The prevalence and risk factors of Hypokalaemia among pregnant women in rural Eastern Cape South Africa.

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Abstract

Hypokalemia is a rare disorder among healthy pregnant women although life threatening muscle and cardiac malfunction may develop if it remains untreated. This study was carried out to estimate prevalence of hypokalemia among pregnant women in rural Eastern Cape South Africa, and to establish whether geophagia, a common practice, increases the risk of hypokalemia.

Methods: This cross-sectional analytical study included 188 participants with geophagia and 233 participants without geophagia enrolled at Gate Way Antenatal Clinic, Mthatha, Eastern Cape, South Africa. Data included socio-demographic characteristics, the magnitude of geophagia, dietary patterns and serum potassium levels. The Chi-square test for categorical variables, ANOVA to compare means, multivariate logistic regression for independent risk factors, and principal component analysis for latent variable patterns that were associated with hypokalemia were carried out. A p <0.05 was considered statistically significant.

Results: Hypokalemia among pregnant women in rural Eastern Cape South Africa was five times higher than expected. Geophagia accounted for only 15% of the observed cases of hypokalemia. The risk of hypokalemia was higher among primigravida below 25 years with low meat and fruit consumption that practiced geophagia; and concurrent low vegetable and excessive cola or caffeinated soft-drink consumption.

Conclusion: Hypokalemia is disproportionally prevalent among pregnant women in rural Eastern Cape South Africa. Low age, primigravida, geophagia, diet deficient in meat vegetables and fruits, and fizzy soft beverages increased the risk of hypokalemia. The association of geophagia with low meat, vegetable and fruit consumption may indicate an underlying iron deficiency hence necessitates further investigation.

Keywords: Hypokalemia, Geophagia, Pregnancy, Eastern Cape, South Africa.

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Introduction

Hypokalemia is diagnosed when the plasma levels fall below the normal range of 3.5-5.5 mmol/L. In healthy pregnant women, hypokalemia like in the general population is rare [1] and is estimated at only 1% [2]. When present, moderate or severe hypokalemia is associated with life threatening cardiac and muscular dysfunction that requires quick recognition and treatment [3].

The markedly low frequency of hypokalemia in the general populations implies that there is adequate supply of potassium in the diet, a normal functional absorptive capacity by the gastro-intestinal system, and that the kidneys have adequate capacity to conserve potassium. Hence spontaneous development of hypokalemia in healthy individuals not on any medication entails possibility of underlying physiological defect that requires further investigation in order to institute adequate management [2].

Proper management of a pregnant woman with hypokalemia requires emergency stabilization for patients with moderate to severe hypokalemia; identification of the underlying cause by differentiating between acute intracellular potassium shifts, prolonged low intake, or increased renal or extra-renal K^+ losses; and titration of K^+ (Potassium ions) according to the cause and magnitude of the deficit [4]. Hypokalemia is divided into 3 categories: mild (K^+ 3.0-3.5 mmol/L), moderate (K^+ 2.5 -3.0 mmol/L), and severe (K^+<2.5 mmol/L). Most patients become symptomatic when the serum potassium falls to <2.5 mmol/L. However symptoms of hypokalemia could manifest at higher levels if there is a rapid fall in serum levels of K^+ [3].

Several cases of hypokalemia in pregnancy and peripartum period have been reported [5-9]. Most had a favorable maternal and fetal outcome with stabilization of maternal condition within 14 days, uneventful delivery or puerperal period. Some patients, however, required intensive care due to respiratory muscle paralysis with miscarriage in one patient while the other had full recovery from hypokalemia but had the preterm delivery due to severe pre-eclampsia [10].

Statement of the problem

Previous research has revealed that about 75% of all women in Oliver Tambo District, in rural Eastern Cape aged 20-60 years engaged in geophagia; the major reason for eating soil was due to craving during pregnancy [11]. Geophagia is a known cause of hypokalemia in pregnancy at times with life threatening complications. It is not yet documented whether geophagia is the underlying cause hypokalemia among pregnant women in Eastern Cape, South Africa. In addition, the prevalence of symptomatic and asymptomatic hypokalemia among antenatal mothers and its association with geophagia is not known.

Methods

Study setting

Mthatha Gateway Clinic is a primary health care clinic that provides antenatal services to pregnant women in King Sabata Health sub-district, located around Mthatha town within OR Tambo district Municipality. This area of the Eastern Cape is largely composed of rural and peri-urban human settlements. The O.R. Tambo District Municipality is one of the poorest in South Africa with high unemployment, and 75% of household's dependent on social welfare grants and 88% living below the minimum living level. The prevalence of geophagia among women of reproductive age was found to be about 75% [11].

