HEAVY METAL CONTENT IN HUMAN HAIR : " A CASE ANALYSIS OF LOW AND MIDDLE INCOME GROUPS FROM INDUSTRIAL AND NON-INDUSTRIAL AREAS OF BARODA".

CHAPTER - VI

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Most of the pollutants in the environment, including metals, find their way into the human body, either directly or indirectly. Whereas a direct entry occurs through the air that we breathe, indirect routes of entry include the water and food. Both plants and animals accumulate metals from their environment and when they are fed on by humans, they ultimately end up in the human body. Like any other animal, the metals that enter the human body can also be removed or else be stored in various parts. Generally, the metal content of human tissues is a reflection of the metal load, often, a consequence of various inter-dependent factors like amount, mode of uptake, availability of binding or chelating agents, removal etc. Persistence of metals in the system, in due course of time leads to bio-accumulation. A characteristic feature of class mammalia is the tendency for accumulation of metals in their hair and fur, in fact uptake and storage of metals in the hair follicles and in the hair ultimately. Hair serves as an excellent mode for deriving the metal content and metal load in the environment. In this respect, analysis of hair for metals is a useful method and, presence, is an indisputable autograph of the degree to which the human body is exposed to metallic pollutants. Expectantly, the metal content of hair in individuals residing in industrial belts would be a true reflection of the degree of contamination of the environment. Hence, in the present study, the metal content of hair of individuals residing in the highly industrialized Nandesari belt, has been assessed and compared with that in the hair of individuals residing in non-industrialized belts, in order to fathom the degree of bio-magnification in relation to environmental metallic load. The hair samples of low income group were collected from both the areas for comparison in order to avoid complications due to dietary variations in different income groups. However, to ascertain this point, hair samples from barber shops in non-polluted areas frequented by middle income group have also been analyzed.

MATERIALS & METHODS

Hair for the analysis of metal content, was obtained from barber shops in the industrialized (polluted) and non-industrilized (non-polluted) areas. The barber shops selected were such that, they are frequented only by low income group (LIG). For the analysis of possible variation in metal content due to dietary variation, hair was also collected from barber shops frequented by middle income group (MIG) in the non-polluted areas. For each of the three groups of study, hair from 64 subjects was collected. The hair for metal analysis was brought to the laboratory and washed first in water, and then in hexane. The samples were then dried in an oven at 35°C. One gram dried sample was then taken in a conical flask containing 3ml each of concentrated H_2So_4 and HNO_3. The volume was made upto 100 ml and was then digested on a hot plate till the volume shrank to 5 ml. The volume was again remade to 100 ml with distilled water and 10 ml sample was drawn from each and was then aspirated into an atomic absorption spectrophotometer for analysis of metals as discribed previously (Chapter- I).

RESULTS

The data on the content of Ca, Cl, Cr, Cu, Fe, Pb, Mn, Ni, K, Na, Zn, and Cd are shown in table 1 and figures 1 - 12. From the table and figures, it becomes clear that the hair of individuals from polluted areas always have significantly higher, in fact the highest content of all metals/halide while, the hair of MIG also had significantly greater content than the LIG individuals. The lowest contents in general were recorded for Pb, Ni, Ca, and Mn followed by Cr and Cd. The highest concentration was recorded for Chloride, Zn, Fe, Na, K and Cu, in that order.

Percentage increment of metal/halide content of hair in LIG and MIG group is given in table 1. The greatest

TABLE 1: RANGE, MEAN METAL CONTENT IN THE HAIR FROM INDIVIDUALS RESIDING IN THE INDUSTRIAL AND NON INDUSTRIAL AREAS OF BARODA

		Na	K	Cl	Ca	Fe	Cu	Cr	Zn	Ni	Pb	Mn	Cd
LIG-C	RANGE	17	7	550	0.02	31	8	0.021	49	0.01	0.001	0.02	0.117
		102	43	1441	0.211	73	31	0.511	140	0.061	0.003	0.121	0.413
	MEAN	27.63	12.19	1014.50	0.05	44.31	12.35	0.27	98.90	0.02	0.00	0.03	0.22
LIG-P	RANGE	22	10	1540	0.296	43	13.2	0.4	150	0.018	0.001	2.21	1.211
		103	44	3297	0.839	98	19.8	0.9	311	0.101	0.006	1972	4.792
	MEAN	49.10	23.11	2242.48	0.45	62.09	16.89	0.49	174.30	0.04	0.00	8.70	3.24
% INCREAMENT IN P		+77.88	+89.62	+121.04	+778.66	+40.12	+36.72	+86.04	+76.23	+89.57	+101.25	+25488	+1372.46
MIG-C	RANGE	41	18	1212	0.099	60	10	0.3	110	0.02	0.001	0.011	0.466
		77	33	1827	0.448	80	15	0.472	135	0.039	0.002	0.039	1.414
	MEAN	56.700	25.650	1436.200	0.250	66.515	12.500	0.367	124.150	0.027	0.002	0.024	0.742
% INCREAMENT IN C		+105.24	+110.47	+41.56	+389.62	+50.11	+1.189	+37.96	+25.53	+29.85	-2957.6	-30.294	+237.64

LIG-C : METAL CONTENT IN HAIR OF LOWER INCOME GROUP POPULACE RESIDING IN NON INDUSTRIAL BELT

MIG-C : METAL CONTENT IN HAIR OF MIDDLE INCOME GROUP POPULACE RESIDING IN NON INDUSTRIAL BELT

LIG-P : METAL CONTENT IN HAIR OF LOWER INCOME GROUP POPULACE R(NANDESARI)

