

Establishing reference intervals for some electrolytes (sodium, potassium, calcium) and phosphorus in healthy adult population of Ambalappuzha north Gramapanchayath, Kerala

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Abstract

Background: There is a long-standing need to establish population-based reference ranges for all laboratory parameters to help in better clinical interpretation and consequent improved health care. Most laboratories resort to reference ranges mentioned in Kit manufacturers' data, journals, text books, western cohorts, which may be irrelevant to the target population in most cases, which diminishes the value of test report. We therefore conducted study on our target population to establish reference ranges for serum sodium, potassium, calcium and phosphorus. **Materials and Methods:** This cross-sectional study was undertaken at Ambalappuzha North Gramapanchayath which is a coastal area in the Alappuzha district of Kerala. Apparently healthy individuals of both sex aged between 18-65 years who attended a health camp were included in the study. The study variables measured were serum Sodium and potassium by indirect ISE method, Calcium by Arsenazo III and Phosphorus by Colorimetric without precipitation Method in Beckmann coulter Au486 modular system. **Results:** Out of the 288 participants in our study, 190 were females (65.97%) and 98 were males (34.03%). The mean serum values of Sodium was 139.33±3.91 mmol/L, Potassium was 4.00±0.34 mmol/L, calcium was 9.44±0.36 mg/dl and phosphorus was 3.30±0.45 mg/dl. **Conclusion:** In our study, not all parameters were on par with the conventionally used reference ranges except serum calcium. However a larger population based studies are needed to confirm our results.

Key Words: Ambalappuzha, electrolytes, reference range.

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INTRODUCTION

Health is necessarily a relative concept. Data collected during the medical interview, clinical examination and supplementary investigations must be interpreted by comparison with reference data. The interpretation of medical laboratory data is an example of decision making by comparison. Therefore reference values are needed for

all tests performed in clinical laboratory. A patient's laboratory result is not medically useful if appropriate data for comparison are lacking¹. According to IFCC it is necessary for every lab to have their own set of reference limits. Establishing reference intervals is a difficult and expensive affair and for the same reasons most of the clinical laboratories adopt to reference values provided by Kit manufacturers, journals, text books, western cohorts. It provides no information on the reference population and even if it did, would most likely be of the Caucasian population. These reference intervals can be questioned because the biochemical parameters are influenced by ethnicity, ecological factors like climate, altitude, life style dietary habits as well as physical activity. India is a country with extreme variations compared to western countries. The laboratory should establish population-based reference intervals for appropriate analysis of test reports². Sodium is the major cation of ECF and is responsible for almost half the osmotic strength of

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plasma. It plays a central role in maintaining normal distribution of water and osmotic pressure in ECF. Potassium is the major intracellular cation which is the critical factor in nerve impulse transmission and contractility of muscle. The main dietary sources are fruits(banana), vegetables, cheese, meat, fish³. Calcium plays significant roles in cell structure components, biochemical functioning through signalling, neuromuscular function, coagulation. Phosphorous is essential as structural support and as organic phosphate it is one of the building blocks of DNA, Phospholipids, ATP.⁴ All these parameters are maintained within a fairly narrow range and mild changes from the typical so called "normal values" can result in numerous signs and symptoms that alert the clinicians. Hence an individualized Reference value is ideal.⁵ at least a population based reference value is necessary for these parameters for the timely intervention and for the unwanted corrective measures. To our knowledge there is not much population based studies on reference intervals of these parameters in India. The aim of this study is to establish reference values for some electrolytes and phosphorus to determine possible difference between published and local reference ranges.

MATERIALS AND METHODS

This cross sectional study was undertaken at Ambalapuzha North Gramapanchayath which is a coastal area in the Alappuzha district of Kerala. Apparently healthy individuals of both sex aged between 18-65 years old who attended a health camp organised by Department of Biochemistry, Govt TD Medical college in association with the ambalapuzha north grama panchayath in the month of February 2018 were included in the study in the month of February 2018. The volunteers who enrolled to the study were first screened with the help of a Registered Medical Practitioner and then were included. Study was conducted as per ICMR guidelines and also by the specific instructions given by Institutional Ethics Committee. The healthy volunteers from different wards of the Gramapanchayath were enrolled with the active participation of the ward ASHA Workers and the panchayath members.

Based on CLSI/NCCLS6, following individuals are excluded

- Individuals with Pathophysiological states-renal failure, congestive heart disease, chronic respiratory disease, liver disease, malabsorption syndromes, nutritional anemias, infections
- Systemic diseases-Hypertension, Diabetes Mellitus, Hyperthyroidism
- Intake of pharmacologically active agents- Alcohol, tobacco, OCP, replacement or

supplementation therapy-eg. insulin, nephrotoxic drugs like Chronic NSAIDS usage, Aminoglycoside antibiotics, Anticancer drugs, Antipsychotics, steroids and other hyperglycemic agents.

- Modified physiological states - pregnancy, psychological and mental disorders such as severe stress and depression, exercise or physical training, food intake prior to blood collection
- Other factors – like obesity (BMI andgt;30 kg/m²) were excluded from the study.

