

Reference Values for Serum Electrolytes (Na^+ , K^+ , Ca^{++}) in Khartoum State

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Abstract: Recently the normal values of pulmonary test parameters [1], level of hemoglobin [2] and glycated hemoglobin [3-5] in Sudanese have been found to be different from the international reference values. The study aimed to compare the values of serum electrolytes (Na^+ , K^+ , Ca^{++}) level in Sudanese with the international values. 100 normal healthy adult Sudanese with aged between 18 and 65 years (50 males and 50 females), who were nonsmokers, not Known to be hypertensive or diabetic, have no renal or thyroid problem, living in Khartoum city were included in our study. The data was collected using a structured questionnaire then the levels of Na^+ , K^+ and Ca^{++} were measured. In the males group the means of Na^+ level range was 129-141 mEq/dl, K^+ was 3.6- 8.2 mEq/dl while Ca^{++} had a level range of 7.2-12.2 mEq /dl. In the females group the means of Na^+ level was 134.94 ± 3.86 mEq/dl; K^+ was 4.34 ± 0.46 mEq/dl while Ca^{++} had a level of 8.95 ± 0.84 mEq /dl. There are slight difference from the international ranges, yet a further bigger scale study is needed to verify those findings.

Keyword: Serum Na, Serum K, Khartoum.

INTRODUCTION

Electrolytes can help to regulate normal functioning of human body such as water regulation and acid base balance.

Sodium is one of the most important electrolytes in the human body and is responsible for numbers of important functions, mostly related to fluid and water regulation. Regarding the serum content of sodium, normal accepted international range for serum sodium is 134 to 145 mEq \L.

Potassium is responsible for the function of excitable tissues such as skeletal, cardiac muscles and nerves. The main dietary sources are Fruits (e.g. Banana), Vegetables (e.g. Spinach), Cheese, Meat and Fish[6]. The normal international range for serum potassium level is 3,5 to 5,0 mmol\L.

Calcium Ca^{++} is an important element in the human body as it helps to control nerve impulses, muscle contraction, formation of bones and has a role in clotting. The main dietary sources of calcium are Milk and milk alternatives [6]. The international serum calcium range is between 2,2 to 2,5 mmol\L.

Dehydration can affect electrolyte levels, in particular sodium level can be adversely affected. Dehydration due to heat exposure and high temperatures can decrease the levels of electrolytes which are lost through sweat[7]. Certain medicines can affect electrolyte levels. Diuretics work by increasing the excretion of sodium and water in the urine and some diuretics can also decrease the level of potassium in the blood stream. Other medicines, such as cough medicines, oral contraceptives and steroids can affect sodium levels[7].

Sweating has thermoregulatory effects and was observed that the increase in exercise and temperature lead to increase in sweating rate and sodium and potassium ions loss in sweat[8].

In the Chronic kidney disease patients were about 8 times at risk of developing hypocalcaemia as compared to the controls, and this stimulate excess PTH secretion[9]. The linear relationship between potassium and PTH was observed in this Study, the high PTH level increases basal levels of cytosolic calcium which affects the permeability of the cellular membrane to potassium thus decreasing extra renal disposal of potassium in CKD[9]. The other most important regulator of calcium homeostasis is vit D. Its action resembles that of parathyroid hormone. The vitamin increases the resorption of bone, even in doses which are too small to affect absorption of calcium from the intestine, it is possible, and the action is mediated through the parathyroid gland. In patients with hypoparathyroidism vitamin D may produce a striking increase in urinary excretion of calcium, although levels of serum calcium remain low.

Calcitonin has an opposite action to that of PTH by causing an immediate transitory hypocalcemic effect [10].

Elevation of plasma potassium above its normal range enhances the kaliuretic action of aldosterone [11]. The physiological importance of aldosterone in advanced renal failure on sodium balance was examined on eight persons in a study by Tomas Berl [12] by administering the aldosterone antagonist spironolactone. Seven of them had natriuresis, as mean urinary sodium excretion increased from 142 to 173 mEq/24 hr during the 3 to 5 days of spironolactone administration, the one patient who failed to show a natriuresis was the patient whose serum aldosterone levels were the lowest.

Emenike *et al.* studied the effect of physical exercise on serum electrolytes. They found that during exercise serum sodium can be decreased with chloride as both are secreted in the excessive sweating. With prolonged exercise dehydration can occur leading to concentrated serum due to decreased blood volume and consequently Na^+ level can increase [13].

