ORIGINAL ARTICLE

Plasma Concentrations of Urea and Creatinine in Primary School Children in Ujung Pandang

by

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Abstract

A study of plasma concentrations of urea creatinine in 202 primary school children aged between 6 to 15 years was carried out in Ujung Pandang from November 1, 1988 through February 28, 1989. Sampling was done using multi-stage random sampling method.

Plasma urea concentrations were not affected by sex, age and nutritional status. Normal distribution of plasma urea concentrations in $P_{2.5}$ and $P_{97.5}$ were 8.13 mg/dl and 24.09 mg/dl respectively (95% confidence level).

There was no difference of creatinine concentration between the two sexes. The overall mean creatinine concentrations was significantly higher in the wellnourished group (0.73 ± 0.081) mg/dl) as compared to PEM group (0.63 ± 0.066 mg/dl). This study revealed a correlation between age and plasma creatinine concentrations in the wellnourished ($r = 0.46, p < 0.01$) as well as in PEM ($r = 0.37, p < 0.01$) group. Hence, normal distribution of plasma creatinine concentrations should be base on values in each age group.

This study showed no correlation between plasma urea and creatinine concentrations.

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Introduction

Urea is the primary end product of protein metabolism in mammals. Its excretion is directly correlated to protein intake. Synthesis of urea occurs in the liver. Urea is released into the blood, and cleared by the kidney (Harper et al., 1979; Rodwell, 1988).

Creatinine is a product of creatine metabolism (Harper et al., 1979; Rodwell, 1988). Ninety eight % of the total body creatine is found in skeletal muscle; of which 2% is converted each day to creatinine and excreted through the urine (Barrat and Chantler, 1975).

Plasma urea and creatinine are among the indicators that could be used for measuring renal function. Plasma concentrations of both substances may be increased in patients with renal disease (Barrat and Chantler, 1975).

Plasma concentrations of urea and creatinine depend on their rate of production and elimination. Hence, if both processes remain constant, the blood level of these subtances will be in equilibrium and normal. However, if GFR decreases and the rate of urea and creatinine productions remain normal, their plasma concentrations will increase (Wardener, 1974).

Urea production is rapidly affected by protein intake and fluctuates more widely during the day than creatinine. A fall in urea production occurs with low protein diet and liver damage (Morrison, 1986).

Increased plasma creatinine concentrations is affected by large muscle mass, meat diet, subtances causing increased Jaffe colour reaction such as ketone (particularly aceto-acetate), chephalosporine, spironolactone and drugs which interfere with tubular secretion (e.g. aspirin, co-trimoxazole), whereas decreased plasma creatinine is influenced by reduced muscle mass, severe renal failure, decreased tubular secretion and intestinal destruction of creatinine (Morrison, 1986).

In healthy children plasma creatinine concentrations rises with age, which is a consequence of the increasing muscle mass (Barrat and Chantler, 1975; Scwartz et al., 1976). Plasma urea concentrations is not affected by muscle mass, but rather by protein intake (Morrison, 1986).

Scwartz et al., (1976) revealed that normal plasma urea concentrations in children between 6 to 15 years of age was 5.23–5.38 mM/L (31.38–33.60 mg/dl) in males and 4.81–5.38 mM/L (28.86–32.28 mg/dl) in females, whereas plasma creatinine concentration was 0.52–0.76 mg/dl in males and 0.48–0.67 mg/dl in females.

Until recently, there has been no study on normal plasma urea and creatinine concentrations in Indonesian children.

The aim of this study is to determine the pattern of normal plasma urea and creatinine concentrations in children between 6 to 15 years of age as well as the influence of age, sex and nutritional status on the concentrations of the two substances.

Subjects and methods

1. Subjects

This study was carried out in primary school children in Ujung Pandang from November 1, 1988 through February 28, 1989.

The total number of samples examined was 200. Sampling was done using multistage random sampling method.

Initially primary schools having "Usaha Kesehatan Sekolah" in Ujung Pandang were clustered into two groups e.g. primary schools located in the centre of the city and primary in the periphery. Subsequently, only one school was taken at random from each group, from which a proportional number of children were again taken randomly until the total number of samples needed was obtained. Primary school children were further classified by class (1 to 6) and by sex. The final samples from each school should represent the same number of children in each class with an even distribution of male and female.