FIG. 1 : COMPARISON OF CALCIUM DATA IN DIFFERENT POPULATION

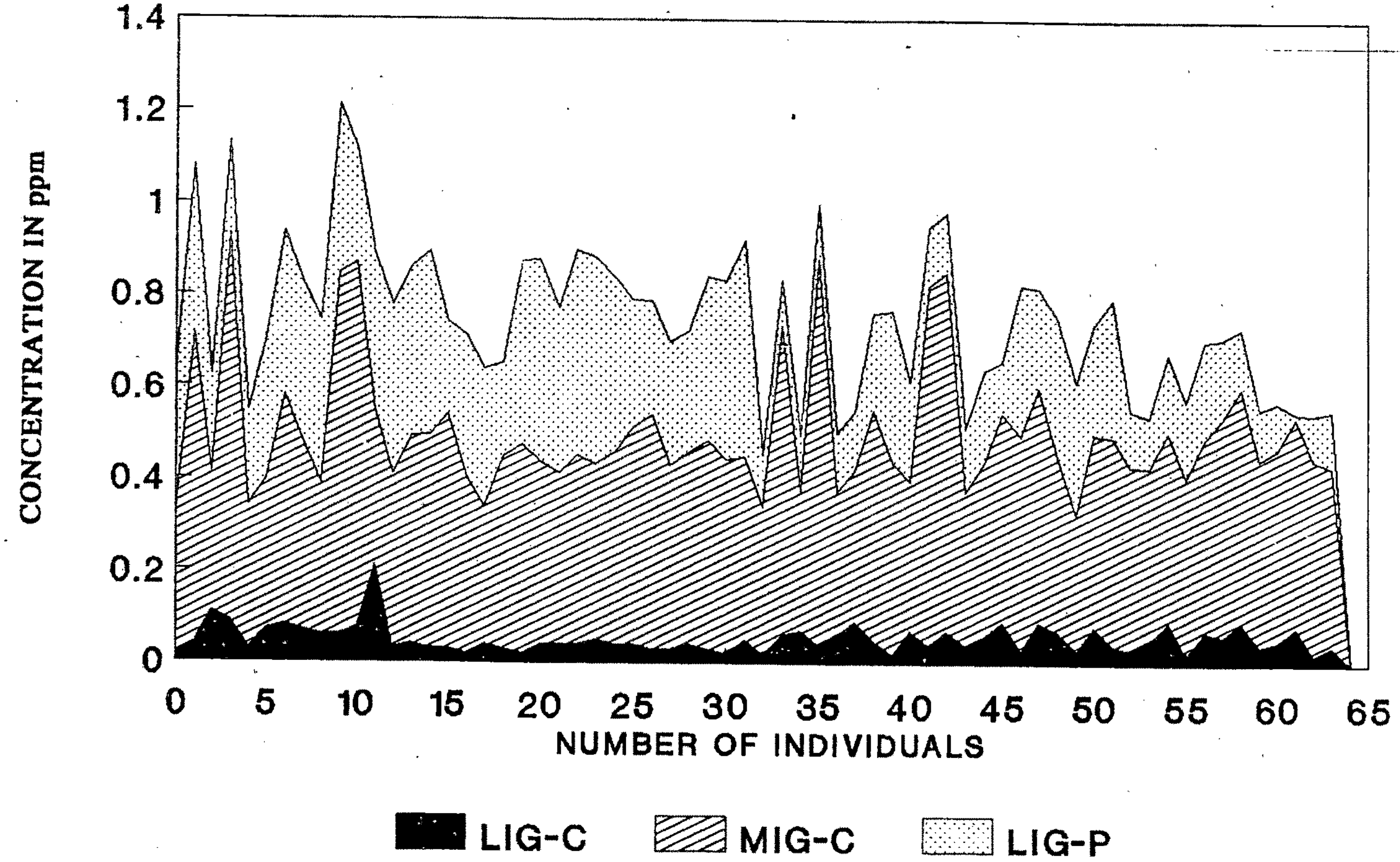
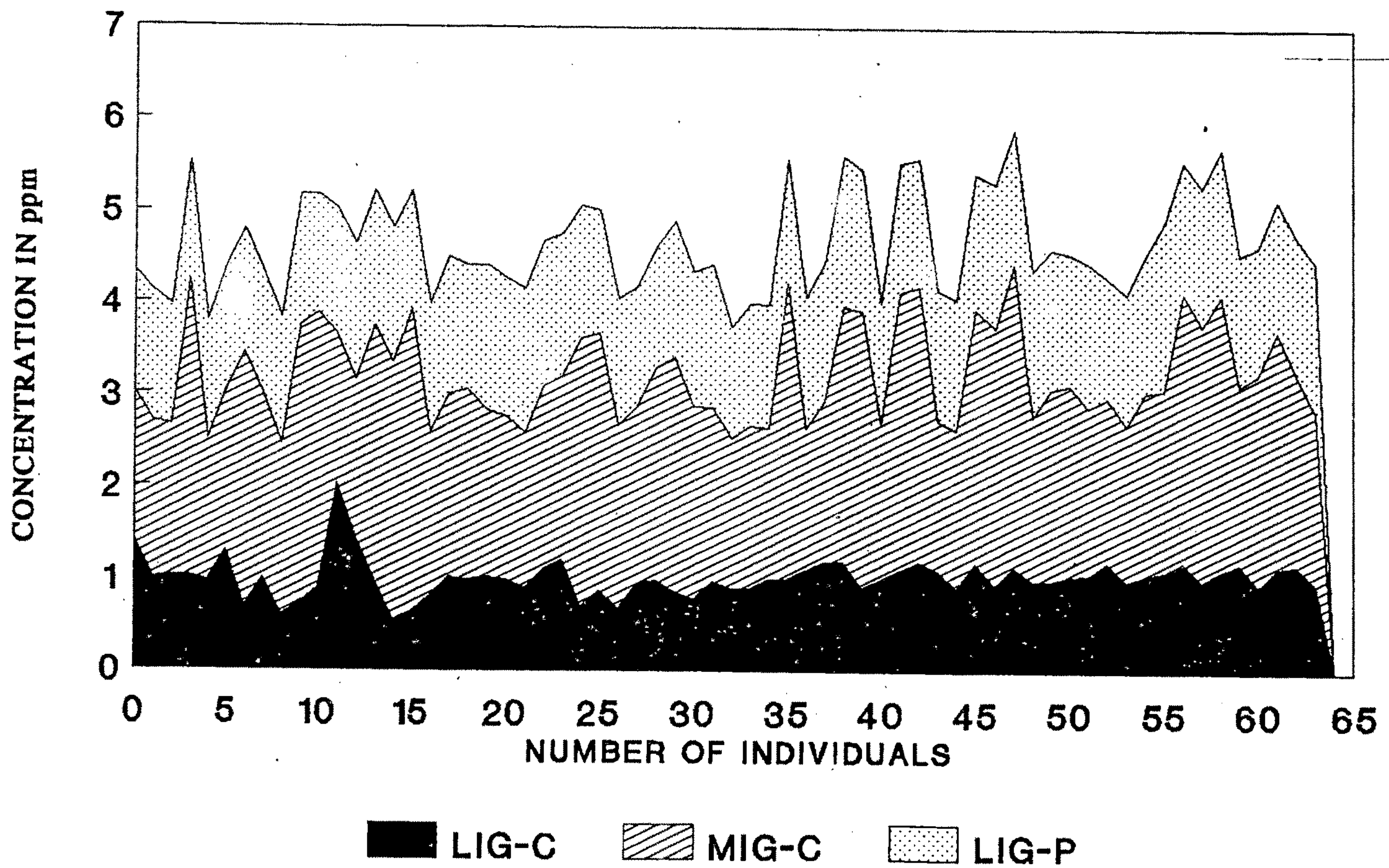


