HAEMATOLOGICAL AND IRON STATUS OF QWAQWA WOMEN IN SOUTH AFRICA WHO INGEST CLAYS

LF Mogongoa, CE Brand, L de Jager, GE Ekosse

1 School of Health Technology, Central University of Technology, Private Bag X 20539, Bloemfontein, Free State Province, South Africa
2 Directorate of Research Development, Walter Sisulu University, Nelson Mandela Drive, Private Bag XI, Mthatha, Eastern Cape Province, South Africa

ABSTRACT
Geophagia is the deliberate habitual consumption of soil and clay. This habit is practiced worldwide and is also common in southern Africa. There are many reasons given for the practice of geophagia like cultural, medicinal, religious and mineral deficiency. Geophagia has been associated with anaemia and recently, specifically with iron deficiency anaemia. The reason for this association includes, among others that clay could actually lead to decreased bioavailability of iron for absorption in the body through kaolinite. The aim of was to investigate the link between iron deficiency anaemia and geophagia in QwaQwa women since this link has not been investigated in South Africa. In this pilot study, blood was drawn from five women who do not consume soil (control group), and twelve women who consumed soil (geophagic group). The participants were from the same vicinity (area) or household, with the expectation that they follow similar diets. Full blood count and iron studies were performed in order to determine the prevalence of iron deficiency anaemia. The results indicated that iron deficiency anaemia was not evident in the control group. In contrast half of the geophagic group had iron deficiency anaemia while the rest of the participants had a state of iron deficiency without anaemia. In conclusion, iron deficiency anaemia is associated with geophagia, and geophagia predisposes or contributes to the development of iron deficiency.

KEYWORDS
Geophagia; pica; iron deficiency anaemia; QwaQwa; hypochromic microcytic anaemia; ferritin

INTRODUCTION
Geophagia, which is a form of pica, is the deliberate consumption of earthy substances including soil and clay [5]. It is widely practiced in Africa, America including USA; Asia including India and China, Australia, and Europe [2-9]. In order to be diagnosed as geophagia, a person must have consumed earthy substances continuously for more than one month [1]. Geophagia is reported among women and children in southern Africa [10], particularly in South Africa. Geophagia is more commonly associated with women during pregnancy, early childhood, mental retardation or psychiatric abnormalities and also in some cultural (specifically family history) and religious traditions [3-12]. There are many reasons given for the practice of geophagia. Women practicing geophagia believe geophagia enhances beauty [8], could be beneficial to pregnant women [11] or even enhance fertility [14]. While literature suggests that the craving could be attributed to a deficiency of nutrients or minerals such as iron, zinc or calcium [3-12]. In addition, Yao [15] suggests that geophagia may serve as a meal replacement, although this hunger theory is not supported by Young et al. [14].

Geophagic clays are usually selected from specific sites such as termite mounds, pits and riverbanks [7]. The colour and texture of the clay may have an influence on the type of soil consumed [5]. White clay is composed largely of kaolin; while yellowish and reddish clays contain iron, which could be a source of iron supplement [17, 18]. Unfortunately many of the geophagic soils contain mainly ferrous-oxide iron that is poorly absorbed by the body [18]. The geophagic clays from QwaQwa contain predominantly quartz and kaolinite. In addition, they contain smectite, goethite and calcite in smaller quantities [19]. It is believed that clay inhibits the absorption of iron from the gut into the blood stream [1]. Kaolinite, a kaolin mineral, is negatively charged. When kaolin is present in the geophagic clay, this negatively charged kaolinite will bind to both Fe²⁺ and Fe³⁺ from the duodenum meaning that these forms of iron are not absorbed by the individual [20]. Despite the fact that iron could be supplied from geophagic clays and absorbed as possible nutritional supplements [17], there are scientific debates regarding the association of iron deficiency anaemia in geophagic individuals [11, 21].

Iron deficiency anaemia is the most common cause of anaemia worldwide [10, 21]. One of the reasons for iron deficiency anaemia is the result of an imbalance between the absorption of iron and an excess loss of iron because of bleeding. This phenomenon occurs more often in women of child bearing age due to menstrual blood loss and pregnancy. Functional iron in the human body is in the form of haem iron, which is found in haemoglobin and is responsible for the transportation of oxygen. Storage iron is present in macrophages as haemosiderin and ferritin; both forms are available for the production of newly formed erythroblasts. Another source of iron is present in muscle as myoglobin and most cells in the body have iron containing enzymes [22]. In a healthy individual, iron is recycled, therefore the actual loss of iron is 1mg per day through the excretion of urine, faeces, nails, hair and skin; and absorption from a well-balanced diet is also 1 mg [22]. When senile red cells are broken down the released haem iron binds with transferrin for transportation to macrophages for erythroblasts production in the bone marrow [22].