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 and those who have no history of geophagia.

Study population

The study population comprised of all pregnant women 18-49 years attending antenatal care at Gateway clinic between June 2017 and January 2018.

Sample size

Moagi found the prevalence of hypokalemia to be 15% among women at antenatal clinic at George Mukhari Hospital who practiced geophagia [8]. Assuming a precision (e) of 5%, an alpha α=0.05 and power of 80%, the sample size for women with geophagia will be given by the formula:

$n=Z2\alpha P (100-P)/e^2$

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

n=196 women with geophagia.

A similar number of pregnant women without geophagia was recruited from the antenatal clinic as a comparative group.

Inclusion criteria and exclusion criteria

All pregnant women 18-49 years of age who granted informed consent were eligible to participate in the study. Pregnant women with renal disease, hypertension, cardiac disease, liver disease, a history of diarrhea and vomiting in the previous 4 weeks, use of diuretics or known hyper-aldesteronism and those who are unable to express themselves due language barrier were excluded.

Sampling

Pregnant women with geophagia were consecutively recruited while every second mother who reports no history of geophagia and agreed to participate in the study was recruited.

Data collection

Interviewer administered questionnaire were used to collect socio-demographic, history of geophagia including the duration, and the amount of soil/clay consumed; and rule out recent history of diarrhoea, vomiting, use of diuretics or liver disease. The presence of myalgia as reported by the participant and muscle weakness through physical examination for muscle power on a scale of 1-5 was also recorded. Other variables included type of diet, frequency of consumption of cola-beverages or other caffeinated beverages, and previous or familial history of recurrent muscle or generalized weakness, previous hospital admission and treatment for those episodes; history of asthma and current treatment. A blood sample for serum K^+, Na^+ (Sodium ions), Mg^{2+} (Magnesium ions) urea, creatinine, and creatinine kinase was collected.

Data analysis

Data analysis was performed using the IBM SPSS STATISTICS version 18 for windows. The data was summarized into proportions (%) for categorical variables and means ± standard deviation (SD) for continuous variable. The Chi-square test was used to delineate the degree of association between categorical variables and hypokalemia; and Analysis of variance (ANOVA) to compare means between different groups. Multivariate logistic regression to identify the independent risk factors of hypokalemia and Principal component analysis to identify latent variable patterns that were associated with hypokalemia were carried out. A $p < 0.05$ was considered statistically significant.

Ethical Considerations

Ethical clearance was obtained from the Human Research Ethics Committees of Walter Sisulu University and the Eastern Cape Department of Health. Written consent was obtained from each participant before enrolment into the study. The following steps were undertaken to ensure the participants' anonymity and confidentiality: the interviews were conducted in places with adequate privacy; study codes were used instead of patients' names or ID numbers on the case record forms and the emphasis, the participants were informed of their right to withdraw from the study at any time without fear of retribution.

Results

General characteristics of the participants

A total of 421 pregnant women were enrolled into the study: 188 were currently practicing geophagia, 233 had no history of geophagia in the current pregnancy. The mean age (range, median) for participants with and without geophagia was 25.8 years (14-43, 25) and 27.3 years (13-43, 27) respectively (p=0.01). The mean parity (number of previous pregnancies) (range, median) for participants with and without geophagia was 1.22 (0- 7, 1) and 1.26 (0-8, 1) respectively (p=0.729). Geophagia was associated with lower chronological age and lower consumption of meat and fruits (Table 1).

Table 1. Factors associated with geophagia.

	No history of geophagia			Geophagia in current pregnancy			f	p
	n	Mean (SD)	Median	n	Mean (SD)	Median		
Age	232	27.3 (6.1)	27	188	25.9 (6.2)	25	6.631	0.010*
Parity	232	1.26 (1.37)	1	186	1.22 (1.44)	1	0.237	0.729
Meat consumption (days/week)	233	3.98 (2.6)	3	188	3.47 (2.5)	3	4.283	0.039*
Fruit consumption (days/week)	232	4.3 (2.5)	4	187	3.4 (2.5)	2	12.637	0.001*
Soft Drinks L/week	229	1.35 (1.6)	0.75	181	1.56 (1.9)	1	1.429	0.233
Veg consumption (days/week)	231	5.2 (2.2)	7	186	5.1 (2.2)	7	0.418	0.518

Veg: Vegetable; *P<0.05, f: frequency, p: probability

Prevalence of hypokalemia

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

Risk factors of hypokalemia

Overall participants with hypokalemia were more likely to consume less meat and vegetables on 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 hypokalemia (results not shown).

