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The practice of geophagia and the predisposing factors to hypokalaemia among pregnant women in rural Eastern Cape Province, South Africa

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Background. Hypokalaemia is a rare disorder among healthy pregnant women. Life-threatening muscle and cardiac malfunction may develop if it remains untreated.
Objectives. This study was carried out to estimate the prevalence and risk factors of hypokalaemia among pregnant women in rural Eastern Cape (EC) Province, South Africa (SA), and to establish whether geophagia, a common practice, increases the risk.
Methods. This cross-sectional analytical study included 188 participants with geophagia and 233 participants without geophagia enrolled at Mthatha Gateway Clinic, EC, SA. Data included sociodemographic characteristics, magnitude of geophagia, dietary patterns and serum potassium levels. The χ^2 test for categorical variables, analysis of variance to compare means, multivariate logistic regression for independent risk factors and principal component analysis for latent variable patterns that were associated with hypokalaemia were carried out. $P<0.05$ was considered statistically significant.
Results. Hypokalaemia among pregnant women in rural EC was five times higher than expected. Geophagia accounted for only 15% of the observed cases. The risk of hypokalaemia was higher among primigravidas aged <25 years with low meat, fruit and vegetable consumption who practised geophagia, with concurrent excessive cola or caffeinated soft-drink consumption.
Conclusion. Hypokalaemia is disproportionally prevalent among pregnant women in the rural EC. Young age, primigravida, geophagia, diet deficiency in meat, vegetables and fruits and excessive consumption of soft drinks increased the risk of hypokalaemia. The association of geophagia with low meat, vegetable and fruit consumption may indicate an underlying iron deficiency, necessitating further investigation.

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Hypokalaemia is diagnosed when plasma levels fall below the normal range of 3.5 - 5.5 mmol/L. In healthy pregnant women, hypokalaemia, as in the general population, is rare, and has a prevalence of only 1%.[1,2] When present, moderate or severe hypokalaemia is associated with life-threatening cardiac and muscular dysfunction that requires rapid recognition and treatment.[3] The markedly low frequency of hypokalaemia in the general population implies that there is an adequate supply of potassium in the diet and a normal functional absorptive capacity by the gastrointestinal system, and that the kidneys have adequate capacity to conserve potassium. Hence spontaneous development of hypokalaemia in healthy individuals who are not on any medication suggests the possibility of an underlying physiological defect that requires further investigation in order to institute adequate management.[2]

Proper management of a pregnant woman with hypokalaemia requires emergency stabilisation for patients with moderate to severe hypokalaemia, identification of the underlying cause by differentiating between acute intracellular potassium shifts, prolonged low intake, or increased renal or extra-renal potassium ion (K^+) losses, and titration of K^+ based on the cause and magnitude of the deficit.

Hypokalaemia is divided into three categories: mild (K^+ 3.0 - 3.5 mmol/L), moderate (K^+ 2.5 - 2.9 mmol/L) and severe (K^+ <2.5 mmol/L).[3] Most patients become symptomatic when the serum potassium falls to <2.5 mmol/L. However, symptoms of hypokalaemia could manifest at higher levels if there is a rapid fall in serum levels of K^+.[3]

Several cases of hypokalaemia in pregnancy and the peripartum period have been reported.[4,5] Most patients had a favourable maternal and fetal outcome with stabilisation of the maternal condition within 14 days, uneventful delivery and an uneventful puerperal period. Some patients, however, required intensive care owing to respiratory muscle paralysis, with miscarriage in one patient, while another had full recovery from hypokalaemia but a preterm delivery due to severe pre-eclampsia.[6]

Previous research has revealed that ~75% of all women in Oliver Tambo District in rural Eastern Cape (EC) Province, South Africa (SA), aged 20 - 60 years engaged in geophagia; the major reason for eating soil was craving during pregnancy.[7] Geophagia is a known cause of hypokalaemia in pregnancy, with life-threatening complications at times. It is not yet documented whether geophagia is the underlying cause of hypokalaemia among pregnant women in the EC. In addition, the prevalence of symptomatic and asymptomatic hypokalaemia among antenatal mothers and its association with geophagia is not known.