FIG. 2 : COMPARISON OF CHLORIDE DATA IN DIFFERENT POPULATION



Conc. In ppm x 1000

FIG. 3 : COMPARISON OF CHROMIUM DATA IN DIFFERENT POPULATION

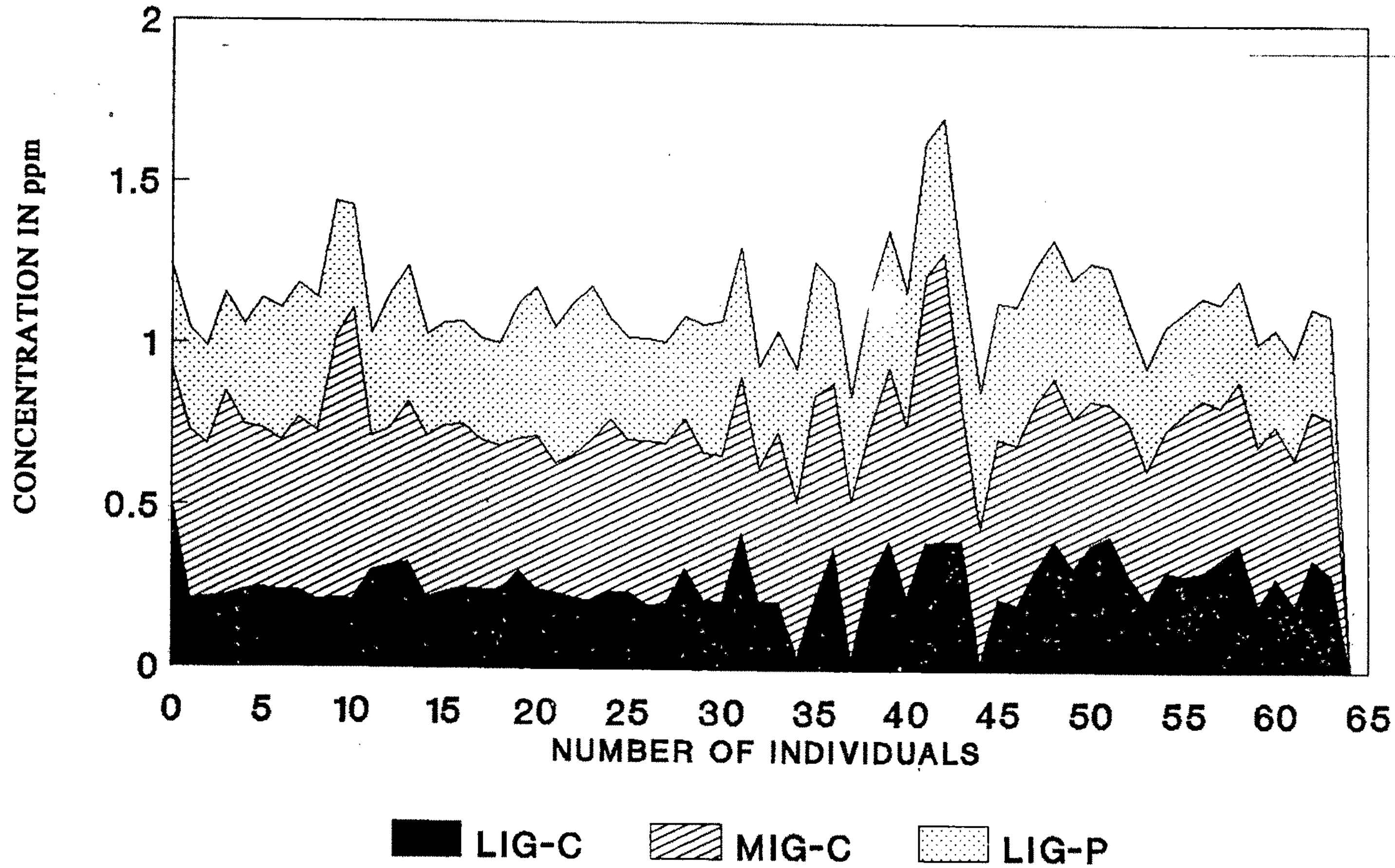


FIG. 4 : COMPARISON OF COPPER DATA IN DIFFERENT POPULATION

