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RESEARCH ARTICLE

GEOPHAGY, ANAEMIA AND GEOHELMINTH INFECTION AMONGST NON-PREGNANT WOMEN IN VHEMBE DISTRICT, SOUTH AFRICA

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ABSTRACT

This study focused on determination of haemoglobin levels in blood of female geophagists and identification of helminth ova in geophagic materials as a possible route for transmission of helminth infections amongst non-pregnant female geophagists. Sixty eight non-pregnant female geophagists, between the ages of 18 and 49 and 5 non-pregnant women between the ages of 18 and 45 (control group) were recruited for the study. Of the 68 non-pregnant female geophagists that were enrolled for the study, 9% of the women were diagnosed of severe anaemia, 35% were anaemic and 56% were normal. All the women in the control group had their haemoglobin levels within the reference range and were normal. An ovum similar to *Ascaris lumbricoides* ovum was detected in one of the geophagic material. Decreased haemoglobin level may be due to geophagy and poor availability of iron supplements in food. This study suggests that geophagy is associated with anaemia, but could not be a probable mode for transmission of geohelminth infections in this locality.

INTRODUCTION

Intentional or involuntary ingestion of soils, anthills, clays, dried up pond sediments and termite mounds is referred to as geophagy, geophagia or pica. This habit has been in existence from historical times and it is widely practiced across the globe (Abrahams, 2005). The rationale why soils are consumed could be very difficult to establish, but known causative reasons are as follows: Food and food detoxifier (Johns, 1986; Aufreiter *et al.*, 1997), as a source of pharmaceuticals (Vermeer and Ferrel, 1985), due to neuro–psychiatric and psychological reasons (Danford *et al.*, 1982) and as a nutrient supplement (Mills, 1996; Davies, 2008). In sub-Sahara Africa, geophagy concerns most pregnant women, lactating mothers and children. This is as a result of inadequate essential elements (Fe, Zn, Cu, Mn, Co, Ca) necessary for formation of new tissues at foetal and maternal stages that is lacking in their normal diets (Chappius and Favier, 1995).

The additional need for these elements cannot be provided by food alone, nutrient supplementation is recommended by way of geophagic practice (Dupin *et al.* 1992) for proper healthy growth of the developing baby and mother. However, there are a number of medical problems that are associated with geophagic practice which includes, iron deficiency anaemia (Danford, 1982), mechanical bowel disorder (Keay *et al.*, 1982), nutritional dwarfism and a potential route for transmission of pathogens (Magnaval *et al.*, 2001). Geissler *et al.* (1998) has identified geophagy as a possible risk factor in the transmission of various geohelminth parasitic infections and also could be implicated in the development of iron depletion and anaemia. Geophagy was also said to be a risk factor for *Ascaris lumbricoides* infection and that it equally plays a role in the transmission of other parasitic infections like *toxocaris* and *amoebiasis* amongst school children in Kwazulu Natal Province of South Africa (Saathoff, 2002). Hooda *et al.* (2004) were of the opinion that geophagia may be more common in groups of people that are at greatest risk of iron deficiency due to poor diet compared to well nourished individuals. Mokhobo (1986),study involving patients in South Africa tend to support the theories that geophagia was a cause of iron deficiency anaemia.

Research undertaken by Munnich *et al.* (1968) using soil materials obtained in Turkey and the United States of America (USA) indicated that ingested clay materials can play a prominent role in the disease (Abrahams, 2011). Nchito *et al.* (2004) undertook a controlled trial that investigated the effect of Fe-supplementation on Zambian school children where geophagy was prevalent. The authors could not support the hypothesis that geophagia is a result of hunger for this mineral nutrient, instead supporting the alternative that soil consumption lowers Fe status by interfering with its absorption from the human gastrointestinal tract (Abrahams, 2011). Anaemia and iron deficiency during pregnancy is a serious risk factor for maternal mortality, poor pregnancy outcomes, low birth weight and infant mortality in developing countries (Kawai *et al.*, 2009). Helminth infection affects over one billion people in tropical developing countries and contributes to severe morbidity (Kawai *et al.*, 2009). Women who practice

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geophagy may be particularly at risk of infection with *Ascaris lumbricoides, Strongyloidesstercoralis* and *Trichuristrichuira* by ingesting eggs from contaminated soils. Geohelminths are parasites in which at least one developmental stage (ova) requires period of development or incubation in the soil prior to being infective. Non-segmented round worms (*A. lumbricoides* and *S. stercoralis*), hookworms (*Nectar americanus* and *Ancylostomaduodenale*) and whipworm (*T. trichuria*) all constitute part of a group of helminth referred to as geohelminth (Sumbele *et al*., 2011). Occurrence of geohelminth in soils is normally linked to the sanitary conditions and habits of the people in the environment in which soils are found (Sumbele *et al*., 2011). The pathway by which humans get infected with these helminth could be by ingestion (*A. lumbricoides, T. trichuria*) or percutaneous (*S. stercoralis*) and others could be both ways; *A. duodenale* and *N. americanus* (Sumbele *et al*., 2011). The purpose of this study was to determine the haemoglobin level of non-pregnant female geophagists and identification of helminth ova in geophagic materials, with a view to establish any link between geophagy, anaemia and helminth infection.