Methods

Study setting

Mthatha Gateway Clinic is a primary healthcare clinic that provides antenatal services to pregnant women in King Sabata Dalindyebo health subdistrict, which includes Mthatha town and the surrounding areas within the OR Tambo District Municipality. This area of the EC is largely composed of rural and peri-urban human settlements. The OR Tambo District Municipality is one of the poorest in SA, with high unemployment, 75% of households dependant on social welfare grants and 88% living below the minimum-wage living level.[8,9] The prevalence of geophagia among women of reproductive age was found to be ~75%.[7]

Study design

This was a cross-sectional analytical study to determine and compare the prevalence of hypokalaemia among pregnant women who report the practice of geophagia with those who have no history of geophagia.

Study population

The study population comprised all pregnant women aged 18 - 49 years attending antenatal care at Mthatha Gateway Clinic from 1 June 2017 to the end of January 2018.

Sample size

Moagi[10] found the prevalence of hypokalaemia to be 15% among pregnant women who practised geophagia at an antenatal clinic at George Mukhari Hospital in Gauteng Province, SA. Assuming a precision (e) of 5%, an α of 0.05 and power of 80%, the sample size for women with geophagia was calculated by the formula:

$n = Z^2_{\alpha} P (100 - P)/e^2$

$n = (1.96)^2 \times 15 (100\text{-}15)/25$

n = 196 women with geophagia.

A minimum number of 196 women with geophagia was found to be required.

Inclusion and exclusion criteria

All pregnant women aged 18 - 49 years were eligible to participate in the study. Pregnant women with renal disease, hypertension, cardiac disease, liver disease, a history of diarrhoea and vomiting in the previous 4 weeks, use of diuretics or known hyperaldesteronism, and those unable to express themselves due to a language barrier, were excluded.

Sampling

This was a convenience sample according to staff availability. Patients attending the Gateway Clinic were sampled sequentially with no obvious bias.

Data collection

An interviewer-administered questionnaire was used to collect relevant information from the participants. The presence of myalgia as reported by the participant, and muscle weakness through physical examination for muscle power on a scale of 1 - 5, were also recorded. A blood sample for serum K^+, sodium ions (Na^+), magnesium ions (Mg^{2+}), urea, creatinine and creatinine kinase was collected.

Data analysis

Data analysis was performed using SPSS version 18 (IBM Corp., USA). Data were summarised into proportions (%) for categorical variables and means (standard deviations (SDs)) for continuous variables. The χ^2 test was used to delineate the degree of association between categorical variables and hypokalaemia; and analysis of variance to compare means between different groups. Multivariate logistic regression to identify the independent risk factors of hypokalaemia, and principal component analysis to identify latent variable patterns that were associated with hypokalaemia, were carried out. $P<0.05$ was considered statistically significant.

Ethical considerations

Ethical clearance was obtained from the Human Research Ethics Committees of Walter Sisulu University (ref. no. WSU HREC 061/15) and the EC Department of Health. Written consent was obtained from each participant before enrolment in the study. Necessary steps were taken to ensure the participants' anonymity and confidentiality. The participants were informed of their right to withdraw from the study at any time without fear of adverse consequences.

Results

General characteristics of the participants

A total of 421 pregnant women were enrolled into the study. Of these, 188 were currently practising geophagia (44.7%), while 233 were not. However, 79 of these 233 had a previous history of geophagia, giving an overall rate of ever-practised geophagia of 63.4%. The mean (range; median) age for participants with and without current geophagia was 25.8 (14 - 43; 25) and 27.3 years (13 - 43; 27), respectively (p=0.01). The mean (range; median) parity for participants with and without current geophagia was 1.22 (0 - 7; 1) and 1.26 (0 - 8; 1), respectively (p=0.729). Current practice of geophagia was associated with younger age and lower consumption of meat and fruits (Table 1).

Prevalence of hypokalaemia

The overall prevalence of hypokalaemia (serum potassium <3.5 mmol/L) was 5.3% (n=21/394). The prevalence of hypokalaemia was 6.6 % and 4.4 % among women with and without current geophagia, respectively. There was no statistical difference in mean (SD) serum potassium levels of the participants with and without current geophagia (4.13 (0.51) and 4.17 (0.52), respectively) (p=0.355).