This study included only healthy children.

Children in the 6 to 15 year age group were selected from this study because of their easy accessibility in primary schools which have homogeneous population.

2. Methods

The teachers were initially informed about the examination of students to be performed. Information of the study was distributed to parents and their consents were obtained.

Age nutritional status was done using body-weight-for-height (W/H) parameter (Pusat Penelitian dan Pengembangan Gizi, Badan Penelitian dan Pengembangan Kesehatan, 1978) and physical examination. Body weight was measured by a balance scale with a precision of 0.1 kg that had been gauged for 50 kg capacity. The height was measured by microtoise with precision of 1 cm. Five ml of urine was taken from each children for urinalysis. The urinalysis was done not later than half hour after urine was taken.

After all requirement were fulfilled, 5 ml of venous blood was drawn in the morning before any exercise for urea and creatinine examinations. The students must avoid high protein food prior to blood sampling.

Plasma urea was determined by Berthelot colour reaction method and plasma creatinine by Jaffe method with deproteinization (Boehringer Mannheim GmbH diagnostica, 1980). Values of plasma urea and creatinine were separated by sex and grouped according to the midpoint age.

3. Criteria

Healthy children is defined as a child not being ill by then, having no history of urinary tract disorders, and not having taken anydrugs such as cephalosporines, spironolactone, aspirin and co-trimoxazole. The anthropometric criteria of nutritional status using weight-for-height parameter was as follows :

- BW 90% of standard W/H = well-nourished (WN),
- BW 80.1 - 90% of standard W/H = undernourished (UN) and
- BW 80% of standard W/H = poor-nourished (PN)

4. Statistical Analysis

Student's t test was used for statistical analysis of the difference of plasma urea and creatinine mean concentrations between the two sexes as well as between nutritional status. Correlation and regression tests were done to determine the relationship between age and plasma urea as well as creatinine concentrations. Ninety five per cent confidence level was used to calculate normal distribution of values of plasma urea and creatinine concentrations.

Results

The sample population involved 204 children. Of these 202 children fulfilled the criteria of this study, consisting of 101 boys and 101 girls. The age of the children varied between 5 11/12 and 14 8/12 years.

Table 1 and Table 2 shows the age, sex and nutritional status distributions.

Table 1 : *Age and sex distribution of sample*

age (yrs)	male (n)	female (n)	total
6	3	2	5
7	7	5	12
8	15	15	30
9	10	12	22
10	16	25	41
11	23	22	45
12	14	11	25
13	6	5	11
14	6	4	10
15	1	-	1
Total	101	101	202

Male-female ratio was 1 : 1

Among 202 children the prevalence of WN was 71.29% (144 children), UN 26.24% (53) and PN 2.47% (5).

Analysis of plasma urea concentrations

Plasma urea concentrations by age and sex was shown in table 3.1, while by age and nutritional status in table 3.2

Table 3.1. shows no difference of urea concentrations between male and female ($P > 0.05$), except in the 6-7 year age groups ($P < 0.05$). The mean urea concentration in male was 16.06 3.98 mg/dl, whereas in female it was 15.37 4.24 mg/dl

There was no statistical significant difference urea concentration between WN and PEM in various individual age groups ($P > 0.05$). However, the mean urea concentration was 16.50 ± 3.91 mg per dl in WN and 15.05 ± 4.36 mg/dl in PEM if all age groups were combined.

Table 2 : *Nutritional status by age*

age (yrs)	WN	UN	PN	n	%
6	4	1	-	5	2.47
7	6	5	1	12	5.95
8	21	8	1	30	14.85
9	15	6	1	22	10.89
10	28	12	1	41	20.29
11	23	11	1	45	22.28
12	21	4	-	25	12.38
13	7	4	-	11	5.45
14	8	2	-	10	4.95
15	1	-	-	1	0.49
Total	144	53	5	202	
%	71.29	26.24	2.47		100

