effect in soil transmitted helminth infection is assumed to increase insulin sensitivity, thereby reducing glucose levels in the blood. This is based on research by Lumeng (2007) in mice models that alternatively activated macrophage is able to maintain insulin sensitivity in fat tissue. Which is reinforced by the results of research by Hussarts (2015) found that chronic worm infection and worm derivative antigens reduce systemic insulin resistance (23%), increase peripheral glucose uptake (+ 25%) and insulin sensitivity in obese mice. In addition, worms were also found to have changed the composition of the microbiota in patients with diabetes mellitus (Khudair, 2021). The majority of research on soil-transmitted helminths is done on children in elementary school when their immunity is still developing. Meanwhile, research related to blood glucose and helminth infection in adult individuals is still limited, so further studies are needed. This study aims to examine blood glucose levels in adult individuals of scavenger families infected with soil-transmitted helminths.

Materials and Methods

Research location/Subjects

The study subjects were scavenger families living around a garbage dump in the suburbs of Padang, West Sumatera. Subjects did not consume cholesterol-lowering drugs, anti-diabetics, anti-allergies, and steroids. The total sample was 70 people, consisting of 35 people infected with soil transmitted helminths and 35 people not infected.

Research Ethics

This study has received permission from the Ethics Commission of the Faculty of Medicine, Andalas University Padang. All research subjects were explained the study including the purpose, risks and benefits of the study. Each of them was asked for consent to participate in the study.

Helminth Examination

Before the fecal examination, subjects were given a fecal pot and asked to collect it in the morning of the next day. The pots containing the feces were collected and brought to the laboratory. The fecal examination was carried out at the Parasitology Laboratory of FK UNAND by direct method using iodine as described by WHO (1991) and by Kato Katz method (Peters, 1980) to count the number of eggs.

Blood Sample Collection

Subjects positive for soil transmitted helminth infection and controls were asked not to eat breakfast and fast for about 8-10 hours before blood sampling. Blood was taken with aseptic procedures in the mediana cubiti vein by trained personnel, using a 3 cc syringe, 2 cc of blood was taken and put into an EDTA tube for fasting blood glucose testing.

Fasting Blood Glucose Estimation

Fasting blood glucose levels were examined by the hexokinase method according to Passey (1974).

Data Analysis

In the measurement of data normality, fasting blood glucose (FGB) levels were normally distributed. Differences in mean levels between individuals infected with soil-transmitted helminths and controls were analyzed using the t-test.

Results and Discussion

A total of 235 fecal samples from families of waste pickers aged 20 to 65 years in the suburbs of Padang were examined. 35 (14.8%) were positive for worm eggs, of which 20 (57.1%) were male and 15 (43.9%) were female. Of all infected individuals, the most common worm species were *Ascaris lumbricoides* 13 (37.1%), hookworm 12 (34.2%), and *Trichuris trichiura* 10 (29%), co-infection of *A. lumbricoides* and *Trichuris trichiura* 3 (8.5%), and co-infection of *A. lumbricoides* and hookworm 1 (2.8%). The number of eggs per gram of feces ranged from 11-1224. All subjects infected with soil-transmitted helminths were classified into mild infection levels, as presented in Table 1.

A total of 235 fecal samples from scavenger families aged 20 to 65 years old in suburban Padang were examined. In this age range, it is expected that their immunity is fully developed. A total of 35 (14.8%) were positive for worm eggs, of which 20 (57.1%) were male and 15 (43.9%) were female.

This study involved 70 research subjects, consisting of 35 worm-positive subjects and 35 controls. To avoid bias, body mass index categories were chosen equally between cases and controls.

Table.1 Characteristics of Research Subjects

Characteristics	STH infection	Control
	N= 35	N=35
Gender		
Male f (%)	20 (57,1)	20 (57,1)
Female f (%)	15 (43,9)	15 (43,9)
Age (year): mean±SD	35 ± 15	36 ± 29
Weight (kg): mean±SD	48 ± 10,2	50 ± 13,7
Height (cm): (mean±SD)	156 ± 6,4	158,6 ± 12,8
BMI category		
Underweight f (%)	16 (36,6%)	16 (36,6%)
Normal f (%)	14 (41,5%)	14 (41,5%)
Obesity 1 f (%)	5 (12,2%)	5 (12,2%)
Soil-transmitted helminth type		
***A. lumbricoides* f (%)**	13 (37,1)	-
Hookworm f (%)	12 (34,2)	-
***T. trichiura* f (%)**	10 (29)	-
***A.lumbricoides* + *T. trichiura* f (%)**	3 (8,5)	-
***A.lumbricoides* + hookworm f (%)**	1 (2,8)	-
Number of eggs/gram of feces(min-max)	11–1224	-
Level of infection		
light f (%)	35 (100%)	-
Moderate and severe f (%)	0 (0%)	-

Table.2 The mean difference in blood glucose levels of helminth-infected and non-helminth infected individuals

Parameters	Helminth (+)	Helminth (-)	P value
FBG level (mean ± SD)	98,8 ± 12,5	103 ± 10,7	p = < 0,05

The most common helminth species found were *Ascaris lumbricoides*, Hookworm, and *Trichuris trichiura*. Hookworm appeared to be in second place, in contrast to previous studies which found hookworm to be in third place after *Trichuris trichiura*. This may be explained by the subjects' occupation as scavengers who often handle soil directly with their hands, or feet that do not wear boots. It is known that hookworm transmission is not through dirty hands, but larvae that penetrate the skin.

All subjects infected with soil transmitted helminths in this study were classified as mild infections, as presented in Table 1. Although helminth infections infect many children, but in this study we focused on adults, to rule out bias due to immune factors, assuming that adults have fully developed immunity.

In this study, blood glucose levels in individuals infected with soil transmitted helminths were lower than in controls (Table 2). Madden (2004) in his study has seen a decrease in glucose absorption in the intestinal epithelium of nematode-infected mice. Although the underlying mechanism is unclear, it is strongly suspected to be related to the Th2 immune response to nematodes.

This study shows that soil transmitted helminth infection reduces fasting blood sugar levels in adult subjects with mature immune systems. This adds evidence that mild soil transmitted helminth infection has a positive effect on the prevention of diabetes mellitus.

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Author Contributions

Nurhayati: Conceived the original idea and designed the model and wrote the manuscript; Selfi Renita Rusjdi: Designed the model and the computational framework and analysed the data; Eka Novita: Writing - Review & Editing

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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