Risk factors for hypokalaemia

Overall, participants with hypokalaemia were more likely to consume lower amounts of meat and vegetables on a weekly basis, but had a higher tendency to participate in geophagia. However, only the consumption of meat was statistically significant (Table 2).

Binary logistic regression did not reveal any independent risk factor for hypokalaemia.

Stratified analyses according to age and parity, as well as factor analysis, were carried out to delineate the latent interactions through which variables predispose to hypokalaemia. Younger women, most of whom were primigravida, tended to have low meat consumption, a higher tendency to ingest large amounts of soil and a combination of low vegetable consumption but higher intake of soft drinks, which are high in caffeine and sugar. Older multiparous women with hypokalaemia had a comparable rate of meat consumption with the

multiparous participants without hypokalaemia. However, they had a lower frequency of vegetable consumption (Tables 3 and 4).

Discussion

The prevalence of hypokalaemia among antenatal mothers in this population was much higher than that reported in other populations.[1,2] This finding is of public health importance, given a prevalence five times higher than that reported elsewhere, and the fact that moderate or severe hypokalaemia is associated with life-threatening cardiac and muscular dysfunction that requires quick recognition and treatment.[2,3]

Contrary to our expectation, geophagia, which is practised widely in the study population during reproductive age, was not the main risk factor, nor was it an independent risk factor for hypokalaemia in pregnancy.[7] This study, however, found that the practice of geophagia was more common among younger participants, who reported a low frequency of fruit and meat consumption. Meat is a major source of dietary iron, while vitamin C (found in fruit) enhances iron absorption particularly from plant sources, hence the craving for soil during pregnancy may be secondary to iron deficiency.[11,12]

Low meat consumption was the only variable significantly

Table 1. Factors associated with geophagia

	No history of geophagia (*N*=233)			Geophagia in current pregnancy (*N*=188)				
Variable	***n***	**Mean (SD)**	**Median**	***n***	**Mean (SD)**	**Median**	**F**	***p*-value***
Age	232	27.3 (6.1)	27.0	188	25.9 (6.2)	25.0	6.631	0.010
Parity	232	1.26 (1.37)	1.0	186	1.22 (1.44)	1.0	0.237	0.729
Meat consumption (days per week)	233	3.98 (2.6)	3.0	188	3.47 (2.5)	3.0	4.283	0.039
Fruit consumption (days per week)	232	4.3 (2.5)	4.0	187	3.4 (2.5)	2.0	12.637	0.001
Soft drinks (L per week)	229	1.35 (1.6)	0.75	181	1.56 (1.9)	1.0	1.429	0.233
Veg. consumption (days per week)	231	5.2 (2.2)	7.0	186	5.1 (2.2)	7.0	0.418	0.518

SD = standard deviation; veg. = vegetable.
*$p<0.05$.

Table 2. Food frequency of participants with and without hypokalaemia

	Serum K^+ <3.5 mmol/L (*N*=21)			Serum K^+ ≥3.5 mmol/L (*N*=373)				
Variable	***n***	**Mean (SD)**	**Median**	***n***	**Mean (SD)**	**Median**	**F**	***p*-value***
Meat consumption (days per week)	21	2.67 (2.20)	2.0	373	3.89 (2.55)	3.0	4.975	0.026
Veg. consumption (days per week)	21	4.29 (2.13)	3.0	370	5.20 (2.20)	7.0	3.423	0.065
Amount of soil ingested (tablespoons per day)	13	16.9 (33.4)	1.0	231	7.4 (17.39)	1.0	2.760	0.098
Duration of geophagia (weeks)	21	104.7 (161.7)	8.0	373	84 (154.5)	12.0	0.340	0.560
Fruit consumption (days per week)	21	3.95 (2.62)	3.0	371	3.89 (2.56)	3.0	0.010	0.921
Soft drinks (L per week)	20	1.38 (0.66)	1.50	364	1.44 (1.79)	1.0	0.022	0.883

K^+ = potassium; SD = standard deviation; veg. = vegetable.
*$p<0.05$.