MATERIALS AND METHODS

Study population

The research was conducted between September and October, 2011 in Vhembe District, South Africa. The District is predominantly rural, which reflects the notion about geophagic practice; which states that it is a habit that is mainly associated with people of low socio-economic status. The study population was limited to non-pregnant women attending out-patient consultation clinics and hospitals. Pregnant women were excluded from the study because they were potentially at risk with iron deficiency anaemia due to the developing foetus. Some selected hospitals and rural clinics were visited and the objectives of the study were explained to them in a meeting; with the heads, staff and nurses in the local languages, Tshivenda, Sotho and Xitsonga. In the meeting, informed consent was obtained from all the patients. Only consenting individuals were accepted and they were at liberty to withdraw at any stage of the study.

Collection of blood samples and geophagic materials

5 ml of blood was collected from consenting geophagists (person who eats earth materials) by a Medical Laboratory technician registered with Health Professions Council of South Africa.A total of thirty geophagic materials were collected from the area. Twenty samples were bought from retail outlets in the local markets. These were mainly smooth grey–brownish natural clays. Eight samples were collected from various geophagic mining sites in some of the communities. They were yellowish silty sandy material found on the bare surface of the earth. Two samples were collected from termite mound found on bark of decayed tree in the area. A list of the sample localities with brief description of the materials and coordinates is found in Table 1.

Experimental

Determination of haemoglobin

Haemoglobin content of the blood was measured using a Complete Blood Count (CBC) 5 coulter counter (Coulter Corp, Miami, FL). This test was to determine the extent of iron deficiency (anaemia). Anaemia was defined as haemoglobin <11.0 g/dl, severe anaemia as <8.5g/dl and >11 g/dl normal haemoglobin human level (Massawe *et al*., 1999; Kawai *et al*., 2009).

Microscopic identification of helminth ova in geophagic samples

Preparation of zinc sulphate solution

Three hundred and thirty (330g) of ZnSO4 was diluted with distilled water in a standard flask and shaken properly. The mixture was made up to 1L mark in the flask.

Preparation of iodine solution

Ten (10g) of potassium iodide was added into 1 L of water and shaken properly to dissolve completely. Then 10 ml of iodine was added to the mixture and shaken thoroughly.

Determination of helminth ova in geophagic materials

Three (3) grams of each powdered geophagic samples was placed in a tube and 15 ml of $ZnSO_4$ was added. The mixture was homogenised by stirring properly. The suspension was strained through a sieve of aperture of 80µ. Supernatant from the mixture was poured into a centrifuge tube and centrifuged at 13600rpm for two minutes. The supernatant was decanted and resultant sediment containing the suum was placed on the glass slide and few drops of iodine was added to stain the suum and slide was covered with a cover slip and viewed at X10 magnification. (Shinondo and Mwikuma, 2009).

Data analyses and presentation

The data obtained were analysed using Statistical Package for Social Sciences (SPSS) version 16.0. The significance of the differences between the experimental and control groups were determined using one paired student's *t*-test.

Ethical considerations

The study protocol was approved by Health, Safety and Research Ethics Committee, University of Venda. Permission was equally sought and approved by Ethical Committee of Health and Social Welfare Department, Limpopo Provincial Government, South Africa. Informed signed consent was obtained from all study participants before collection of blood samples.

RESULTS

Sixty eight non-pregnant geophagic women between the ages of 18 and 49 years mean age of 25 years and 5 non-geophagic women between the ages of 18 and 45 years mean age of 26 were enrolled into the study. Of the sixty eight non-pregnant women, 9% of the women were diagnosed of severe anaemia, 35% were anaemic, while 56% were normal (Table 2). The mean haemoglobin value for the experimental group was 11.34 g/dl±2.09 while the mean haemoglobin for the control group was 13.94g/dl±1.5g/dl (Table 3). There was significant (t = 3.6, p = 0.0001) difference between the two groups. The remaining 29 samples and 3 control samples were devoid of any helminth ova. The only sample with *A. lumbricoides* ova (Fig. 1) was sold in Mutale local market. The geophagic vendor obtained her supplies on weekly basis from a middle woman who in turn obtains her supplies from the miner.