Table 3.1. : *Distribution of urea concentrations by age and sex (mg/dl)*

Age (yrs)	male				female			
	n	X	range	SD	n	$\bar{X}$	range	SD
6	3	20.37	19.1-22.9	1.79	2	15.5	15.1-15.9	0.4
7	7	16.5	14.1-19.2	2.37	5	20.12	16.1-23.2	2.82
8	15	17.19	11.0-26.9	4.95	15	14.45	9.2-23.9	3.72
9	10	15.82	11.4-19.7	2.66	12	14.17	11.8-18.7	2.02
10	16	15.02	9.7-20.6	2.93	25	16.32	8.9-23.4	3.57
11	23	16.68	12.7-27.6	4.23	22	15.34	8.5-21.1	3.08
12	14	15.89	9.5-25.6	4.48	11	18.21	10.5-27.5	4.72
13	6	16.55	11.8-25.3	4.62	5	15.6	5.3-24.9	6.62
14	6	13.37	10.6-18.0	2.77	4	16.1	9.5-21.7	4.46
15	1	20.3	-	-	-	-	-	-

Results

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13	6	5	11
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Total	101	101	202

Male-female ratio was 1 : 1

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Plasma urea concentrations by age and sex was shown in table 3.1, while by age and nutritional status in table 3.2

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Table 2 : *Nutritional status by age*

age (yrs)	WN	UN	PN	n	%
6	4	1	–	5	2.47
7	6	5	1	12	5.95
8	21	8	1	30	14.85
9	15	6	1	22	10.89
10	28	12	1	41	20.29
11	23	11	1	45	22.28
12	21	4	–	25	12.38
13	7	4	–	11	5.45
14	8	2	–	10	4.95
15	1	–	–	1	0.49
Total	144	53	5	202	
%	71.29	26.24	2.47		100

Table 3.1. : *Distribution of urea concentrations by age and sex (mg/dl)*

Age (yrs)	male				female			
	n	X	range	SD	n	$\bar{X}$	range	SD
6	3	20.37	19.1–22.9	1.79	2	15.5	15.1–15.9	0.4
7	7	16.5	14.1–19.2	2.37	5	20.12	16.1–23.2	2.82
8	15	17.19	11.0–26.9	4.95	15	14.45	9.2–23.9	3.72
9	10	15.82	11.4–19.7	2.66	12	14.17	11.8–18.7	2.02
10	16	15.02	9.7–20.6	2.93	25	16.32	8.9–23.4	3.57
11	23	16.68	12.7–27.6	4.23	22	15.34	8.5–21.1	3.08
12	14	15.89	9.5–25.6	4.48	11	18.21	10.5–27.5	4.72
13	6	16.55	11.8–25.3	4.62	5	15.6	5.3–24.9	6.62
14	6	13.37	10.6–18.0	2.77	4	16.1	9.5–21.7	4.46
15	1	20.3	–	–	–	–	–	–

Table 3.2 : *Distribution of urea concentrations by age and nutritional status (mg/dl)*

Age (yrs)	wellnourished group (WN)				malnourished group (PEM)			
	n	X	range	SD	n	X	range	SD
6	4	19,2	15,9–22,9	2,47	1	15,1	-	-
7	6	19,5	16,1–23,2	2,27	6	15,9	12,4–22,3	1,85
8	21	16,1	11,0–26,9	4,02	9	18,5	9,2–26,9	4,5
9	15	15,2	11,8–19,7	2,50	7	14,5	11,8–18,5	2,19
10	28	15,8	9,2–23,4	3,42	13	16,2	8,9–20,6	2,64
11	33	16,6	8,5–27,6	3,72	12	15,9	8,5–20,7	3,04
12	21	17,5	7,9–27,5	4,82	4	13,9	10,5–18,1	2,72
13	7	17,2	12,1–24,9	4,13	4	14,2	5,3–25,3	7,21
14	8	14,5	9,5–21,7	4,21	2	14,1	13,2–15,1	0,95
15	1	20,3	-	-	-	-	-	-

Figure 1. reveals that no correlation exists between age and plasma urea concentration ($r = -0.07$, $P > 0.05$).