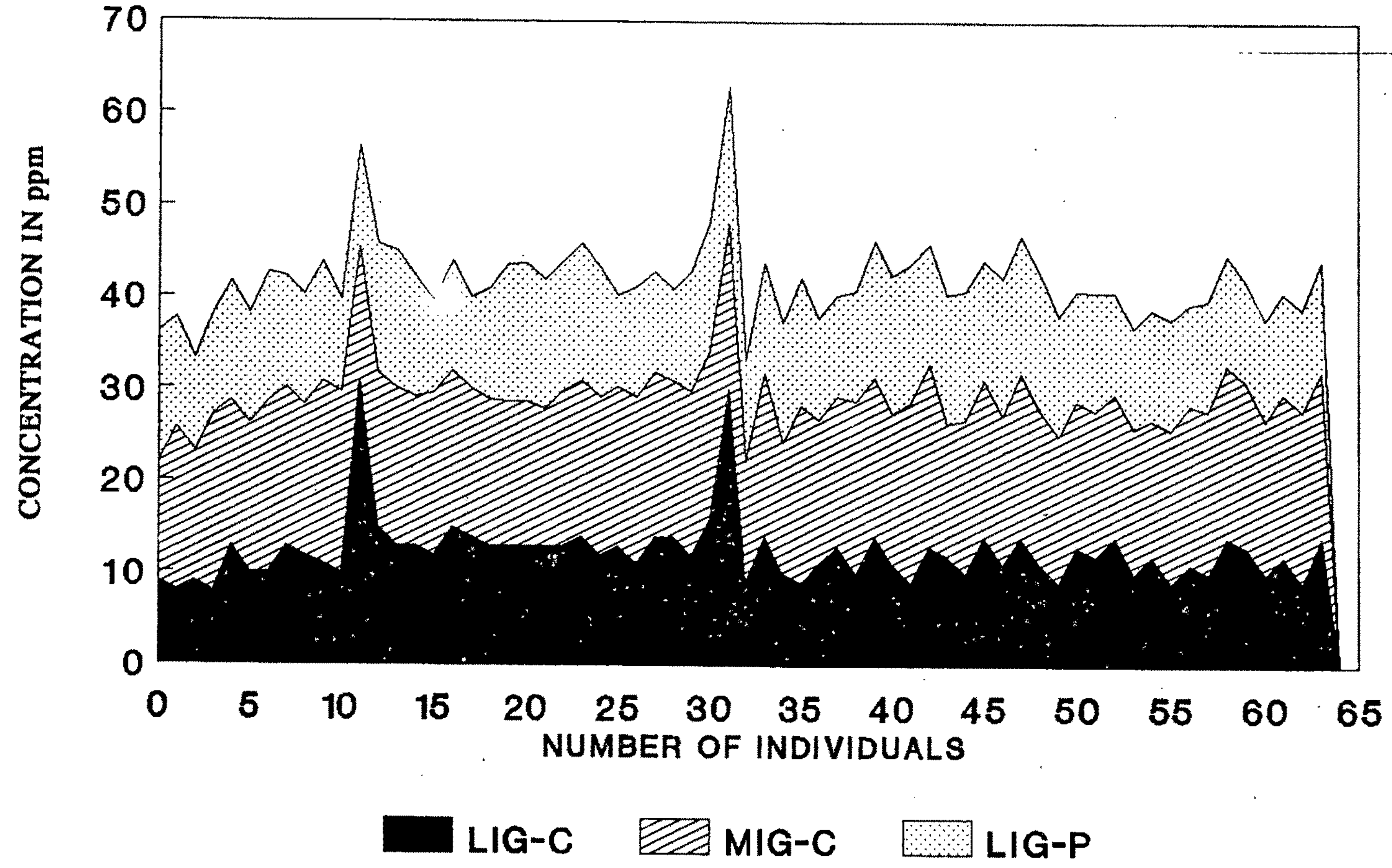


FIG. 5 : COMPARISON OF IRON DATA IN DIFFERENT POPULATION

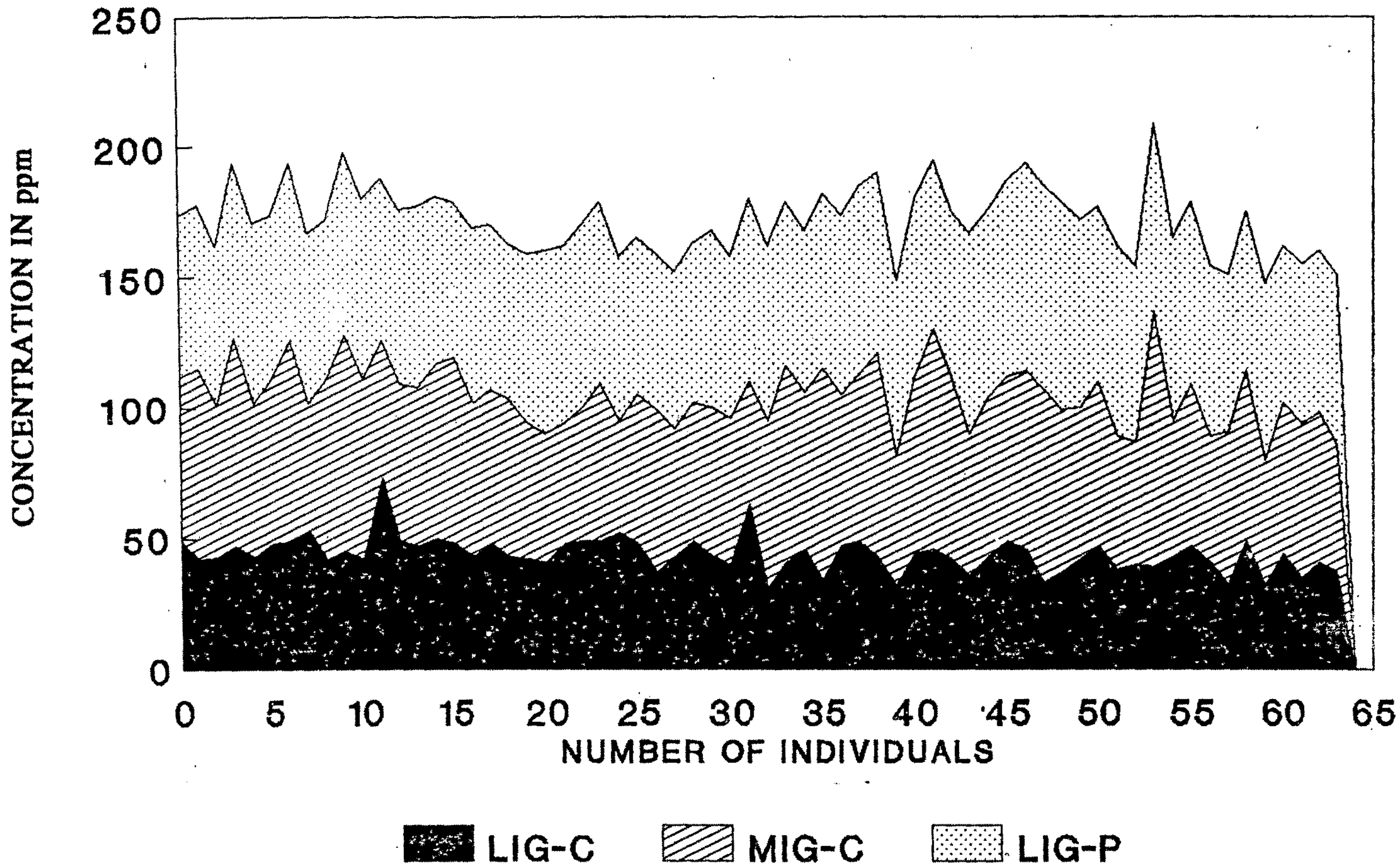


FIG. 6 : COMPARISON OF LEAD DATA IN DIFFERENT POPULATION

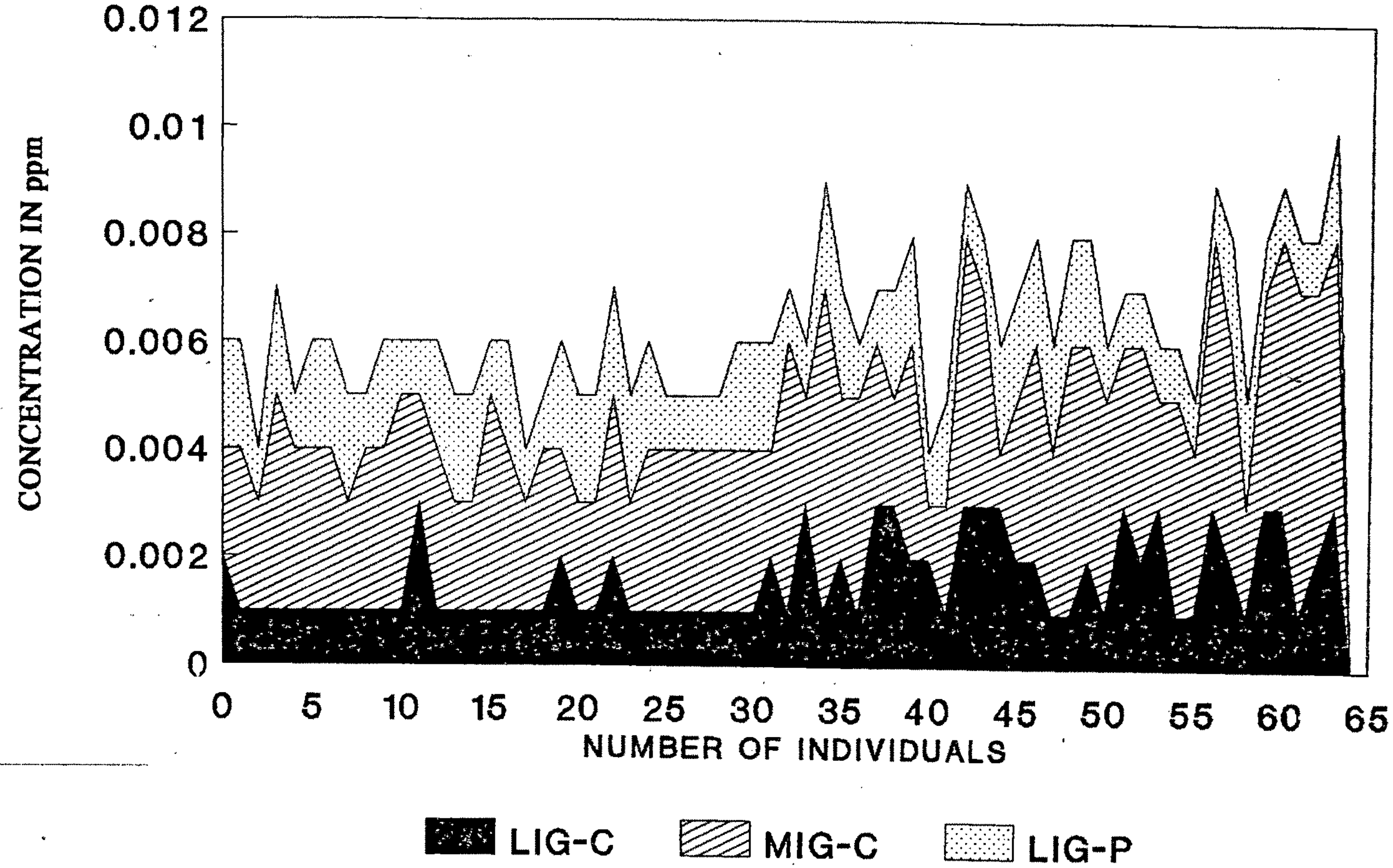
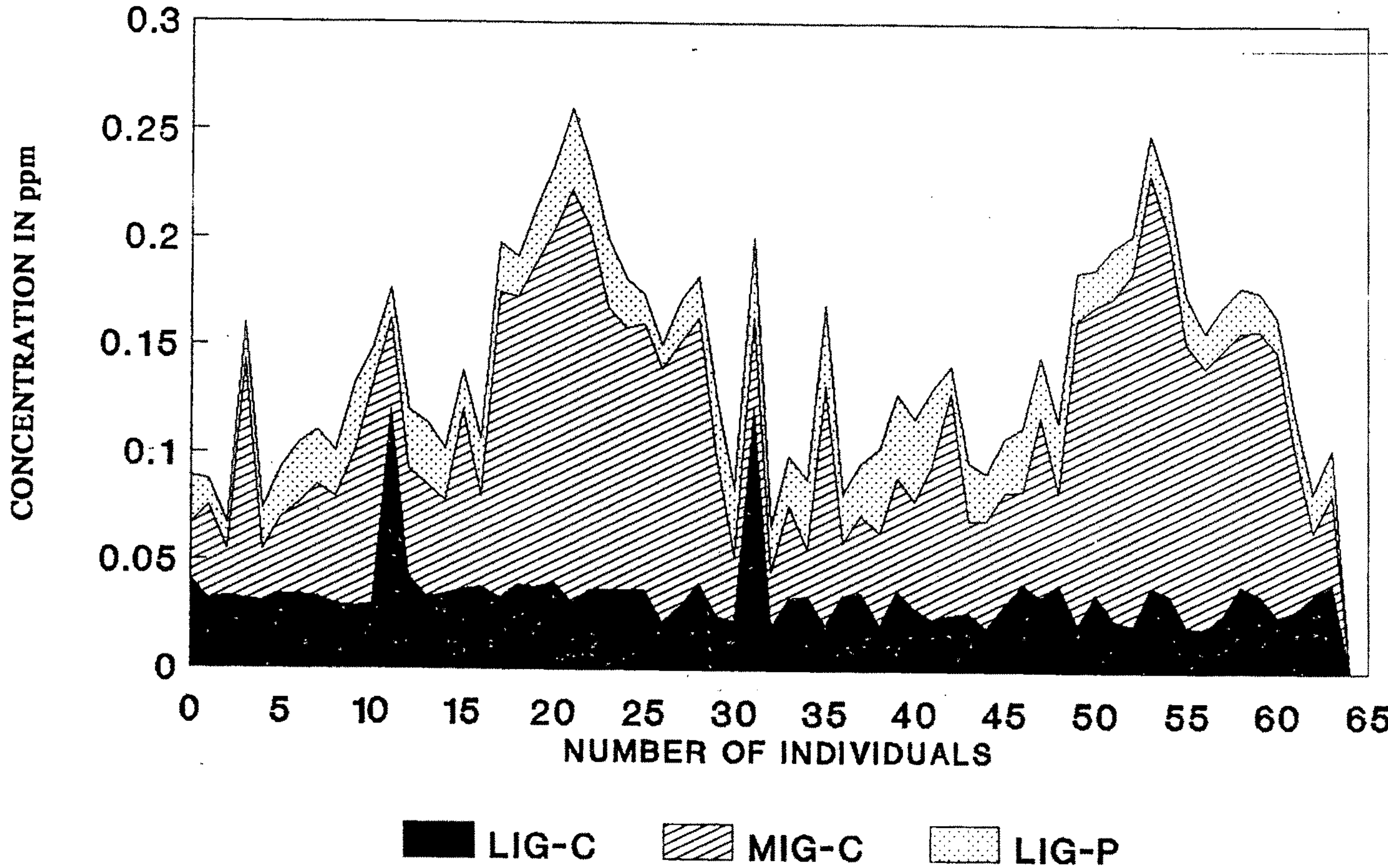