Table 1. Localities, description of geophagic materials

Sample number	Location	Description	Coordinates
001	Louis Trichardt	Yellowish smooth clayey material	23° 01′ 39″S 29°54′ 19″E
002	Makuya	Reddish brown termite mound	22° 53′ 57″S, 30° 02′ 37″E
003	Tshisaulu	Fine clayey material	22° 47′ 48″S, 30° 45′ 09″E
004	Tshisaulu	Smooth clayey material	22° 48′ 15″S, 30° 44′ 18″E
005	Gaba	Very smooth clay	22° 48′15″S, 30° 44′ 18″E
006	Mathasha	Grey clayey material	22° 53′ 52″S, 30°31′ 35″E
007	Sibasa[a]	Brown clay	22° 57′ 00″S, 30° 28′ 18″E
008	Thohoyandou[a]	Highly compact clay	22° 59′ 39″S, 30° 26′ 47″E
009	Thohoyandou[b]	Yellowish smooth clay	22° 58′18″S, 30° 27′ 28″E
010	Thohoyandou[c]	Very fine textured clay	22° 58′ 18″S, 30°27′ 27″E
011	Thohoyandou[d]	Brown compact clay	22° 58′ 18″S, 30° 27′ 27″E
012	Thohoyandou[e]	Sandy clay material	22° 58′ 18″S, 30° 27′ 28″E
013	Elim[a]	Smooth clayey material	23° 09′ 23″S, 30° 03′ 17″E
014	Elim[b]	Yellowish clayey material	23°09′ 23″S, 30° 03′ 18″E
015	Sibasa[b]	Clay with decayed vegetation	22° 56′ 58″S’ 30° 28′ 19″E
016	Thohoyandou[f]	Silty clay material	22° 58′ 18″S, 30° 27′ 28″E
017	Thohoyandou[g]	Greasy clayey material	22°58′ 18″S, 30° 27′ 28″E
018	Thohoyandou[h]	Yellowish clayey material	22° 58′ 27″S, 30° 27′ 30″E
019	Thohoyandou[i]	Fine clayey material	22° 58′ 27″S, 30° 28′ 30″E
020	Sibasa[c]	Smooth clayey material	22° 56′ 58″S, 30° 28′ 18″E
021	Shanyaba	Fine textured clay	22° 58′ 18.5″S, 30°27′ 27.8″E
022	Elimmarket[b]	Pale smooth clay	23° 09′ 23.3″S, 30°03′ 18.6″E
023	Univen Recreation park	Fine clay material	22° 58′ 29.7″S, 30° 26′ 45″E
024	Tshandama	Friable smooth material	22° 52′ 49.5″S, 30° 05′ 34.8″E
025	Riverside Residence	Reddish termite mound	22° 58′ 27.4″S, 30° 27′ 01.9″E
026	Westgate Residence	Fine clay with decomposed roots	22° 58′ 20.8″S, 30° 31′ 05.9″E
027	Russel shop Thohoyandou[f]	Fine clay material	22° 58′ 18.5″S, 30° 28′ 18″E
028	Fashion world shop Thohoyandou[g]	Compact clay	22° 58′ 24.4″S, 30° 27′ 29.5″E
029	Pep shop Thohoyandou[h]	Very smooth clay	22° 58′ 28.2″S, 30° 27′ 31.1″E
030	Pep shop Thohoyandou[i]	Fine textured material	22° 58′ 28.2″S, 30° 27′ 31″E

Table 2. Distribution pattern of haemoglobin level (anaemia) for experimental group

Reference value (g/dl)	Frequency	Percentage (%)	Cumulative percentage
< 8.5	6	9	9
< 10.99	24	35	44
> 11 g/dl	38	56	56
Total	68	100	100

Table 3. Mean haemoglobin and standard deviation values of experimental and control groups

Experimental group (n =68)		Control group (n = 5)		
Mean	Standard deviation	Mean	Standard deviation	p –value
11.34	2.09	13.94	1.5	0.0001*

*Statistically significant at ≥ 0.05

Table 4. Geohelminth ovum in geophagic materials

Sample	*A. lumbricoides*	*T. trichuria*	*S. stercoralis*	Hookworm
1- 20	-	-	-	-
21	+	-	-	-
22 – 30	-	-	-	-
Negative control 1-3	-	-	-	-

Four different types of geophagic materials were consumed by geophagists in the area. These are reddish brown termite mound found on bark of tree, yellowish silty sandy material found on horizon A soil profile, gray smooth natural clays and whitish geophagic materials believed to be magnesite (mineralogical data not reported in this study). Results of ova identification on 30 samples and 3 negative control samples (Table 4) showed that *an A. lumbricoides ovum was* detected in sample 21.