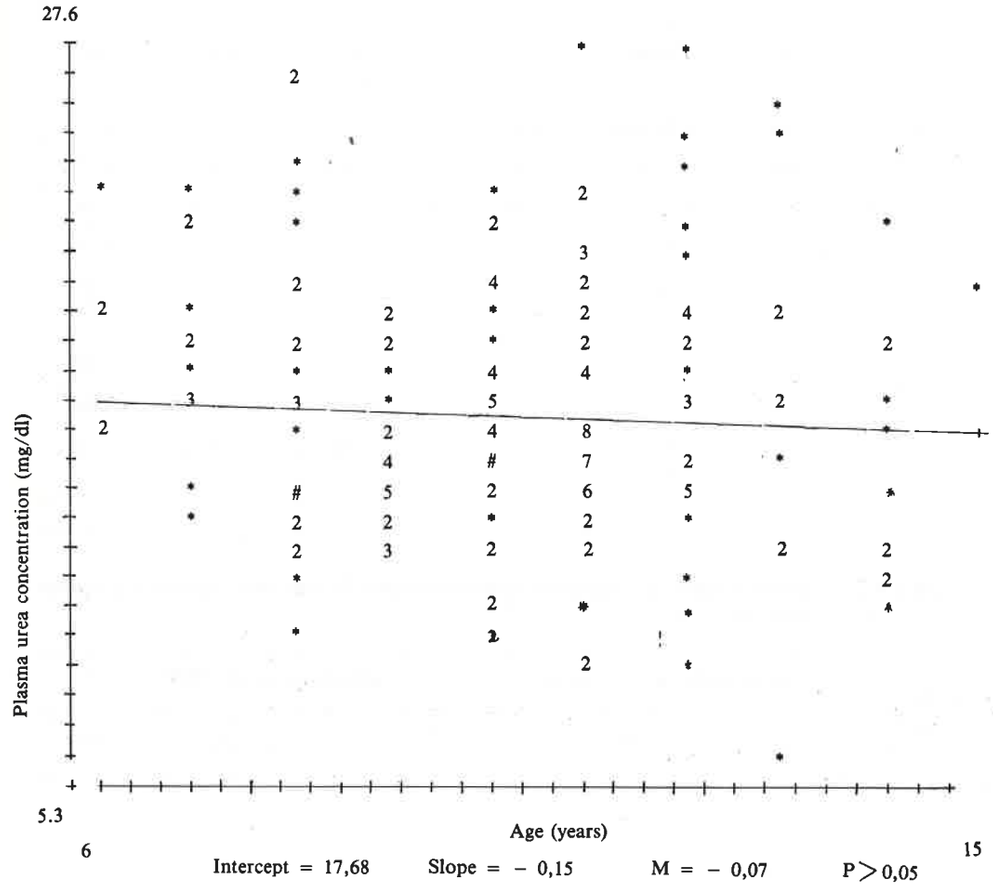
The normal distribution of urea concentration with a confidence level of 95% was P 2.5 = 8.13 mg/dl and P 97.5 = 24.09 (table 3.3).

Table 3.3 : *Urea concentration in both sexes combined (mg/dl)*

N	$\bar{X}$	$P_{2.5}$	$P_{97.5}$
202	16.11	8.13	24.09

Intercept = 17.68 slope = −0.15 r = −0.07 P > 0.05

Fig. 1. *Correlation between age and urea concentration*



Analysis of plasma creatinine concentration

Plasma creatinine levels by age and sex were shown in table 4.1, while by age and nutritional status in table 4.2.

There was no significantly difference in creatinine concentration between the two sexes in all age groups ($P > 0.05$). However, the mean creatinine concentration were 0.71 ± 0.086 mg/dl in males and 0.68 ± 0.093 mg/dl in females if all age groups were combined.