Table 3A. Food frequency of participants with and without hypokalaemia according to age category (years <25)

	Serum K^+ ≤3.4 mmol/L (*N*=11)			Serum K^+ >3.4 mmol/L (*N*=176)				
Variable	***n***	**Mean (SD)**	**Median**	***n***	**Mean (SD)**	**Median**	**F**	***p*-value**
Meat consumption (days per week)	11	1.45 (1.21)	1.0	176	3.88 (2.69)	3.0	8.767	0.003
Veg. consumption (days per week)	11	3.9 (2.1)	3.0	173	4.9 (2.3)	7.0	2.067	0.152
Soil ingestion (tablespoons per day)	6	30.8 (46.3)	11.5	112	4.14 (8.1)	1.0	26.291	0.000
Duration of geophagia (weeks)	11	103.3 (144.5)	4.0	176	64.5 (114.4)	12.0	1.115	0.284
Fruit consumption (days per week)	11	3.0 (2.3)	2.0	174	3.7 (2.5)	1.0	0.846	0.359
Soft drinks (L per week)	10	1.53 (0.63)	2.0	170	1.44 (1.7)	1.0	0.022	0.882

K^+ = potassium; SD = standard deviation; veg. = vegetable.
*$p<0.05$.

Table 3B. Food frequency of participants with and without hypokalaemia according to age category (years ≥25)

	Serum K^+ ≤3.4 mmol/L (*N*=10)			Serum K^+ >3.4 mmol/L (*N*=196)				
Variable	***n***	**Mean (SD)**	**Median**	***n***	**Mean (SD)**	**Median**	**F**	***p*-value**
Meat consumption (days per week)	10	3.9 (2.6)	3.5	196	3.9 (2.4)	3.0	0.000	0.987
Veg. consumption (days per week)	10	4.7 (2.2)	4.5	196	5.4 (2.1)	7.0	1.1987	0.275
Soil ingestion (tablespoons per day)	7	3.6 (7.2)	1.0	120	10.4 (22.5)	1.0	0.628	0.450
Duration of geophagia (weeks)	10	106 (186.9)	14.0	196	102.8 (181.8)	11.0	0.003	0.945
Fruit consumption (days per week)	10	5.0 (2.7)	7.0	196	4.1 (2.6)	3.0	1.238	0.267
Soft drinks (L per week)	10	1.25 (0.69)	1.0	193	1.44 (1.9)	0.75	0.108	0.743

K^+ = potassium; SD = standard deviation; veg. = vegetable.
*$p<0.05$.

Table 4A. Food frequency of participants with and without hypokalaemia by gravidity status – primigravida

	Serum K^+ ≤3.4 mmol/L (*N*=9)			Serum K^+ >3.4 mmol/L (*N*=133)				
Variable	***n***	**Mean (SD)**	**Median**	***n***	**Mean (SD)**	**Median**	**F**	***p*-value**
Meat consumption (days per week)	9	1.44 (1.33)	1.0	133	3.74 (2.62)	3.0	6.789	0.010
Veg. consumption (days per week)	9	4.0 (2.3)	3.0	131	5.1 (2.3)	7.0	2.013	0.138
Soil ingestion (tablespoons per day)	5	13.0 (17.0)	3.0	83	6.84 (17.7)	1.0	0.576	0.450
Duration of geophagia (weeks)	9	99.6 (149.7)	4.0	133	55.8 (109.5)	8.0	1.280	0.260
Fruit consumption (days per week)	9	2.4 (2.0)	2.0	132	3.8 (2.5)	3.0	2.528	0.114
Soft drinks (L per week)	8	1.59 (0.56)	2.0	129	1.36 (1.68)	0.5	0.157	0.693

K^+ = potassium; SD = standard deviation; veg. = vegetable.
*p<0.05.

Table 4B. Food frequency of participants with and without hypokalaemia by gravidity status – multigravida (≥2)