Geethavani *et al.* studied the effect of caffeine on serum and urinary electrolytes, they found it significantly decrease serum K^+ and slightly decrease serum Na^+ Level [14].

In Sudan Abdealla and Salih investigated the impact of thyroid dysfunction and treatment on serum electrolytes and bone minerals on 150 Sudanese females, 50 tested subjects with hypothyroidism, 50 subjects with hyperthyroidism, and 50 volunteer subjects as control group. The results showed that there was a slight decrease in serum sodium and magnesium and significant decrease in serum calcium with significant increase in serum potassium and phosphate level in hypothyroidism group when compared with control group. There was a slight increase in serum sodium, serum calcium and phosphate, with significant increase in serum magnesium and slight decrease in serum potassium level in hyperthyroidism group when compared with control group. In hypothyroidism patients serum potassium and phosphate was significantly positively correlated with the duration of the disease and negatively correlated with the duration of the disease treatment and serum calcium was significantly negatively correlated with the duration of the disease and positively correlated with the treatment of the disease. In contrast in hyperthyroidism patient's serum sodium, magnesium and phosphate was significantly positively correlated with the duration of the disease, and negatively correlated with the duration of the disease treatment [15].

Yassmin Mohammed studied the effect of smoking on the level of electrolytes in Sudanese male smokers. 70 male smokers were included and the study

showed that there was a significant increase in serum sodium, potassium, calcium and phosphate in smokers when compared with 50 nonsmokers. Also showed a significant positive correlation between the number of cigarettes and the change in sodium, potassium, calcium and phosphate serum level. It also showed a significant positive correlation between the duration of smoking and the change in sodium, potassium, calcium and phosphate. The study concluded that smoking cigarettes elevated serum electrolytes and the number of cigarettes per day and duration of smoking was positively correlated with the change of electrolytes [16].

As the serum electrolytes are affected by all these factors, then there may be a difference in serum electrolytes of Sudanese compared to the known international reference values. This question is approached by this present study on the normal values of Sudanese.

METHODS

100 normal healthy Sudanese adult aged between 18 and 65 years (50 males and 50 females), who were nonsmokers, not Known to be hypertensive or diabetic, having no renal or thyroid problems, living in Khartoum city were enrolled in this study. The data was collected using a structured questionnaire covering age, gender, physical activity, daily salt intake, food habits, smoking history and family history of chronic illness. 5 mL of venous blood was taken and collected in EDTA container. Na^+ and K^+ were measured by using Easylyte analyzer and Ca^{++} was measured by using Biosystems 350 and Mindray BS -200. The collected data was analyzed using the statistical package for the social sciences version 23. Descriptive data are provided as mean \pm SD compared with international values. P value less than 0.05 is consider statistically significant. This study was ethically cleared and consent has been taken.

RESULTS

In this study the data was collected from 100 Sudanese healthy participants their age ranged between 18 to 65 years. In the males group the serum level of K^+ was ranged between 3.6- 8.2 mEq/dl, with mean value of 4.62 ± 1.03 mEq/dl compared with the international reference and mean value of 4.4 mEq/dl and range of 3.5 -5.3 mEq /dl (fig 1). 81.8% of the studied subjects had a serum K^+ level coinciding with the international reference value. The international serum Na^+ level is range between 135-145 mEq/dl while the mean value is 140 mEq/dl but the serum Na^+ level of the studied subjects was 129-141 mEq/dl and its mean value was 135.52 ± 2.86 mEq/dl (fig2) 66.7% of the study subjects had a serum Na^+ level within the international range. The serum Ca^{++} level of our subjects ranged between 7.2- 12.2 mEq /dl and the mean value was 10.52 ± 1.29 mEq/dl (fig3) our study found that 69.7% of the studied subjects had serum Ca^{++}

level of more than 10 mEq/dl which is high than the international value. See Table (1).