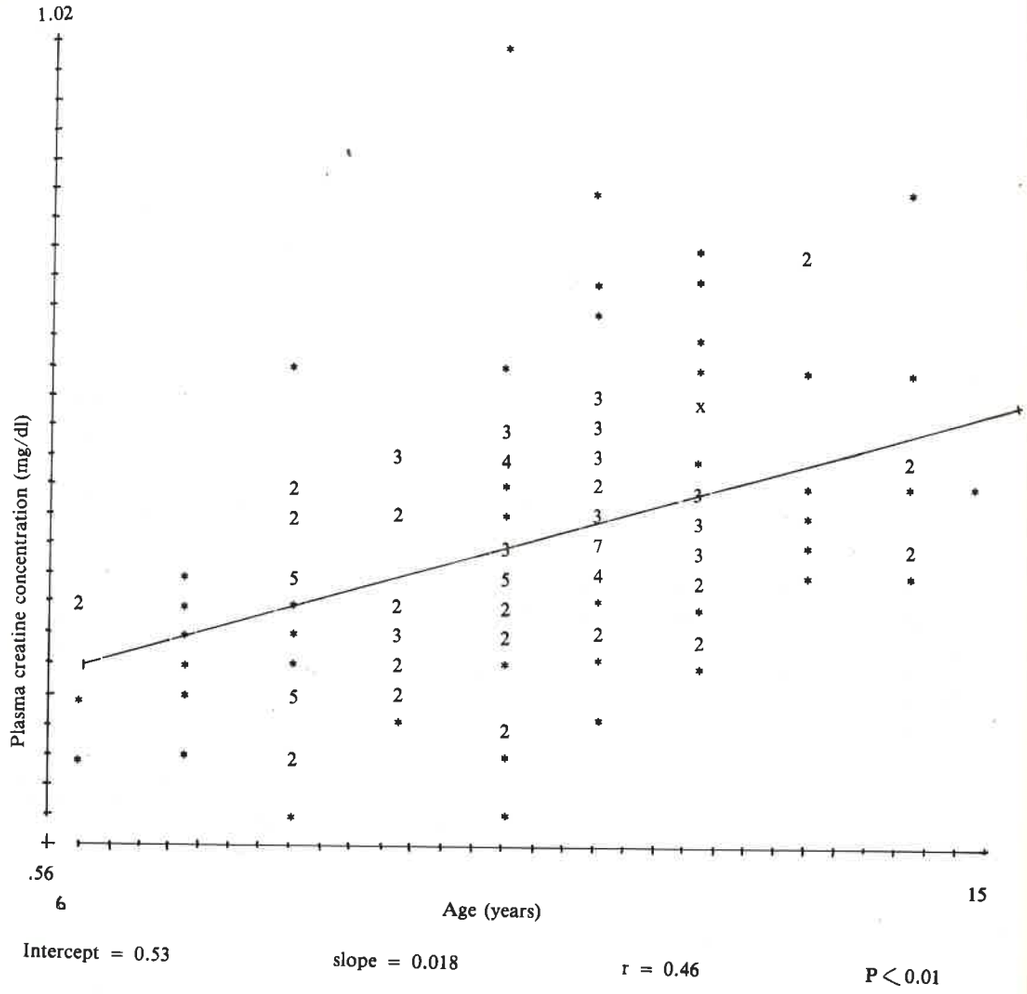
Table 4.1. : *Distribution of creatinine concentrations by age and sex (mg/dl)*

Age (yrs)	male				female			
	n	$\bar{X}$	range	SD	n	$\bar{X}$	range	SD
6	3	0.65	0.59–0.69	0.047	2	0.58	0.53–0.63	0.05
7	7	0.61	0.52–0.71	0.063	5	0.61	0.51–0.67	0.057
8	15	0.64	0.46–0.83	0.080	15	0.63	0.54–1.00	0.109
9	10	0.68	0.56–0.77	0.061	12	0.65	0.54–0.77	0.074
10	16	0.69	0.54–0.83	0.070	25	0.69	0.51–1.02	0.104
11	23	0.74	0.54–0.94	0.087	22	0.70	0.59–0.88	0.069
12	14	0.75	0.65–0.89	0.075	11	0.71	0.63–0.84	0.061
13	6	0.75	0.65–0.89	0.100	5	0.73	0.63–0.83	0.064
14	6	0.75	0.65–0.83	0.055	4	0.74	0.62–0.93	0.114
15	1	0.76	—	—	-	—	—	—

Table 4.2. : *Distribution of creatinine concentrations by age and nutritional status (mg/dl)*