Table 2. Comparison of food frequencies of participants with and without hypokalemia.

	< 3.5 mmol/L			≥ 3.5 mmol/L			f	p
	n	Mean (SD)	Median	n	Mean (SD)	Median		
Meat consumption (days/week)	21	2.67 (2.20)	2	373	3.89 (2.55)	3	4.975	0.026*
Veg consumption (days/week)	21	4.29 (2.13)	3	370	5.20 (2.20)	7	3.423	0.065
Amount of soil ingested (table spoons/day)	13	16.9 (33.4)	1	231	7.4 (17.39)	1	2.76	0.098
Duration of geophagia (weeks)	21	104.7 (161.7)	8	373	84 (154.5)	12	0.34	0.56
Fruit consumption (days/week)	21	3.95 (2.62)	3	371	3.89 (2.56)	3	0.01	0.921
Soft Drinks (L/week)	20	1.38 (0.66)	1.5	364	1.44 (1.79)	1	0.022	0.883

*P<0.05

Stratified analysis according to age and parity as well factor analysis were carried out to delineate the latent interactions through which the various variables predispose to hypokalemia. Younger women, most of whom were primigravida, tended to have low meat consumption, higher tendency of ingesting large amounts of soil, and a combination of low vegetable consumption but higher intake of fizzy soft drinks which are rich in cola and sugar (Tables 3 and 4).

The older multiparous women with hypokalemia had a comparable rate of meat consumption with the multiparous participants without hypokalemia. However, they had less frequency of vegetable consumption.

Table 3. Comparison of food frequencies of participants with and without hypokalemia according to age category <25 or >25 years.

Participants below 25 years								
	Serum potassium ≤ 3.4 mmol/L			Serum potassium >3.4 mmol/L			f	p
	n	Mean (SD)	Median	n	Mean (SD)	Median		
Meat consumption (days/week)	11	1.45 (1.21)	1	176	3.88 (2.69)	3	8.767	0.003*
Veg consumption (days/week)	11	3.9 (2.1)	3	173	4.9 (2.3)	7	2.067	0.152
Soil ingestion (table spoons/day)	6	30.8 (46.3)	11.5	112	4.14 (8.1)	1	26.291	0.000*
Duration of geophagia (weeks)	11	103.3 (144.5)	4	176	64.5 (114.4)	12	1.115	0.284
Fruit consumption (days/week)	11	3.0 (2.3)	2	174	3.7 (2.5)	1	0.846	0.359
Soft Drinks (L/week)	10	1.53 (0.63)	2	170	1.44 (1.7)	1	0.022	0.882
Participants > 25 years								
Meat consumption (days/week)	11	3.9 (2.6)	3.5	196	3.9 (2.4)	3	0	0.987
Veg consumption (days/week)	10	4.7 (2.2)	4.5	196	5.4 (2.1)	7	1.1987	0.275
Soil ingestion (table spoons/day)	7	3.6 (7.2)	1	120	10.4 (22.5)	1	0.628	0.45
Duration of geophagia (weeks)	10	106 (186.9)	14	196	102.8 (181.8)	11	0.003	0.945
Fruit consumption (days/week)	10	5.0 (2.7)	7	196	4.1 (2.6)	3	1.238	0.267
Soft Drinks (L/week)	10	1.25 (0.69)	1	193	1.44 (1.9)	0.75	0.108	0.743
*P<0.05								

Table 4. Comparison of food frequencies of participants with and without hypokalaemia according Gravidity status - Primigravida or multigravida.

