5. Ferguson, D. J., Visscher, M. B., *Cancer Res.*, 1953, v13, 405.
6. Monsen, H., *Cancer Res., Sci. Proc.*, 1952, v12, 284.
7. Casas, C. B., King, J. T., Visscher, M. B., *Am. J. Physiol.*, 1959, v157, 193.
8. ———, Koppisch, E., *Endocrin.*, 1952, v51, 322.
9. Martinez, C., Bittner, J. J., *Cancer Res.*, 1955, v15, 612.
10. Monsen, H., Kirschbaum, A., *Proc. Am. Assn. Cancer Res.*, 1954, v1, 33.
11. King, J. T., Visscher, M. B., Casas, C. B., *Fed. Proc.*, 1947, v6, 142.
12. Cranston, E. M., PROC. SOC. EXP. BIOL. AND MED., 1958, v98, 320.
13. ———, *Endocrin.*, 1961, v69, 331.

Received Sep. 5, 1961. P.S.E.B.M., 1961, v108.

Study of Copper and Zinc Metabolism During Pregnancy. (26983)

N. C. JOHNSON (Introduced by W. B. Kountz)
Division of Gerontology, Washington University School of Medicine, St. Louis, Mo.

Previous studies have demonstrated that the total serum copper level increases with administration of certain hormones such as testosterone and estrogen, during pregnancy, and in different pathological states(1,2,3,4). Few studies have been reported on the effect of sex hormones on serum zinc level. The studies in this laboratory indicated that total serum zinc level declined with parenteral administration of testosterone propionate and estradiol benzoate. The mechanism of the mobilization and utilization of copper and zinc with the endogenous release or administration of sex hormones is unknown. The purpose of this investigation was to determine if total serum zinc level is changed during pregnancy.

It is known that the zinc content in serum is greater than the copper content. We found that the normal serum copper and zinc ranged from 99-113 μg/100 ml and 158-178 μg/100 ml, respectively, on 200 geriatric patients(4), as compared to 84-137 μg/100 ml and 158-285 μg/100 ml reported by others on middle aged subjects(5,6,7).

Method. Thirty female subjects were selected for this investigation. Their ages ranged from 21-40. All subjects were ambulatory with no acute or debilitating disease, and with no known disorder of copper or zinc metabolism. Twenty subjects were pregnant from 12-40 weeks. Ten non-pregnant subjects were used as controls. Venous blood was secured with the necessary precaution to avoid contamination. Duplicate determination of total serum copper and zinc was made during pregnancy and 8 weeks post partum. Colorimetric methods were employed for trace mineral determination(8,9) with modification by the author. Serum oxidase activity was determined by the method of Ravin(12), modified by Houchin(13).

Results: Table 1 gives the code, ages, weeks of pregnancy, total serum level of zinc, copper, and oxidase activity during the indicated period of pregnancy and 8 weeks after parturition. While the serum zinc level was found to be lower during pregnancy in all subjects, the serum copper level was increased in all subjects. The lowest zinc value and highest copper value were 45 and 289 μg/100 ml, respectively, for a subject 29 weeks pregnant. Eight weeks after parturition we found that the copper value decreased and the zinc value increased, approaching the normal reported range. The copper oxidase activity value ranged from 0.26-0.37 OD unit during pregnancy and declined after delivery to a range of 0.13-0.27 OD unit.

Discussion. Several investigators have observed an increase in total serum copper values in pregnancy and estrogen administration(1,5,6,4) and one author(10) has reported a decline in zinc during pregnancy. The results of investigation on copper and zinc excretion(1,5,11) during pregnancy and sex hormone administration indicated such changes are not significant. A high degree of correlation was observed between total serum copper and oxidase activity(14) in

TABLE I. Total Serum Copper and Zinc Levels and Oxidase Activity Before and After Parturition

			Before parturition			8 Weeks postpartum		
Code	Age	Wks. of Pregnancy	Zn μg	Cu %	Cu Oxidase O.D.	Zn μg	Cu %	Cu Oxidase O.D.
C-2	32	12	175	170	.35	195	110	.27
T-1	27	16	55	205	.26	201	150	.22
C-5	32	20	115	224	.33	199	116	.20
C-6	31	20	110	214	.37	206	120	.20
T-3	30	32	153	259	.30	212	114	.18
C-4	34	23	82	180	.33	175	128	.28
W-4	23	29	45	289	.32	188	121	.23
C-3	31	30	118	186	.30	194	100	.19
C-1	27	30	90	245	.31	185	145	.16
T-4	27	30	148	259	.31	210	125	.18
W-7	27	33	80	256	.32	257	126	.23
W-8	35	35	45	197	.34	310	117	.25
W-9	30	36	58	275	.33	240	128	.27
W-5	25	36	63	283	.31	125	82	.20
W-6	31	36	95	227	.34	205	115	.24
T-2	24	38	113	207	.29	220	101	.16
W-1	38	39	63	275	.31	205	98	.17
W-10	21	39	65	255	.35	213	105	.26
W-3	30	40	75	289	.34	222	120	.26
W-2	34	40	50	179	.28	207	110	.13
10 control subjects			192	116	.19	197	114	.19

Age range in control subjects from 21 to 28.
Second determinations on control subjects were done 8 weeks after the first.

pregnant women. Serum copper and zinc levels tend to increase and decrease respectively with administration of sex hormone in non-pregnant subjects, and in pregnant subjects where there is known to be an increase in sex hormone. These facts suggest the changes are due to the change in hormone level in the body.

Summary. 1. There was an increase in total serum copper content and a decrease in total serum zinc content during pregnancy. 2. The total values of copper and zinc returned to or near their normal reported range, post partum.

The author wishes to express appreciation to Drs. C. Wegner, E. Taylor, W. A. Younge, T. Kheim, and Mrs. E. Williams, Asst. Lab. Technician.

1. Lahey, M. E., Gubler, C. J., Cartwright, G. E., Wintrobe, M. M., *J. Clin. Invest.,* 1953, v32, 322.

2. Von Studnitz, W., Berezin, D., *Acta Endocrinol.,* 1958, v27, 245.

3. Russ, E. M., Raymunt, J., PROC. SOC. EXP. BIOL. AND MED., 1956, v92, 465.

4. Johnson, N. C., Kheim, T., Kountz, W. B., *ibid.,* 1959, v102, 98.

5. Vallee, B. L., *Metabolism,* 1952, v1, 420.

6. Candura, F., Matioli, G., *Boll. Soc. Ital. Ematol.,* 1955, v3, 485.

7. Paixas, L. M., Yoe, J. H., *Clin. Chem. Acta,* 1959, v4, 507.

8. Greenleaf, C. A., *J. Assn. Off. Agr. Chem.,* 1947, v30, 144.

9. Wolf, H., *Biochem. Zeitung,* 1954, v325, 275.

10. Rothe, K., Piskazeck, K., Bilek, K., *Arch. Gynokologies,* 1960, v192, 349.

11. Perry, H. M., Perry, E. F., *J. Clin. Invest.,* 1959, v38, 1452.

12. Ravin, H. A., *Lancet,* 1956, v1, 726.

13. Houchin, O. B., *Clin. Chem.,* 1958, v46, 519.

14. Markowitz, H., Gubler, C. J., Mahoney, J. P., Cartwright, G. E., Wintrobe, M. M., *J. Clin. Invest.,* 1955, v34, 1498.

Received Sep. 5, 1961. P.S.E.B.M., 1961, v108.