Age (yrs)	wellnourished group (WN)				malnourished group (PEM)			
	n	$\bar{X}$	range	SD	n	$\bar{X}$	range	SD
6	4	0.65	0.59–0.69	0.042	1	0.53	-	-
7	6	0.66	0.59–0.71	0.039	6	0.56	0.51–0.63	0.044
8	21	0.69	0.59–1.00	0.096	9	0.61	0.46–0.71	0.082
9	15	0.69	0.62–0.77	0.052	7	0.62	0.54–0.72	0.067
10	28	0.72	0.56–1.02	0.086	13	0.63	0.51–0.74	0.057
11	33	0.75	0.65–0.94	0.065	12	0.65	0.54–0.88	0.084
12	21	0.75	0.65–0.89	0.065	4	0.64	0.63–0.67	0.016
13	7	0.79	0.71–0.89	0.072	4	0.66	0.63–0.68	0.019
14	8	0.77	0.70–0.93	0.069	2	0.63	0.62–0.65	0.015
15	1	0.76	-	-	-	-	-	-

Fig. 2a. : *Correlation between age and creatinine concentration in wellnourished children.*

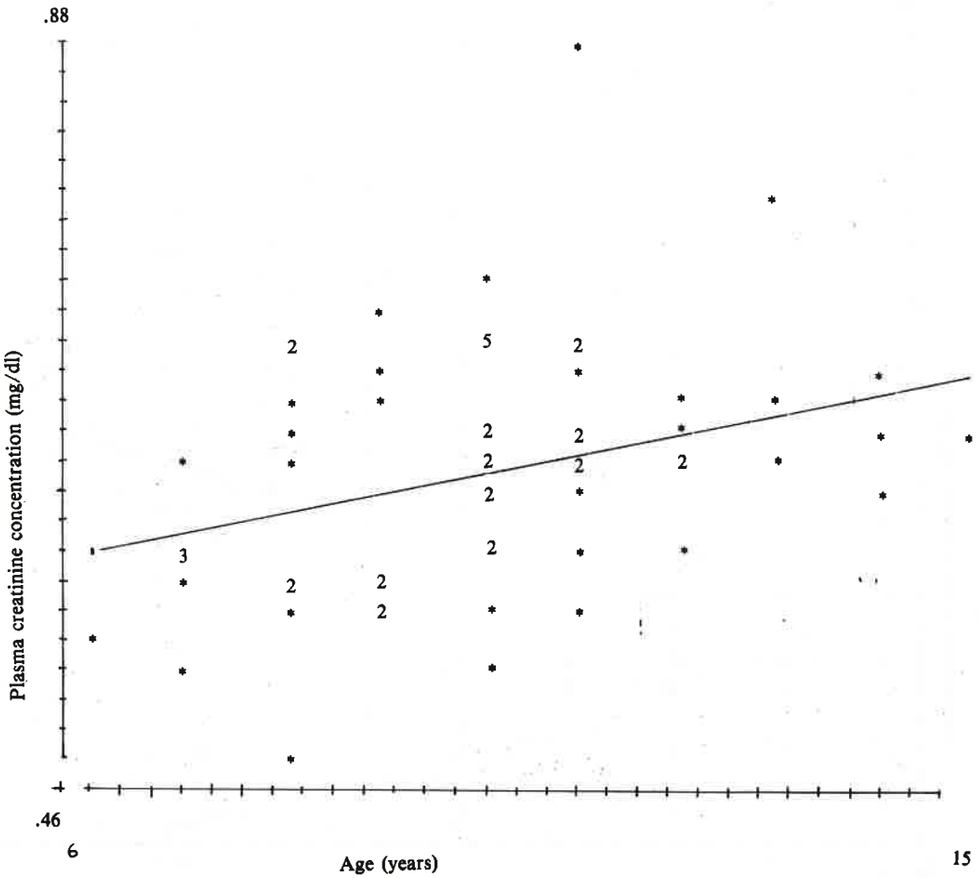


There was a statistically significant difference of creatinine concentrations between the WN and PEM in various age groups ($P < 0.05$). The overall mean creatinine concentration was higher in the WN group (0.73 ± 0.081 mg/dl) as compared to the PEM (0.63 ± 0.066 mg/dl).

Correlation between age creatinine level in the WN as well as in PEM group were shown in figure 2a and 2b.