Primigravida (first pregnancy)								
	Serum potassium ≤ 3.4 mmol/L			Serum potassium >3.4 mmol/L			f	p
	n	Mean (SD)	Median	n	Mean (SD)	Median		
Meat consumption (days/week)	9	1.44 (1.33)	1	133	3.74 (2.62)	3	6.789	0.010*
Veg consumption (days/week)	9	4.0 (2.3)	3	131	5.1 (2.3)	7	2.013	0.138
Soil ingestion (table spoons/day)	5	13.0 (17.0)	3	83	6.84 (17.7)	1	0.576	0.45
Duration of geophagia (weeks)	9	99.6 (149.7)	4	133	55.8 (109.5)	8	1.28	0.26
Fruit consumption (days/week)	9	2.4 (2.0)	2	132	3.8 (2.5)	3	2.528	0.114
Soft Drinks (L/week)	8	1.59 (0.56)	2	129	1.36 (1.68)	0.5	0.157	0.693
Multigravida (≥ Gravida 2)								
Meat consumption (days/week)	11	3.73 (2.3)	3	238	3.97 (2.5)	3	0.102	0.75
Veg consumption (days/week)	11	4.5 (2.1)	4	237	5.2 (2.2)	7	1.37	0.243
Soil ingestion (table spoons/day)	7	20.7 (44.3)	1	148	7.7 (17.3)	1	3.089	0.081
Duration of geophagia (weeks)	11	109.6 (185.3)	8	238	101.1 (173.1)	12	0.026	0.873
Fruit consumption (days/week)	11	5.45 (2.3)	7	237	3.94 (2.6)	3	3.609	0.059
Soft Drinks (L/week)	11	1.18 (0.69)	1	234	1.49 (1.86)	1	0.317	0.574.
*P<0.05								

Factor analysis revealed that 39% of the prevalent cases of hypokalemia could be attributed to a combination of young age, primigravidity and less frequent consumption of meat and fruits; while 27% due to higher preponderance to consume less meat and vegetables as well as a high consumption of fizzy drinks rich in sugar; while 15% was associated with a longer duration and higher amount of soil consumption during pregnancy (Figure 1; Table 5).

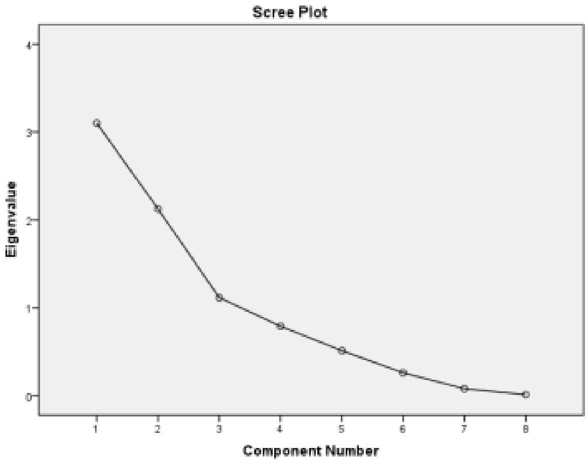

Figure 1. Scree plot for participants with hypokalemia showing components with corresponding Eigenvalues.

Table 5. Rotated component matrix and Eigenvalues for participants with hypokalemia.

Variables in the rotated matrix	Components‡		
	1	2	3
Age	0.871	-	-
Parity	0.896	-	-
Fruit consumption (days per week)	0.851	-	-
Meat consumption (days/week)	0.754	-	-
Fizzy drinks consumption (litres/ week)	-	0.781	-
Vegetable consumption (days/ week)	-	0.694	-
Duration of geophagia (weeks)	-	-	0.589
Soil amount (table spoons/day)	-	--	0.822
Component	**Eigenvalues**	**% variance**	**Total variance**
1	3.102	38.769	38.769
2	2.126	26.574	65.343
3	1.394	13.991	79.281
All the components with Eigenvalues <1	2.864	20.709	100
‡Only factor loadings with values ≥0.500 are shown for each component			

Among participants without hypokalemia, higher parity and age were associated with a higher frequency of meat and vegetable consumption; and less soil and fizzy drink consumption which explained 64% of the protection against hypokalemia (Figure 2; Table 6).

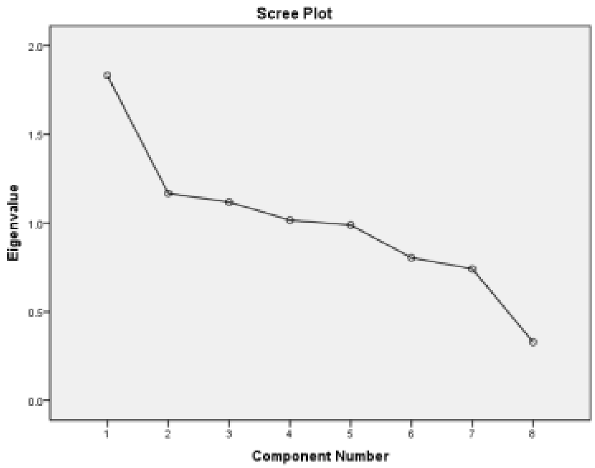

Figure 2. Scree plot for participants without hypokalemia showing components with corresponding eigenvalues.

Table 6. Rotated component matrix and Eigenvalues for participants without hypokalemia.