DISCUSSIONS

Mean haemoglobin levels were low in geophageous women than in non geophageous women. This is consistent with previous studies on pica (a form of geophagy) in adults with iron deficiency due to menorrhagia or pregnancy (Barton *et al*., 2010). Severe anaemia suggestive of iron deficiency was associated with the prevalence of geophagy. This was similar to the work of Raphuting *et al*. (2011) where results of haemoglobin for the control group were within reference range while the geophagic group were decreased. The significant difference in the two results pointed out that some geophagists were anaemic. Also, geophagy was associated with decreased haemoglobin concentration and a marginally risk of anaemia among Human immunodeficiency virus (HIV) infected women in Tanzania (Kawai *et al*. 2009). Geophagy has been associated with iron deficiency and anaemia, but no causal relationship has been established (Nyaruhucha, 2009; Raphuting *et al*., 2011). Other studies have reported geophagy to be associated with severe iron deficiency anaemia in up to half of the people who practiced it (von Garnier *et al*., 2008). Conclusions drawn from these studies were supported by this present study. Munoz *et al*. (1998) reported that occurrence of pica is not necessarily related to the severity of iron deficiency anaemia. The control group in this study were neither anaemic nor iron deficient and as such this study does not support the views of these investigators.

Figure 1. Embryonated*Ascaris lumbricoides* ovum

Geohelminth infection was linked to iron deficiency anaemia among HIV infected women who indulge in geophagia (Kawai *et al*., 2009; Bisi-Johnson *et al*., 2010). Anaemia resulting from geophagia, to which the craving for soil was attributed, is believed in some cases to have actually resulted from the worm infection encountered by ingestion of soil (Bisi-Johnson *et al*., 2010). This finding by Bisi-Johnson *et al*. (2010) is not supported by the findings of present study and that of Bopape *et al*. (2008). The causes of iron deficiency anaemia are known to be multi factorial. These include; geophagy, inadequate intake of essential nutrients in diet and poor availability of iron supplements in food (Bopape *et al*.,2008). Results of helminth ova identification showed *A. lumbricoides* association with geophagy but no associations were noted between geophagy and other helminth infections, such as *T. trichuria, S. stercoralis,* and Hookworm. *A. lumbricoides* infections may be a consequence of soil pica (Kawai *et al*. 2009). Results obtained from this study were consistent with their study. Similar researches in Zanzibar, Tanzania found no association with infection with *A. lumbricoides*, *T. trichuria* and Hookworm (Young *et al*., 2007; Kawai *et al*., 2009).

Some researchers have speculated geophagy to be a risk factor for soil transmitted helminth infection, exposure of individuals to parasites (Mokhobo, 1986; Kawai *et al*., 2009) and contribute to the helminth load when soils with infective stages of parasites are consumed (Luoba *et al*., 2004; Peter, 2011). These observations were similar to this present study. Saathoof *et al*. (2002) and Glickman *et al*. (1999) found that geophagy is a risk factor for *A. lumbricoides* infection and that it also plays a leading role in the transmission of other parasitic infections namely *toxocariasis* and *amoebiasis.* This study is not consistent with the views of these authors. In a related study by Sumbele *et al*. (2011) *A. lumbricoides*, *S. stercoralis*, *T. trichuria* and Hookworm infection amongst geophagic individuals in the Eastern Cape Province of South Africa was linked to geophagy. According to Shinondo and Mwikuma (2009), geophagy does not put pregnant women at risk for geohelminth infections because no ovum was isolated from the soils ingested by these women. Also, Kutalek *et al*. (2010) were of the opinion that geophagy is not a cause of adult helminth infection. Their finding is not supported by this study as a geohelminth ovum of *A. lumbricoides* was identified in one of the geophagic sample from this locality.

Limitations of this study

The major limitation of this study was inadequate number of control subjects (non-female geophagists) to match or close to the number of consented subjects. Most women were not willing to participate in the study for fear of using their blood to determine their Human Immunodeficiency Virus (HIV) status. The study involved patients who had visited referral hospitals and clinics during the period of this study. Haemoglobin level of other female geophagists who did not visit health facilities during the period of study were not represented in this study.

Conclusions

This study has demonstrated that geophagy could be one of the causes of anaemia (decreased haemoglobin level) and a probable mode for transmission of geohelminth infections (*A. lumbricoides*) amongst female geophagists in Vhembe District. The detection of a single geohelminth ovum in geophagic material could be due to sanitary state of the environment. There is need for health providers and social workers to educate the populace on dangers posed by eating earth materials with high cation exchange capacity as this could impede the uptake of soluble Fe, Mn and Cu leading to decreased haemoglobin level as reflected in this study. Some of the female geophagists with decreased haemoglobin level should be encouraged to eat iron rich foods and oral intake of iron folate could correct the decrease in haemoglobin level. The widely held view that geophagy is associated with anaemia is supported by this study.

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