FIG. 7 COMPARISON OF MANGNESE DATA IN DIFFERENT POPULATION



MIG-C is to be multiplied by 100

FIG. 8 : COMPARISON OF NICKEL DATA IN DIFFERENT POPULATION

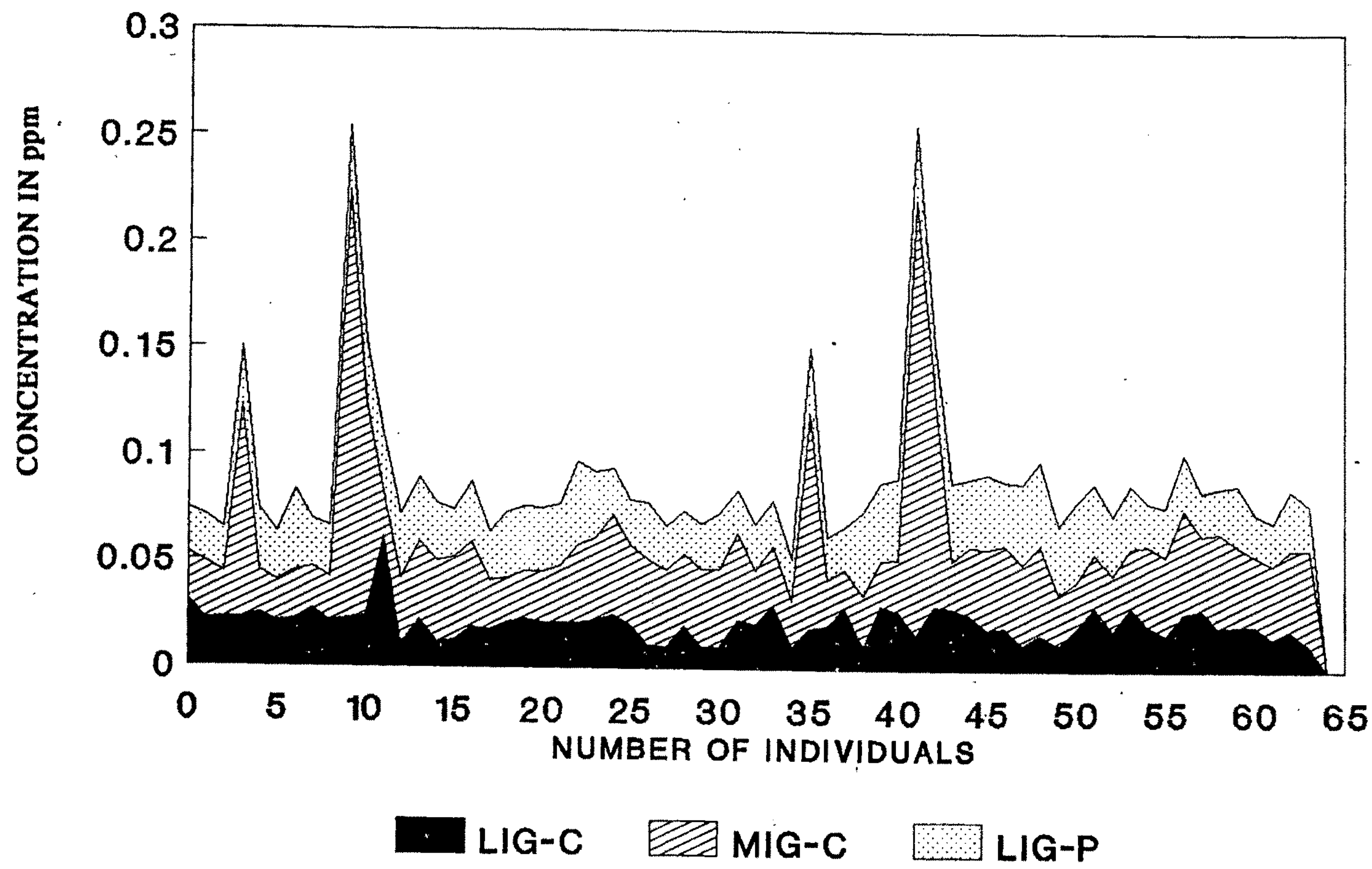