Figure 2a revealed a significantly positive correlation ($r = 0.46$, $P < 0.01$) between age and plasma creatinine concentration. The older the child, the higher the creatinine level.

Fig 2b : *Correlation between age creatinine concentration in PEM*



Intercept = 0.49 slope = 0.013 r = 0.37 P< 0.01

In PEM a significantly positive correlation (r = 0.37, P < 0.01) was also found between age and plasma creatinine level. The older the child, the higher the plasma creatinine level.

Normal distribution of creatinine concentration in WN as well as PEM with a confidence level of 95% was depicted in table 4.3, fig. 3a and 3b.

Table 4.3. : *Creatinine concentrations by age and nutritional status in both sexes combined (mg/dl)*

Age (yrs)	male				female			
	n	$\bar{X}$	$P_{2.5}$	$P_{97.5}$	n	$\bar{X}$	$P_{2.5}$	$P_{97.5}$
6	4	0.65	0.57	0.73	1	0.53	-	-
7	6	0.66	0.58	0.74	6	0.56	0.47	0.65
8	21	0.69	0.50	0.88	9	0.61	0.45	0.77
9	15	0.69	0.59	0.79	7	0.62	0.49	0.75
10	28	0.72	0.55	0.89	13	0.63	0.52	0.74
11	33	0.75	0.62	0.88	12	0.65	0.48	0.81
12	21	0.75	0.62	0.88	4	0.64	0.61	0.67
13	7	0.79	0.51	1.07	4	0.66	0.62	0.70
14	8	0.77	0.63	0.90	2	0.63	0.60	0.66

Correlation between plasma urea concentration and plasma creatinine concentration.

No correlation was found between plasma urea concentrations and plasma creatinine concentrations in male (r = 0.13, P > 0.05) and in female (r = 0.16, P > 0.05).

Fig. 3a : *Creatinine concentrations at $P_{2.5}$ and $P_{97.5}$ in wellnourished children.*

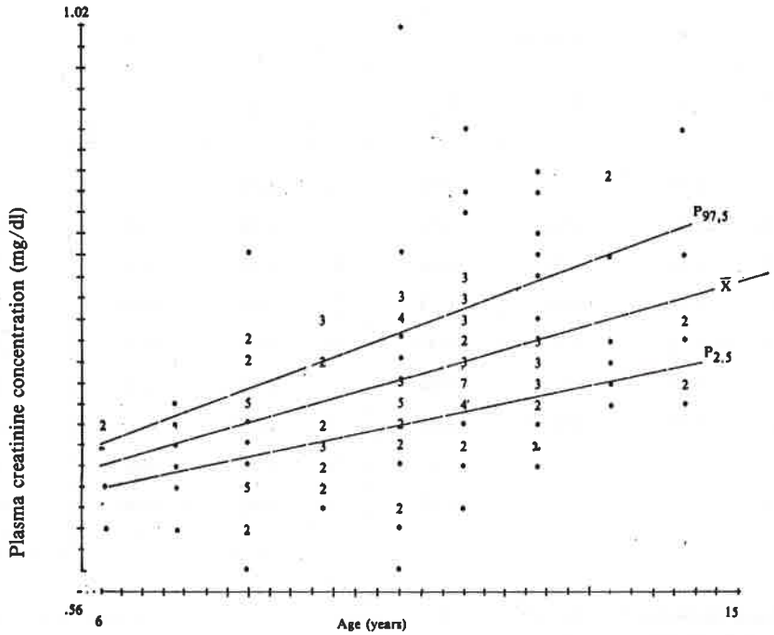
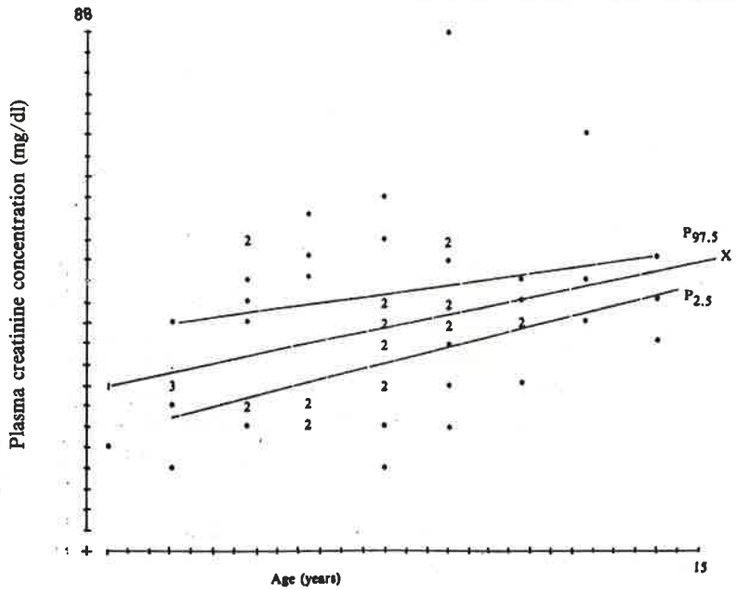