Variables in the rotated matrix	Component‡			
	1	2	3	4
Age	0.871	-	-	-
Parity	0.896	-	-	-
Soil ingestion (table spoons/day)	-	0.781	-	-
Duration of geophagia (weeks)	-	0.694	-	-
Fruit consumption (days per week)	-	-	0.589	-
Fizzy drinks consumption (liters/ week)	-	-	0.822	-
Vegetable consumption (days/ week)	-	-	-	0.805
Meat consumption (days/week)	-	-	-	0.537
Component	**Eigenvalues**	**% variance**	**Total variance**	
1	1.832	22.9	22.9	
2	1.167	14.594	37.494	
3	1.119	13.991	51.485	
4	1.016	12.698	64.183	
All the components with Eigenvalues <1	2.864	35.817	100	
‡Only factor loadings with values ≥ 0.500 are shown for each component				

Discussion

The prevalence of hypokalemia in among antenatal mothers in Eastern Cape South Africa was much higher than that reported in other populations. This is of public health importance given a prevalence which is five times that reported elsewhere [2] and that moderate or severe hypokalemia is associated with life threatening cardiac and muscular dysfunction that requires quick recognition and treatment [3].

Contrary to our expectation, geophagia which is practiced widely in the study population during reproductive age [11] was not the main risk factor nor was it an independent risk factor for hypokalemia in pregnancy. 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 fruits enhances iron absorption particularly from plant sources [12] hence craving for soil during pregnancy may be secondary to iron deficiency [13,14].

Low frequency of meat consumption was the only variable significantly associated with hypokalemia. However, neither meat consumption nor any other factors were found to be independent predictors of hypokalemia. Instead various combinations of demographic and dietary factors were associated with hypokalemia in the study population. Young primigravida women below 25 years of age who had less meat and fruit vegetable consumption were the most vulnerable to hypokalemia. Meat and fresh fruits are known sources of dietary minerals including iron and potassium, more importantly fruits contain vitamin C that enhances absorption of iron from vegan diets [12]. The observation in this study that age below 25 and low meat consumption were associated with geophagia may imply a possible role of geophagia in increasing the risk of hypokalemia in this specific population of pregnant women.

The second specific group at risk of hypokalemia were women who took vegetables less frequently but had a higher frequency of consumption of fizzy drinks that are rich in cola and sugar. This reveals the role of nutrition transition and dietary choices in increasing the risk of hypokalemia in the study population as food processing is associated with depletion of minerals [15]. Low consumption of fresh vegetables deprives the pregnant woman of a natural source of minerals like potassium and magnesium [16] which are not usually supplemented during antenatal care. Magnesium deficiency is associated with increased loss of potassium through the kidneys [17]. Consumption of large quantities of cola beverages or caffeine is risk factor for hypokalemia both in pregnant women [5,6] and among non-pregnant individuals [18,19]. The high concentration of caffeine in cola beverages competes with adonisine at its receptors in the Central Nervous System leading to increased release of catecholamines. This results into excessive Beta-2 adrenergic stimulation of the Na/K/ATPase pumps with 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 hypokalemia [4,18,19]. 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 polarization and hypokalemia following prolonged consumption of high loads of cola-beverages [4]. While this may not alter the total body potassium, the resulting hypokalemia if persistent will lead to neuro-muscular malfunction which manifest as paresthesia, myalgia and muscle weakness whose severity may be in excess of that usually expected in pregnancy.

Longer duration in of geophagia in conjunction with larger amounts of soil consumption accounted for the third group of pregnancy related hypokalemia which according to our findings was responsible for about 15% of the observed hypokalemia. Some soils contain resins that prevent the absorption of potassium. Hence the risk of hypokalemia will depend not only on the amount of soil consumed but also on the duration, type of soil, and the content of potassium in the regular diet. Severe hypokalemia has been reported in a number of cases with geophagia during pregnancy [20,21]. Chronic ingestion of clay especially among pregnant women in some populations can result in the binding of potassium in the gut depending on the cation exchange capacity of the clay, leading to increased loss of potassium via stool [22].

Conclusion

Hypokalemia is disproportionally prevalent among pregnant women in rural Eastern Cape South Africa and may contribute to the severity of myalgia, paresthesia and muscle weakness reported in pregnancy. Younger primigravida women who practice geophagia and take less meat and fruits are at increased risk of hypokalemia. Low vegetable consumption in conjunction with regular high consumption of fizzy soft beverages also predisposed to hypokalemia 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.

Conflict of Interest

The authors declare that they have no competing interests.

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