Samples were collected between 7.30 am and 10 am. Under aseptic precautions 5 ml sample was collected in plain tubes with gel .Cold chain was maintained throughout sample collection and the samples were analyzed in batches within a week's time. All icteric, hemolytic and lipemic samples were identified and were not processed. The study variables measured were serum Sodium and potassium by indirect ISE method, Calcium by Arsenazo III and Phosphorus by Colorimetric without precipitation. The study incorporated internal QC materials(biorad bi-level) and EQAS from CMC Vellore .The Coefficient of Variation and Z score for the parameters noted were within the acceptable limits. Non parametric methodology for determination of Reference interval was adopted in the study. Median, central 95 percentile and 90 % confidence interval were calculated. The 97.5 percentile and 2.5 percentile formed the upper and lower reference limits of the population. Statistical analysis was done using SPSS Version 16. The data was visually inspected for extreme values and ten values for single parameter that appeared physiologically impossible were removed. For a given continuous variable, outliers are those observations that lie outside 1.5 * IQR, where IQR, the 'Inter Quartile Range' is the difference between 75th and 25th quartiles. The higher value outliers were excluded using Q3+ 1.5 Interquartile range and the lower value outliers were excluded using Q1-1.5 Interquartile range. The selected reference individuals were apparently healthy individuals hailing from Ambalapuzha north gramapanchayath aged between 18 and 65yrs

OBSERVATIONS AND RESULTS

Out of 447 apparently healthy adults aged between 18-65years who enrolled for a free medical camp conducted by Department of biochemistry, Govt. TD Medical college, Alappuzha in association with Amabalappuzha North Grama Panchayath 288 were included in the study after aligning them with above laid down exclusion criteria Out of the 288, 190were females(65.97%) and 98were males(34.03%) The results for the selected parameters (Serum Na, K, Ca and Inorganic Phosphorus) of target population are tabulated in table 1.

Table 1

			Sodium (mmol/L)	Potassium (mmol/L)	Calcium (mg/dl)	Phosphorous (mg/dl)
Total n = 288	mean ± SD		139.33±3.91	4.0±0.34	9.44±0.36	3.30±0.45
	percentile	2.5	131.0	3.50	8.88	2.48
		97.5	145.0	4.78	10.39	4.21
	90% CI	lower	138.95	3.96	9.41	3.26
		upper	139.72	4.03	9.48	3.35
Male n=98	mean ± SD		138.33±4.12	3.92±0.31	9.62±0.40	3.10±0.41
	percentile	2.5	130.48	3.50	8.96	2.41
		97.5	145.0	4.75	10.49	4.01
	90% CI	lower	137.63	3.87	9.56	3.03
		upper	139.03	3.97	9.69	3.17
Female n=190	mean ± SD		139.85±3.71	4.04±0.34	9.35±0.31	3.41±0.43
	percentile	2.5	131.0	3.50	8.87	2.61
		97.5	145.0	4.90	10.16	4.28
	90% CI	lower	139.40	3.99	9.31	3.35
		upper	140.29	4.08	9.39	3.46

SD-Standard Deviation CI-Confidence Interval

The mean serum Sodium values were 139.33± 3.91 mmol/L with 2.5th percentile 131mmol/L and 97.5th percentile 145mmol/L. The mean serum Potassium values were 4.00±0.34mmol/L with 2.5th and 97.5th percentile being 3.50 and 4.78. Similarly the mean serum calcium had values of 9.44±0.36mg/dl with its corresponding 2.5th and 97.5th percentiles being 8.88mg/dl and 10.39 mg/dl whereas mean serum inorganic phosphorus was 3.30±0.45mg/dl and 2.5th and 97.5th percentiles were 2.48mg/dl and 4.21mg/dl.

DISCUSSION

Most of the laboratories adopt to the manufacturers reference range because of the financial constraints involved in establishing their own reference range although it provides no information on the reference population and even if it does, would most likely be of the Caucasian population. The reference interval derived in our study differs a little from the conventional ones which were the package insert reference interval or adapted ones from Caucasian studies, in that the serum sodium was on the lower side for the lower reference limit whereas serum potassium and serum inorganic phosphorus showed a lower upper reference limit in contrast to the kit insert value Serum Calcium was on par with pack insert value . 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 sweat⁷. Our study showed serum sodium on lower side for the lower reference limit and was in agreement with the study conducted by Hassan *et al*. Another study conducted by Emenike *et al* showed 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 excessive sweating⁸. In case of serum potassium our study showed a lower upper reference limit from the kit insert, although most of the articles do not support this finding. It could be attributed to variations in the dietary intake and ethnic variations. Geethavani *et al*. studied the effect of caffeine on serum and urinary electrolytes, they found it significantly decreases serum K⁺ and slightly decrease serum Na⁺ Level⁹. The NORDIC Study carried out by P. Rustad *et al* as well as the study conducted by K A Koram and his co-workers also opined similar to our study with respect to serum potassium^{10,11}. A strong association of BMI with blood Na⁺ and K⁺ levels and blood pressure was noted by Vijay pandey and others in their study.¹² The life style as well as diet of a particular group of people might be factors playing crucial role in the variations of electrolytes as proposed by Salawu A. *et al* and they reported significantly low lower reference limit for Sodium and potassium.¹³ In our study the reference ranges of Serum Calcium was similar to the pack insert but serum inorganic phosphorus showed a lower upper reference limit (including both males and females) The study sampling was done in the winter month of February and hence it explains the lower upper reference limit due to lesser exposure to sunlight and because serum inorganic phosphorus levels in the blood is directly regulated by VitaminD.¹⁴ A lower reference range for calcium was noted in South Indian population by the study conducted by Sundaram and his co workers¹⁵.

CONCLUSION

In our study we could conclude that there exists some small changes in reference ranges with respect to serum sodium, potassium and inorganic phosphorus from the

conventional pack inserts. However owing to the smaller number of participants there is a need for a study with a large number of participants to extrapolate the results obtained.

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Conflict of Interest: None Declared