FIG. 9 : COMPARISON OF POTASSIUM DATA IN DIFFERENT POPULATION

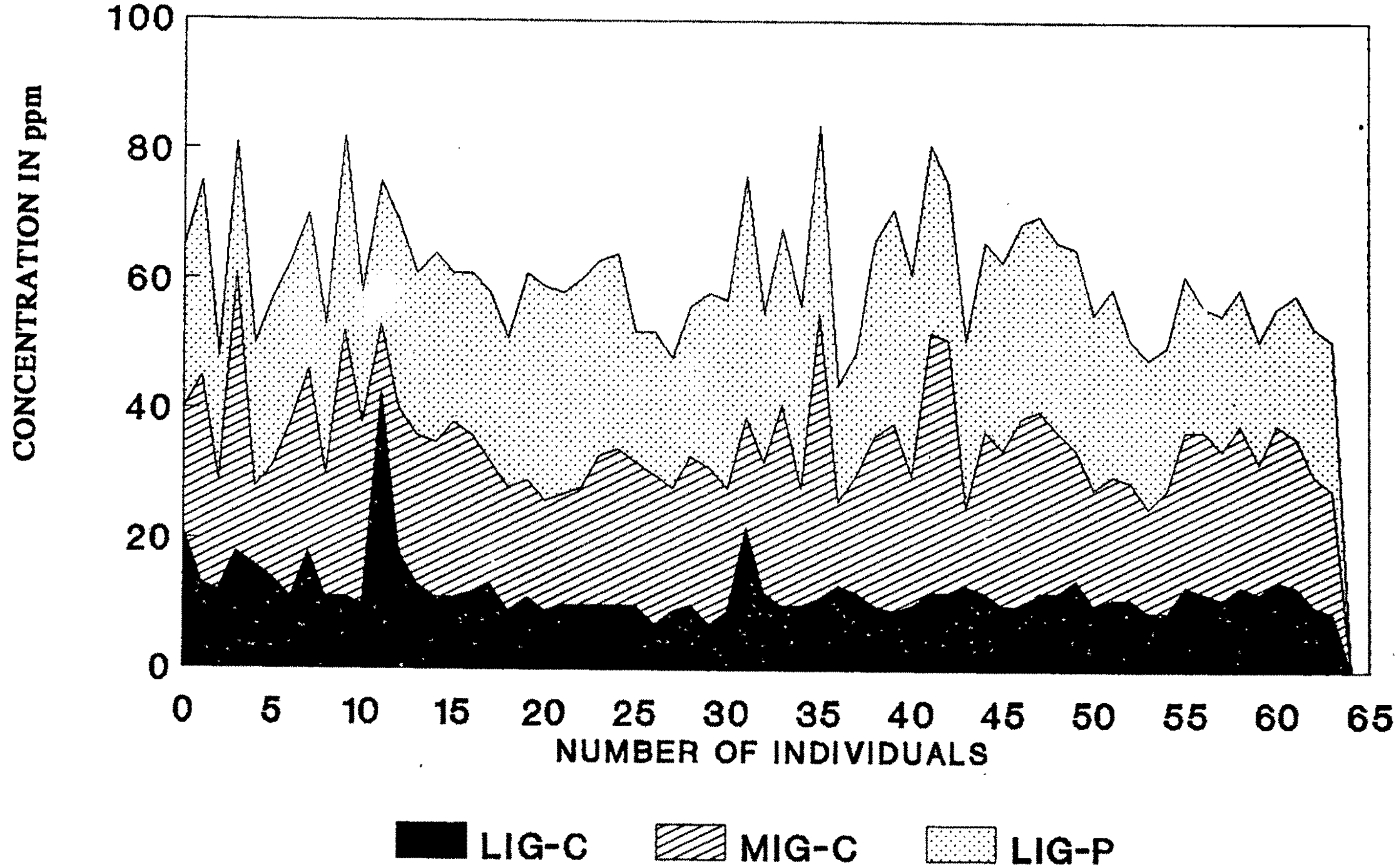


FIG. 10 COMPARISON OF SODIUM DATA IN DIFFERENT POPULATIONS