Table-1: The Means of Electrolytes in males and females compared to the international Mean

Electrolyte	International Mean	Sudanese Males	Sudanese Females
Serum K	4.40 mEq/dl	4.62 ± 1.03 mEq/dl	4.34 ± 0.46mEq/dl
Serum Na	140 mEq/dl	135.52 ± 2.86 mEq/dl	134.94 94 ± 3.86 mEq/dl
Serum Ca	9.0 mEq/dl	10.52±1.29 mEq/dl	8.94 ± 0.84 mEq/dl

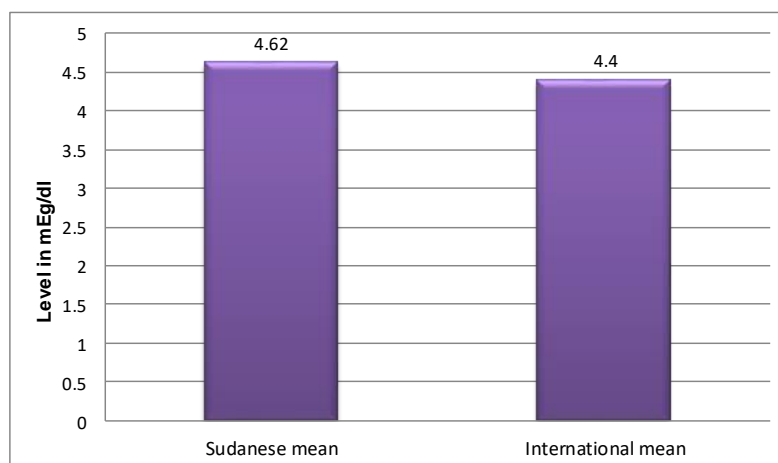


Fig-1: The mean serum K⁺ level of Sudanese males vs. international reference values. P. value 0.233 (P value less than 0.05 is consider statistically significant)

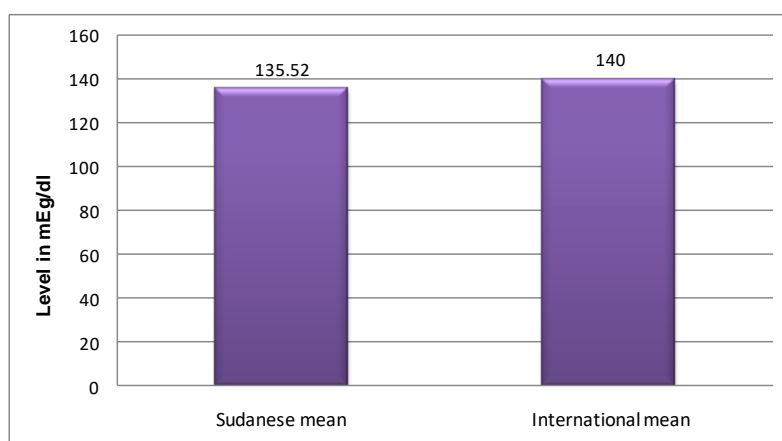


Fig-2: The mean serum Na⁺ level of Sudanese males vs. international reference values. P. value 0.00

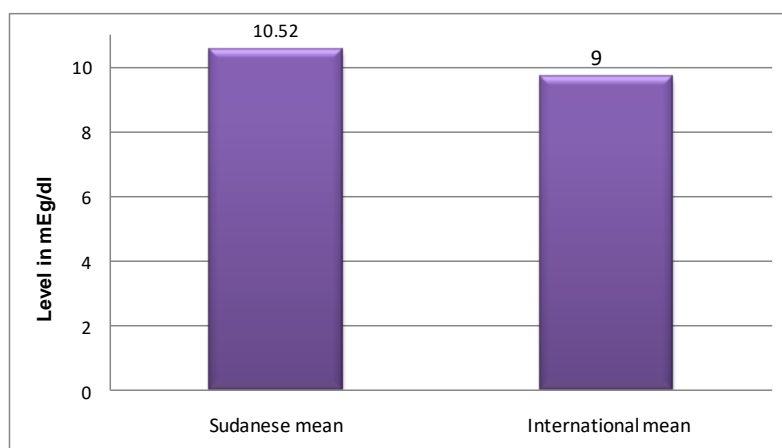


Fig-3: The mean serum Ca⁺⁺ level of Sudanese males vs. international reference values. P. value 0.00

The other study group were 50 females, their serum level of K^+ ranged between 3,6- 6,10 mEq\dl , the mean was 4.34 ± 0.46 mEq\dl compared with the international mean of 4.4 and a range of 3,5 -5,3 mEq \dl. The international range of serum Na^+ level is between 135-145 mEq\dl while the mean is 140 mEq\dl but the serum Na^+ level of the study subjects was 126-

145 mEq\dl and its mean was 134.94 ± 3.86 mEq\dl. The serum Ca^{++} level of our subjects ranged between 6,6- 10,8mEq \dl and the mean was 8.95 ± 0.84 mEq\dl compared with an international range of (8-10 mEq\dl) and a mean of (9)mEq\dl. (fig,4,5,6). There was no significant difference compared to the international values.