	Serum K^+ ≤3.4 mmol/L (*N*=11)			Serum K^+ >3.4 mmol/L (*N*=238)				
Variable	***n***	**Mean (SD)**	**Median**	***n***	**Mean (SD)**	**Median**	**F**	***p*-value**
Meat consumption (days per week)	11	3.73 (2.3)	3.0	238	3.97 (2.5)	3.0	0.102	0.750
Veg. consumption (days per week)	11	4.5 (2.1)	4.0	237	5.2 (2.2)	7.0	1.370	0.243
Soil ingestion (tablespoons per day)	7	20.7 (44.3)	1.0	148	7.7 (17.3)	1.0	3.089	0.081
Duration of geophagia (weeks)	11	109.6 (185.3)	8.0	238	101.1 (173.1)	12.0	0.026	0.873
Fruit consumption (days per week)	11	5.45 (2.3)	7.0	237	3.94 (2.6)	3.0	3.609	0.059
Soft drinks (L per week)	11	1.18 (0.69)	1.0	234	1.49 (1.86)	1.0	0.317	0.574

K^+ = potassium; SD = standard deviation; veg. = vegetable.
*p<0.05.

associated with hypokalaemia in the study population. However, neither meat consumption nor any other factors were found to be independent predictors of hypokalaemia. Instead, various combinations of demographic and dietary factors were associated with hypokalaemia. Young primigravida women <25 years of age who had lower meat, fruit and vegetable consumption were the most vulnerable to hypokalaemia. Meat and fresh fruit are known sources of dietary minerals including iron and potassium. More importantly, fruits contain vitamin C that enhances absorption of iron from vegan diets.[11] The observation in this study that age <25 years and low meat consumption were associated with geophagia may imply a possible role of geophagia in increasing the risk of hypokalaemia in this specific population of pregnant women.

The second group at risk of hypokalaemia was women who ate vegetables less frequently but had higher consumption of soft drinks that are rich in caffeine and sugar. This reveals the role of nutrition transition and dietary choices in increasing the risk of hypokalaemia in the study population, as food processing is associated with depletion of minerals.[14] Low consumption of fresh vegetables deprives the pregnant woman of a natural source of minerals such as potassium and magnesium, which are not usually supplemented during antenatal care. Magnesium deficiency is associated with increased loss of potassium through the kidneys. Consumption of large quantities of cola beverages or caffeine is a risk factor for hypokalaemia both in pregnant women and non-pregnant individuals.[4] The high concentration of caffeine in cola beverages competes with adenosine at its receptors in the central nervous system, leading to increased release of catecholamines. This results in excessive beta-2 adrenergic stimulation of the sodium-potassium-ATPase pumps with a resultant shift of extracellular K^+ into the intracellular compartment. The high carbohydrate load in the cola beverages can lead to increased insulin release, further facilitating the transcellular potassium shift and the development of hypokalaemia.[14] In addition, caffeine reduces the conductance of the neutral potassium channels that allow potassium to diffuse from the intracellular compartment along its concentration gradient. This traps the K^+ inside the cells, leading to increased polarisation and hypokalaemia following prolonged consumption of high loads of cola beverages.[14] While this may not alter the total body potassium, the resulting hypokalaemia, if persistent, leads to neuromuscular malfunction that manifests as paraesthesia, myalgia and muscle weakness, the severity of which may be greater than that usually expected in pregnancy.

Longer duration of geophagia, in conjunction with larger quantities of soil consumption, accounted for the third group of pregnancy-related hypokalaemia, which, according to our findings, was responsible for about 15% of the observed hypokalaemia. Some soils contain resins that prevent the absorption of potassium. Hence the risk of hypokalaemia will depend not only on the amount of soil consumed but also on the duration of consumption, the type of soil and the content of potassium in the regular diet.[15] Chronic ingestion of clay, especially among pregnant women in some populations, can result in the binding of potassium in the gastrointestinal tract, depending on the cation exchange capacity of the clay, leading to increased loss of potassium via stool.[16]

Study limitations

In the present study, only 188 participants with a history of geophagia, lower than the required number of 196, which may affect the accuracy of the study findings. Furthermore, the response rate from participants was not always 100% for some study variables.

Conclusion

Hypokalaemia is disproportionally prevalent among pregnant women in the rural EC, SA, and may contribute to the severity of myalgia, paraesthesia and muscle weakness reported in pregnancy. Younger primigravida women who practice geophagia and eat less meat and fruit are at increased risk of hypokalaemia. Low vegetable consumption in conjunction with regular high consumption of soft drinks also predisposed subjects to hypokalaemia in pregnancy in

the study population. The association of geophagia with low meat and fruit consumption may indicate an underlying iron deficiency in the affected women, which needs further investigation.

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