The aim was to investigate the haematological and iron changes of iron deficiency anaemia in geophagic QwaQwa women. This link has not been investigated in South Africa. Literature mostly linked anaemia with geophagia, with few stud-
ies specifically linking iron deficiency anaemia with geophagia. Two case studies of African women who consumed soil for more than 10 years have indicated the association of geophagia with iron deficiency anaemia [14, 20]. The discussed patient in von Garnier et al., [20] failed to respond to oral iron therapy since she was still consuming stones. She was subsequently treated with intravenous iron replacement which corrected the anaemia. On a three month follow-up still had a haemoglobin value within normal reference range [21]. The lesson from this study was that physicians should consider asking whether patients are geophagic [20]. Geophagia is associated with iron deficiency in humans but whether people consume iron because of iron deficiency or iron deficiency is the result of geophagia has not yet been established [1, 23]. While other authors [24, 25] believe that pica is a symptom rather than a cause, no conclusive study has proved this finding specifically for geophagia.

EXPERIMENTAL SECTION

Women from QwaQwa were randomly identified by a field worker through door to door recruitment. An interview questionnaire was completed to obtain the participants’ demographic and geophagic data; with emphasis on clay consumption habits. Demographic information sought included information such as family history of health conditions, as well as major and minor health implications that could lead to the consumption of clay. Only healthy participants between the ages 20 and 50 years of age where included in the study. Pregnant and lactating women were excluded from the study, since these conditions can cause iron deficiency anaemia by increasing the demand. The control group had to comply with the same criteria as the geophagic group; preferably be from the immediate vicinity or same household, with the exception of consuming clay.

This study was approved by the ethical committee of the University of the Free State (reference number Etovs 104/08). The participants were informed about the study; gave informed consent for participation and collection of clotted and EDTA blood specimens. The EDTA specimen was used for the full blood count analysis, reticulocyte count, and erythrocyte sedimentation rate (ESR) determination. A blood smear was made on each specimen and stained to confirm the morphology on the red blood cells and to confirm the eosinophil count [24]. The clotted specimen was used for iron studies which were performed by a private laboratory. The tests included C-reactive protein (CRP), total serum iron, transferrin, transferrin saturation and ferritin studies.

Full blood counts were performed using the ABX PENTRA 60 which uses current impedance changes; spectrophotometry; double hydrodynamic sequential system coupled with cytometry; and measuring of transmitted light; to measure the different parameters of the full blood count [27]. ESR was measured using the SEDIPLAST® which is a closed system based on the Westergren method. The Westergren method is considered the gold standard [28] and it is recommended by the International Council for Standardization in haematology (ICSH). The reticulocyte count was performed manually by two individuals using the standard supravital staining technique [26].

The iron studies were performed by van Rensburg private pathologists on the serum specimens. The total serum iron and transferrin were done on the Beckman Coulter CX9 and the transferrin saturation automatically calculated. The ferritin studies were performed on the Siemens Advia Centaur using a method as described by UCSF Clinical Labs-Chemistry [29].

**RESULTS**

The control group consisted of five women with a median age of 26 and a range of 21 to 50 years. The geophagic group consisted of twelve women with a median age of 34 and a range of 21 to 47 years. Most of control group women were from the same household or vicinity as the geophagic participants and therefore, had similar eating habits as determined by the food frequency questionnaire (data not presented).

**Table 1:** Median results of haematological studies on control and geophagic groups.

<table>
<thead>
<tr>
<th>Laboratory test</th>
<th>Normal reference range *</th>
<th>Median values on control group &amp; geophagic group &amp; (min – max)</th>
<th>Student t-test p results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cell count</td>
<td>3.9 – 5.6 x 10⁹/l *</td>
<td>4.7 (4.1 – 4.9)</td>
<td>4.2 (3.6 – 5.1)</td>
</tr>
<tr>
<td>Haemoglobin</td>
<td>11.5 – 15.5 g/dl *</td>
<td>13.2 (12.4 – 13.5)</td>
<td>11.5 (9.0 – 14.0)</td>
</tr>
<tr>
<td>Haematocrit</td>
<td>36 – 48% *</td>
<td>39 (37 – 39)</td>
<td>34 (28 – 41)</td>
</tr>
<tr>
<td>MCV</td>
<td>80 – 95 fl *</td>
<td>82 (79 – 94)</td>
<td>79 (68 – 84)</td>
</tr>
<tr>
<td>MCH</td>
<td>27 – 34 pg *</td>
<td>28 (27 – 33)</td>
<td>26 (22 – 29)</td>
</tr>
<tr>
<td>Absolute reticulocyte count</td>
<td>25 – 125 x 10⁹/l *</td>
<td>94 (27 – 128)</td>
<td>49 (28 – 239)</td>
</tr>
<tr>
<td>Platelet count</td>
<td>150 – 400 x 10⁹/l *</td>
<td>374 (310 – 676)</td>
<td>301 (115 – 609)</td>
</tr>
<tr>
<td>Eosinophil count</td>
<td>0.04 – 0.44 x 10⁹/l *</td>
<td>0.28 (0.05 – 0.80)</td>
<td>0.07 (0.03 – 1.10)</td>
</tr>
<tr>
<td>ESR</td>
<td>12 or &lt; mm in 1 hour *</td>
<td>13 (5 – 40)</td>
<td>15 (2 – 100)</td>
</tr>
<tr>
<td>CRP</td>
<td>&lt;10 mg/l *</td>
<td>6.1 (&lt;2 – 10.1)</td>
<td>18.2 (&lt;2 – 39.9)</td>
</tr>
</tbody>
</table>