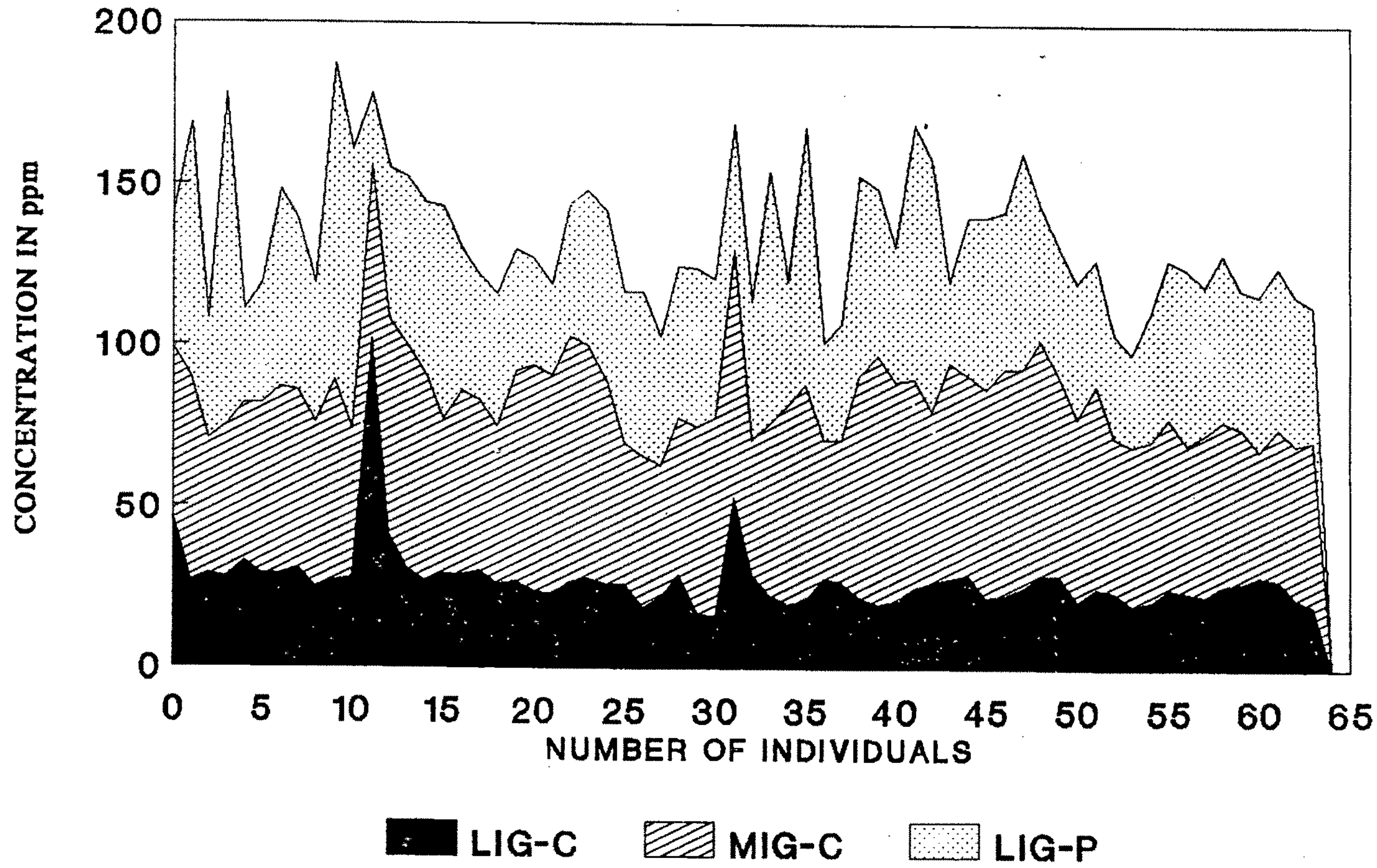


FIG. 11 : COMPARISON OF ZINC DATA IN DIFFERENT POPULATION

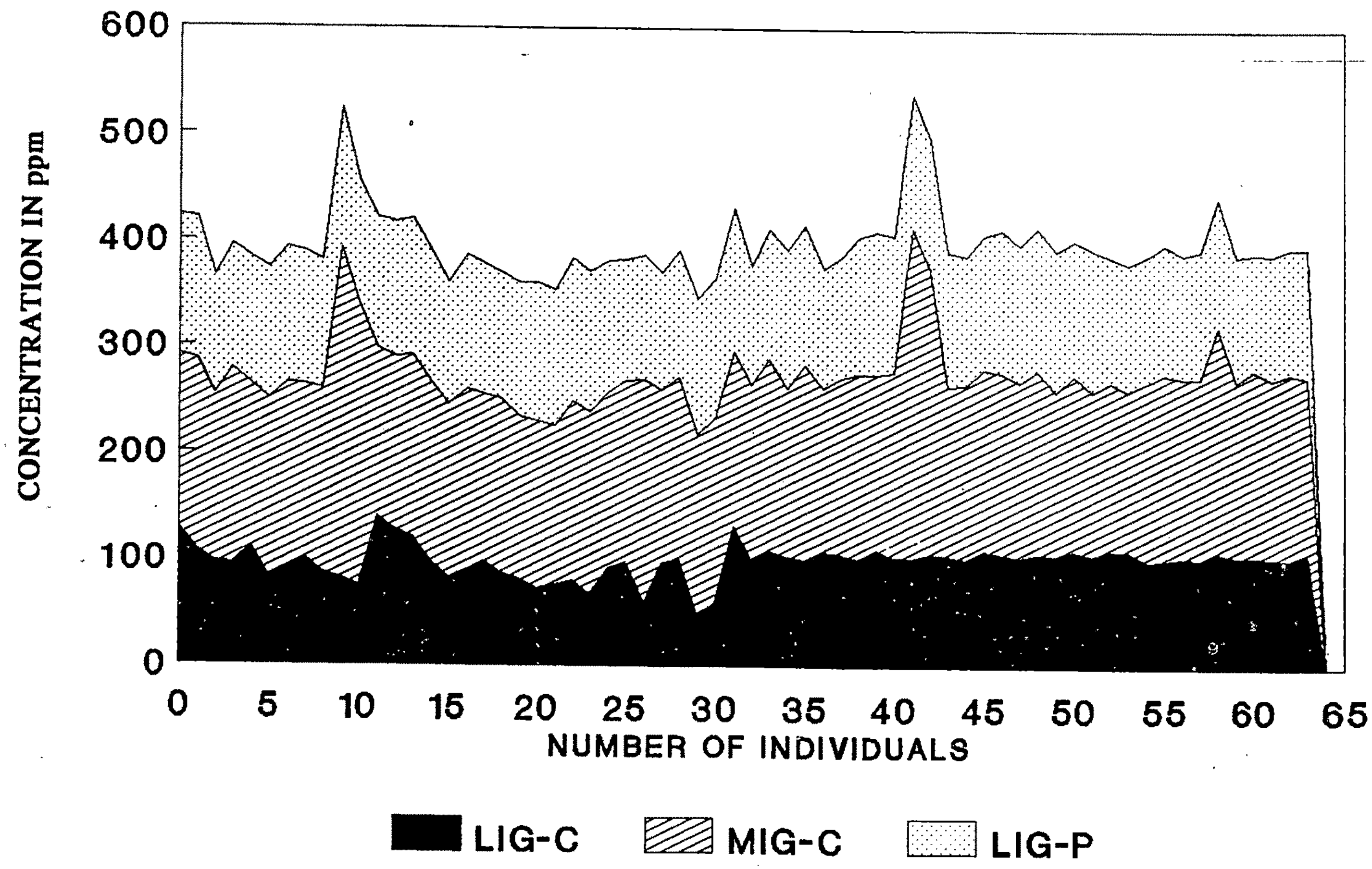
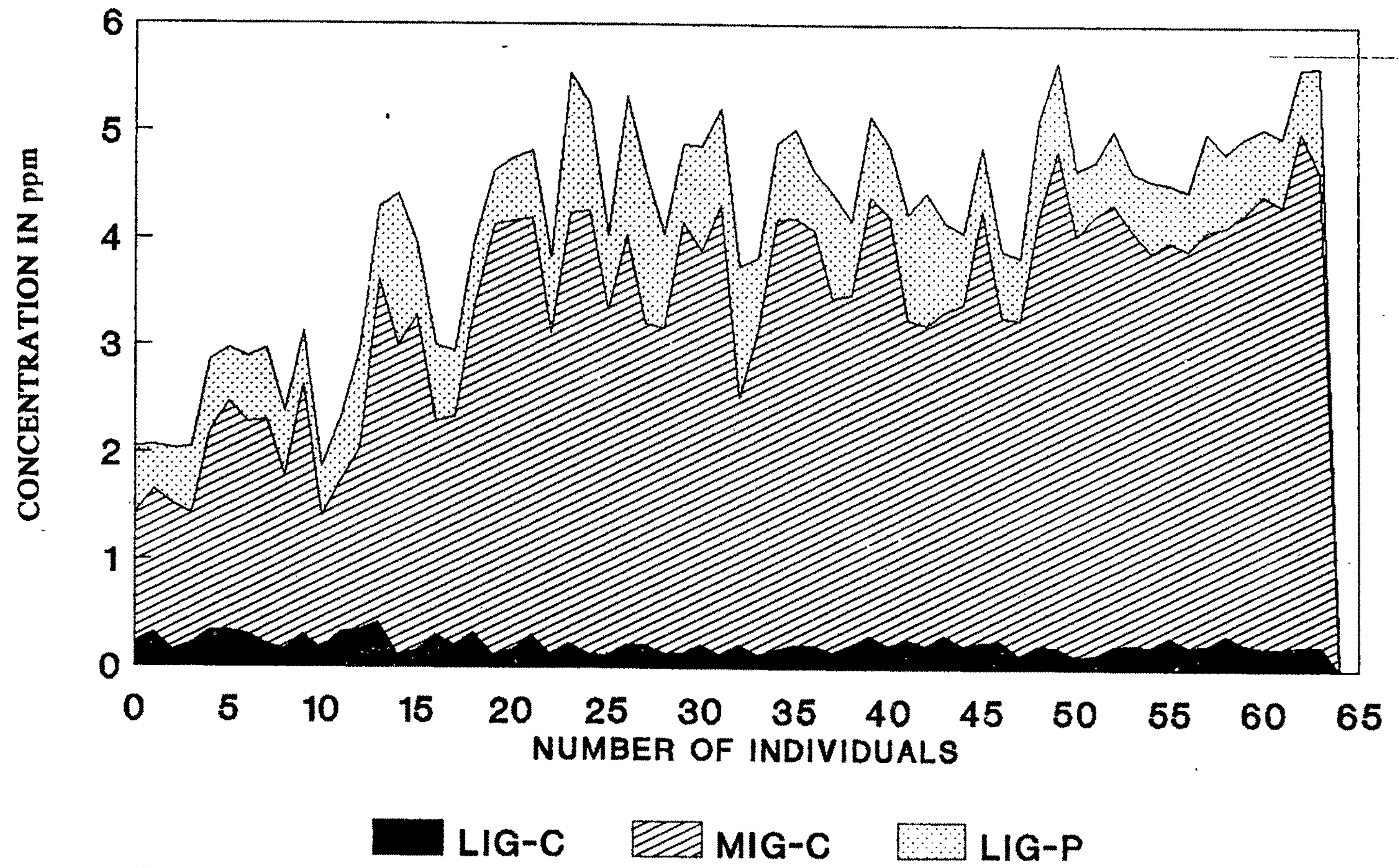