Fig. 3b. *Creatinine concentrations at $P_{2.5}$ and $P_{97.5}$ in malnourished children (PEM)*



Discussion

Published data defining normal values of plasma urea and creatinine in children are scanty, particularly for children less than four years of age or more than 12 years (Schwartz et al., 1976). In this study normal values of both substances were determined in children 6 to 15 years of age because of their easy accessibility.

The normal mean values of both substances in this study as compared to Schwarz's finding were as follow :

Investigator	Urea conc. (mg/dl)	Creatinine conc. (mg/dl)	Age (yrs)
Schwartz et al.	31.38–33.60	0.52–0.76	6–15 *
(1976)	28.86–32.28	0.48–0.67	6–15 * *
This study	13.37–20.37	0.61–0.76	6–15 *
(1989)	14.17–20.12	0.58–0.74	6–14 * *

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The mean creatinine values in this study didn't differ from those of Schwartz et al. (1976) Males seemed to have a higher mean creatinine values than females but there was no statistically significant difference. This corresponds to study of Schwartz et al (1976). There was a correlation between mean creatinine values and age in the WN as well as the PEM group because of the creatinine value is proportional to muscle mass (Hill, 1984; Morrison, 1986). It was difficult to compare the plasma urea and creatinine value between the WN and the PN groups because of the scarcity of PN cases (only 5 or 2.47%) (see table 2). This study showed that the mean plasma creatinine concentration in the WN group was higher than in the PEM (UN + PN) group.
were lower than Schwartz's finding which might be due to difference in protein content of the diet. These values in both sexes. There was significant difference of urea concentrations between the two sexes in the 6–7 years age group probably because of the small number of samples or other reasons. Plasma urea concentrations were not affected by age as it didn't relate to muscle mass, but rather to protein intake (Harper et al., 1978; Morrison, 1986; Rodwell, 1988).

There was no statistically significant difference of urea concentration between the WN and PEM in various individual age groups (P 0.05).

Schwartz et al. (1976) revealed that plasma urea value correlate significantly with plasma creatinine value, which was not found in this study.

Conclusion

1. No statistically significant difference of urea concentration exists between the two sexes. The mean urea concentration was 16.06 ± 3.98 mg/dl in male, whereas in female it was 15.37 ± 4.24 mg/dl if age groups were combined.
2. There was no difference of urea concentrations between the WN and PEM groups in various individual age groups. Mean urea concentration were 16.50 ± 3.90 mg/dl in WN and 15.05 ± 4.36 mg/dl in PEM if all age groups were combined.
3. There was no correlation between age and plasma urea concentrations
4. There was no difference of creatinine concentrations between the two sexes in various age groups. Mean creatinine concentrations were 0.71 ± 0.086 mg/dl in males and 0.68 ± 0.093 mg/dl in females, if all age groups were combined.
5. There was a significant difference of creatinine concentrations between the WN and PEM in various age groups. The overall mean creatinine concentration was higher in the WN group (0.73 ± 0.81 mg per dl) as compared to the PEM group (0.63 ± 0.066 mg/dl).
6. A correlation exists between age and plasma creatinine concentration in the WN as well as in the PEM. The older the child, the higher the creatinine level.
7. No correlation was found between plasma urea concentrations and plasma creatinine concentrations in the two sexes.

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