* = Hoffbrand et al. [21]; * = van Rensburg pathologists, Bloemfontein, 2008.
The results in Table 1 show that the red blood cell parameters (red blood cell count, haemoglobin, haematocrit, reticulocyte count) and red cell indices (mean cell volume (MVC), mean cell haemoglobin (MCH)) of the control and geophagic groups were within reference ranges. Hence there was no indication of HMA in the control group confirming the expectations, since the participants do not consume clay. The median red blood cell parameters of the geophagic group were within normal range except for haematocrit which is slightly decreased. The haemoglobin median was on the lower limit of the range; the minimum value was below the range and in comparison to the control group the geophagic group had a lower haemoglobin level. These findings, together with the fact that 42% (5/12) of the participants were anaemic, support the idea that geophagia is associated with anaemia as indicated in other studies [16; 20]. The medians of the red cell indices were slightly below the reference range and lower than that of the control group. The reason for the lack of noticeable difference between the groups is that iron deficiency anaemia is common to this study group, due to increased iron loss through menstruation amongst other factors [22]. Due to the differences observed between the groups and the fact that 42% of the geophagic participants had red cell indices below the reference range (which indicates hypochromic microcytic red cells). It can be concluded that approximately half the geophagic participants had an HMA. This supports the literature where geophagia was associated with anaemia and the fact that 42% of the geophagic participants had red cell indices below the reference range (which indicates hypochromic microcytic red cells). It can be concluded that approximately half the geophagic participants had an HMA. This supports the literature where geophagia was associated with anaemia and hypochromic microcytic red cells. The CRP was increased in two participants while ESR was increased in five participants.

Table 2 presents a summary of the results of the total serum iron, transferrin, transferrin saturation and ferritin for the control and geophagic groups. The geophagic group had decreased median values for the total serum iron, transferrin saturation and ferritin, meanwhile the control group had values within the normal reference ranges for all the iron studies. Anaemia due to iron deficiency was therefore confirmed by the iron studies as reflected in the geophagic group. A statistical significant change (p<0.05) was observed with transferrin saturation, total serum iron and ferritin concentration. For the control group, it can be noted that two participants had decreased percentage saturation with a normal ferritin, together with increased ESR. Furthermore, the entire geophagic group can be presumed to be iron deficient due to decreased serum iron, ferritin and percentage saturation with the exception of two participants whose values were within reference range.

**DISCUSSION**

Iron deficiency anaemia is characterised by a hypochromic microcytic anaemia (HMA) coupled with decreased serum iron, transferrin saturation and ferritin. Anaemia can be defined as a decreased haemoglobin concentration, while hypochromic and microcytic are a decrease in MCH and MCV, respectively. Serum ferritin levels are a reflection of the body’s iron stores thus it can be viewed as diagnostic, but it can be misleadingly increased during inflammatory response because it is an acute phase protein [22]. The median platelet counts of both the geophagic and control groups were within the reference range, and there were no statistical significant changes found between the groups. Each

<table>
<thead>
<tr>
<th>Laboratory test</th>
<th>Normal reference range</th>
<th>Median values on control group &amp; (min – max)</th>
<th>Median values on geophagic group &amp; (min – max)</th>
<th>Student t-test results</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total serum iron</td>
<td>9.0 – 30.4 μmol/L b</td>
<td>14.6 (10.9 – 19.0)</td>
<td>6.7 ↓ (2.4 – 13.2)</td>
<td>0.002892</td>
<td>0.994855</td>
</tr>
<tr>
<td>Transferrin</td>
<td>2.5 – 3.8 g/l b</td>
<td>2.69 (2.60 – 2.98)</td>
<td>2.94 (1.42 – 3.43)</td>
<td>0.020995</td>
<td>0.105945</td>
</tr>
<tr>
<td>Transferrin saturation</td>
<td>20 – 55% b</td>
<td>23.1 (18.1 – 32.5)</td>
<td>10.95 ↓ (3.6 – 30.5)</td>
<td>0.016504</td>
<td>0.00012</td>
</tr>
<tr>
<td>Ferritin</td>
<td>10 – 291 ng/ml b</td>
<td>16.8 (9.1 – 41.6)</td>
<td>8.1 ↓ (4.3 – 14.1)</td>
<td>0.060124</td>
<td>0.00012</td>
</tr>
</tbody>
</table>