FIG. : 12 COMPARISON OF CADMIUM DATA IN DIFFERENT POPULATION



percentage increment in the hair sample of polluted areas, was recorded for Mn and Cd. The least increment noted was for Cu, which was about 36%. All other metals showed near hundred percent increment. Except for Mn, all other metals showed higher content in the hair of middle income group of non polluted areas, which ranged from a minimum of 1% for Cu to a maximum of 389% for Ca. Other metals/halide showed varying increment ranging in between.

DISCUSSION

In the present study, significant amounts of metals/halide have been detected in hair. Further, explicitly correlatable clear difference in terms of hair metal content between metal infested and non-infested areas is reflected. Apparently, like various organs, hair can also accumulate sizable amount of metals. Metals that enter into the human body enter into the blood-stream, from where they reach the hair root and get deposited. As hair grows away from the root, it carries with it the deposits of metals, thus enclosing within it a permanent record of the metal pollutant. Since the hair metal content bears strong correlation with the environmental metal load, as can be deduced from the present observations, analysis of hair metal content could easily be carried out to assess not only the environmental metal load but even the extent of exposure of the human body and its metal load. In this respect, a study by Hariono and Sutton (1993) on lead concentration in tissues of fruit bats from urban and non-urban locations, found significant depositions of Pb in the fur, and concluded that Pb concentration in fur could be an index of metal content of internal organs and that, fur metal content could be valuable in monitoring environmental exposure to Pb. Similarly, Czarnowski and Krechiak (1990) found flouride (F) in human hair and, based on the F content in the hair of individuals residing in the vicinity of a phosphate industry waste deposit site, concluded that the hair F content is related with the degree of F exposure. There also seems to be a definite hair-organ correlation in terms of mercury (Hg) contents (Tsuguyoshi *et al.*, 1993). These reports clearly suggest the utility of hair analysis in assessing the human body metal load and also the extent of environmental pollution.

From table 1, , and figures 1 - 12, it is clear that all the 12 metals/halide studied have registered significantly higher content in individuals residing in the industrial belt. Almost all the metals/halide have shown double the content, with Mn registering as high as 255 fold increment, Cd 15 fold and, Ca nearly 9 fold. Except for Cu and Fe, which showed only 36 to 40% increment, all other metals had an increment ranging form 75 to 100% or more.

Data on the metal content of hair of Indian population (Arunachalam *et al.*, 1979) as reported by Jagannatha Rao and Valeswara Rao (1992), gives lower and upper ranges of various metals, and also average values of some metals in terms of zones. Since the data does not give the mean content of various metals or, its relevance in terms of areas of study, urban, rural, proximity to industries etc., a meaningful comparison is not possible.

Another comparison in the present study is between the hair metal content of LIG and MIG individuals from non-industrial belt. This comparison also reveals significant difference, which is attributable to the dietary affluence. The only two metals which have not shown the difference between the two groups, are Pb and Mn and even Cu. All other metals showed significant increase in MIG. As food is the major source of entry into the human body, the type of diet and the dietary habits can have profound influence on body metal/halide load. In this respect it is clear from table 1 and figures 1 - 12, that, dietary affluence has definitely contributed to a higher body metal load. Interestingly, Riolfatti *et al.* (1992) have shown that the metal content of human tissues can be correlated with the food intake.

Overall, the results of the present study are not very encouraging and are reflective of the increasing metal contamination to which the populace of Baroda is exposed to. The levels of some of the metals recorded from individuals residing in industrial belt and, even in those residing in non-industrial belt, but with dietary affluence, are quite high and may be considered close enough to levels correlatable with adverse health effects. Since most of the metals affect various physiological and biochemical activities in the body, their continued accumulation in body is likely to result in myriad of disorders, most of which may not be related with metal toxicity in the normal course. A close scrutiny and survey of the populace in the industrial areas, is warranted, to bring out the possible correlation between metal contamination and, the various diseases/disorders that may be common among them. The present study therefore clearly gives a prognosis for the alarmingly increasing metal pollution/contamination in and around Baroda and, on its consequences in a futuristic sense.