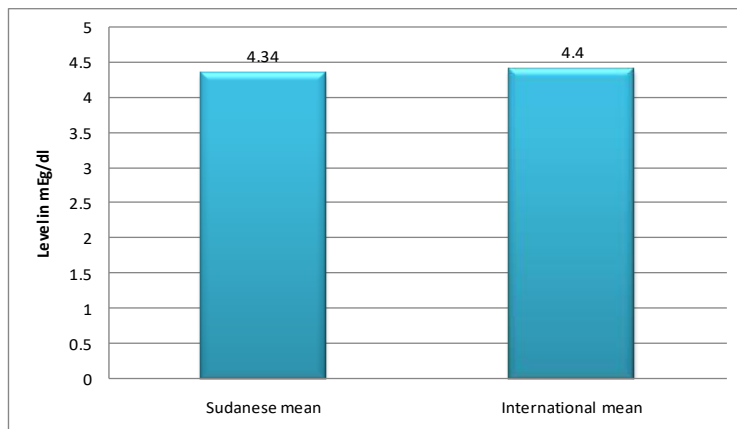


Fig-4: The mean of K^+ level in Sudanese females vs. international

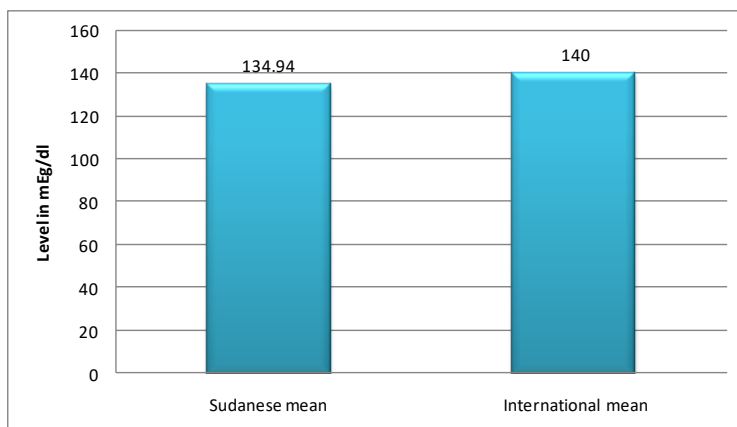


Fig-5: The mean of Na^+ level in Sudanese vs. international

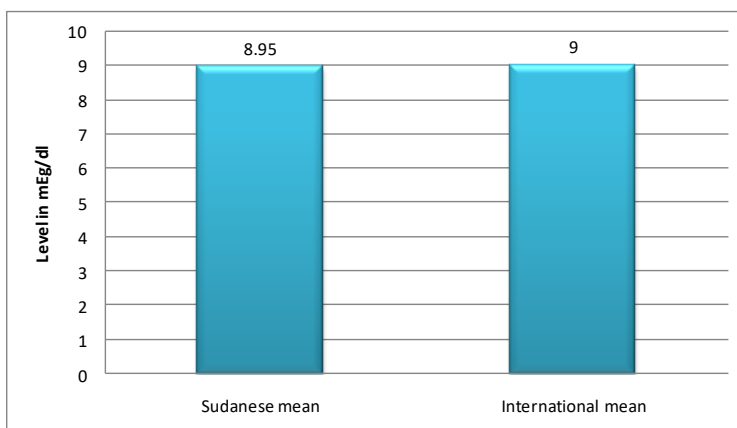


Fig-6: The mean of Ca^{++} level in Sudanese females vs. international

DISCUSSION

The normal values used in Sudanese laboratories are the international reference values. Differences in the normal values in Sudan have been documented in some hematological values and respiratory function test parameters [1,2].

In this study in the males group there was slight differences in the range of the normal values of serum electrolytes from the international values (fig 1,2,3). These differences are most probably due to difference in life style, hot weather, exposure to sun light for long time and sweating rate [8], physical activity level specifically walking, type of diet and amount of added salt. In the females group serum electrolytes Na, K, and Ca are not significantly different from the international values (fig 4,5,6). This might indicate that the hormonal homeostatic mechanisms are similar and maintain the normal values the same.

CONCLUSION

In males there is insignificant increase in the mean values of serum K^+ and Ca^{++} level and insignificant decrease in the mean values of serum level of Na^+ . The serum Na, K and Ca in Sudanese females are within the international range. Large scale study is needed to verify this.

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