b = van Rensburg pathologists, Bloemfontein, 2008.
group had one participant with an increased platelet count as observed by the maximum values reflected in Table 1. An increased platelet count can be associated with haemorrhage, chronic iron deficiency and trauma, amongst others factors [22]. Therefore normal counts for both groups signifies that there was no significant bleeding tendency (although not measured directly). This was also an observation by von Garnier et al. [20] who noted that anaemia caused by geophagia was not accompanied by bleeding.

The median eosinophil counts of both groups were within the reference range, except for one volunteer in each group. There were no significant statistical changes between the control and geophagic groups. An increased eosinophil count can be associated with parasitic infestation and allergy [22]. Therefore, normal eosinophil counts demonstrate in all probability that both groups did not have indirect evidence of parasitic infestation. This finding is supported by Young et al., [30] who did not find a significant association of parasitic infestation with geophagia in Zanzibar. This finding is contrary to other studies in the literature [31, 32], thus further investigation is warranted.

The median iron studies of the control group were within reference range, as depicted in Table 2, indicating no iron deficiency in this group. However, two participants had decreased transferrin saturation coupled with a normal ferritin. These results were supported by the red cell parameters and indices in Table 1 which indicated an absence of HMA. In contrast, the geophagic group showed an iron deficiency state where the median serum iron, transferrin saturation and ferritin were all below the reference range. This was also associated with statistically significant changes in serum iron (p=0.0028), ferritin (p=0.0165) and transferrin (p=0.0299). The serum iron of 58% (7/12) was below the reference range with the remainder being within the reference range. This is in contrast to the control group where the total serum iron levels were within the reference range.

The transferrin saturation of 83% (10/12) participants were below the reference range, with 60% of them (6/10) being below 10% saturation, which is commonly associated with iron deficiency anaemia [11, 12]. The remaining two participants had values of 21.7 and 30.5%, but this could be accounted for by the inflammatory response that they may have undergone as indicated by ESRs of 78 and 100 mm/hr in conjunction with CRPs of 8.8 and 27.5 ng/ml respectively.

Ferritin is a diagnostic indicator of body iron stores and demonstrated that the iron stores were below the reference range in 83% (10/12) of the participants. The remaining two participants had values of 13.5 and 14.1 ng/ml, and this was accompanied by ESRs of 15 and 100 respectively. In addition to this, the C-reactive results were 2.2 and 28 ng/ml respectively. The reason for the ferritin being within the normal range could be because of an inflammatory response or infection which was indicated by the ESR and CRP results. These normal values could still be lower than the reference range because in inflammatory conditions the threshold of 30-50 ng/ml should be used to distinguish the presence or absence of iron [34].

In summary, the full blood count and iron studies results all indicate that 42% (5/12) of the participants in the geophagic group had iron deficiency anaemia, while 42% (5/12) where iron deficient, without an indication of anaemia. The remaining 16% (2/12) who were complicated by inflammatory response findings, it can be surmised that they might be progressing to a point of being iron deficient. These findings are supported by numerous studies in the literature [1, 14, 15, 20, 28]. With the theory or statement made by Dugan [1] and von Garnier et al., [20] that kaolinite absorbs iron from the duodenum, it can be implied that geophagia contributes to iron deficiency instead of contributing towards the addition of iron to the body.

CONCLUSIONS

In spite of the small numbers in both groups the results obtained confirmed that the comparison between the iron status in the two groups differed tremendously and were statistically significant. The geophagic group could be classified as being iron deficient or having iron deficiency anaemia whereas the control group was not classified as being anaemic at all. The results obtained confirmed that there is a relationship between people consuming soil and iron deficiency anaemia. This pilot study is currently in the process of being followed up with a larger number of geophagic and control subjects.

ACKNOWLEDGEMENTS

The research team is thankful towards Mr FR Mokoena for field work done as well as serving as local language interpreter during sample collection, Mrs Annette van Onselen for the food frequency questionnaires, and Ms A Richter for preparations done prior to collection of samples.

REFERENCES


Support the SCIENCES and sponsor a page in an issue of MEDICAL TECHNOLOGY SA!

... with our new SPONSORSTRIP advertising option.

Call Karen on +27 21 783 5817 or email karen@adamsonfive.com for our latest rates and material specs.