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Obesity is a serious physiological disorder and is recognized as being a high risk to health because of its correlation with cardiovascular diseases, non-insulin dependent diabetes mellitus (NIDDM), hypertension, cancer, gall bladder diseases and early death (Hodge and Zimmet, 1994).

Weight reduction is, therefore, routinely recommended to overweight and obese individuals to decrease these risks and improve already existing conditions. Women more than men of upper and middle income groups enter structural weight reduction program of their own by dieting for aesthetic reasons. Currently, there is a fashion need to be thin, yet few manage to lose weight and maintain that loss. Part of the reason for these paradoxes and difficulties lie in the complex nature of the problem combined with social interactions and pressures, eating habits, professional compulsions, genetic predisposition, nutrition with metabolic consequences, psychology of individuals and of the society (Caterson, 1994).

There is an increasing concern, however that dieting may itself be detrimental to health. The cycles of weight loss and gain have been reported to result in hypertension and hyperinsulinemia in experimental animals (Ernsberger and Nelson, 1988 and Reed et al., 1988). Some epidemiological studies suggest that humans who repeatedly lose and regain weight are at an increased risk for coronary heart diseases (Hamm et al., 1989 and Pamuk et al, 1992).

The obesity results when anabolism exceeds catabolism, may be due to increased food intake or reduction in utilization of absorbed calories. This shift of metabolism leads to deposition of fat in fat accumulating tissues which may result in an abnormal growth of adipose tissue due to either enlargement of fat cell size
(hypertrophic obesity) or an increase in fat cell number (hyperplastic obesity) or a combination of the two (Hager, 1981). In humans, it is often expressed in terms of body mass index (B.M.I.), also known as Quetelet's index (weight (kg)/height (m)^2, Hodge and Zimmet, 1994) because of its correlation with body fat content with correlation co-efficient generally above 0.5 (Bray, 1992). Obesity begins at B.M.I. > 27 kg/m^2 (Canadian Guidelines for Healthy Weights, 1988).

There are evidences that obesity is a genetic disorder. It was shown that there is a high correlation (r = 0.7) in monozygotic twins irrespective of how they were reared. In contrast, the correlation co-efficient in dizygotic twins is considerably lower (r = 0.3) suggesting a stronger influence of genetic compared with environmental factors in the development of human obesity (Stunkard et al., 1990). The lower value in dizygotic twins suggests that the high correlation in monozygotic twins is not the result of shared intrauterine environment (Proietto and Thorburn, 1994).

Genetically manipulated laboratory animals have now conclusively proved that obesity is a genetic disorder but the mechanisms involved in the development of obesity has not been identified conclusively. Many theories have, therefore, been proposed for the aetiology of obesity. Hyperphagia as the cause of obesity has been attributed to a psychological disorder causing overeating (Bray, 1991). The fact that all genetically obese rodents are hyperphagic support this view (Proietto and Thorburn, 1994). Contradictions to this view are that calorie excess does not cause the same level of obesity in different strains of rats (Rothwell et al., 1982) or mice (West et al., 1992) or even different members of the same strains (Levin et al., 1989) which
suggest that the hyperphagia alone cannot be held responsible for the development of obesity.

It has been suggested that its not the quantity but the quality of the food that causes obesity. There is a limited capacity in humans to convert carbohydrates to lipids; obesity in man can only result from an increased intake of fat (Ravussin and Swinburn, 1992). This has been supported by the finding of Schutz et al. (1989) who reported that the excess carbohydrate intake increases thermogenesis and does not contribute significantly in the adiposity. However, excess fat intake does not increase thermogenesis and contributes significantly to adiposity. Against this are the evidences which suggest fat intake can induce obesity as the subjects fed isoenergetic formulae containing extreme differences in fat /carbohydrate ratio (fat energy varying from 0 to 70% of total intake) for 30 days were able to maintain their initial weights irrespective of the fat content (Leibel et al., 1992).

Vohr et al. (1980) and Pettitt et al. (1983, 1993) observed that hyperglycaemia in the mother during third trimester of pregnancy may be a cause of obesity in the offspring in later life. They believed that hyperglycæmia may have some effect on adipocyte development as it results in overnutrition in immediate postnatal period.

Gestational and early postnatal nutrition have been suggested as another cause of obesity based on the observation that nutritional deprivation during early intrauterine life results obesity in later life in humans (Ravelli et al., 1976) and in rats (Jones et al., 1984 and Anguita et al., 1993). Aubert et al. (1979) suggested that a nutritional oversupply in the early postnatal period may predispose to obesity in
adulthood. This has been reported more recently by Plagemann et al. (1992) in rat pups.

Abnormalities have been described in the fat cells of preobese animals which could result in excess fat deposition. Increased transcription of the genes encoding the enzymes like fatty acid synthase was reported by Dugail et al. (1988, 1993). Recently, Shepherd et al. (1993) observed that the gene of insulin responsive glucose transporter (GLUT 4) was specifically over-expressed in adipocytes of transgenic mouse. Obesity, once experienced, seems to be self perpetuating (Levin et al., 1989), with individuals maintaining an 'ideal' adipocyte size and number (Faust et al., 1976, 1977).

Bray and Gallagher (1975) have documented that damage to hypothalamus in human can cause obesity. Sclafani and Grossman (1969), Bray and York (1979) employed electrolytic or knife cut lesions to the ventromedial area of hypothalamus while others like Olney (1969), Rutman et al. (1966) and Burbach et al. (1985) used chemical agents to damage different areas of hypothalamus and succeeded to cause obesity. The crucial role of hypothalamus in the regulation of body weight is further illustrated by the fact that lesions to the lateral hypothalamus result in weight loss (Bernardis and Bellinger, 1993).

Autonomic nervous system dysfunction has been reported to play a crucial role in regulation of obesity. This has led to the formulation of the acronym 'MONALISA' i.e. most obesities known are low in sympathetic activity (Proietto and Thorburn, 1994). Bray and York (1979) hypothesized that the damages to the ventromedial and ventrolateral hypothalamus which constitute the major component in causing weight
gain and loss respectively is due to changes in sympathetic and parasympathetic components of autonomic nervous system. In animals, this abnormality can emerge very early in life before obesity develops (Krief and Bazin, 1991).

Recently certain neurotransmitters like neuropeptide Y (NPY) have been investigated to cause obesity. NPY acts as a powerful appetite stimulant and can induce obesity in Sprague Dawley rats (Stanley et al., 1986). Recent work has shown that hypothalamic NPY levels are increased in obese (fa/fa) Zucker (Beck et al., 1993) and obese (CP/CP) JCR: LA corpulent rats (William et al., 1992). When both obese fa/fa and lean rats were fasted, NPY levels increased only in the lean as if the rats were constantly starved (Mckibbin et al., 1991). But certain findings of Wilding et al. (1992) and Malabu et al. (1993) suggested that increases in NPY levels may be secondary to the obesity rather than primary genetic defect.

Increased concentration of insulin is characteristic of obesity. This defect may occur due to imbalance of autonomic nervous system. Bray and Gallagher (1975) and Inoue et al. (1978) observed decreased sympathetic tone in (fa/fa) rats by atropine injections and insulin hypersecretion was abolished, suggesting that activity of parasympathetic system was also involved. The resulting hyperinsulinemia could lead to lipid accumulation and obesity by increasing lipogenesis in adipose and hepatic tissues (Cusin et al., 1990). The recent data showed that transgenic animals overexpressing glucose transporters have increased insulin activity early in the development of obesity and is a common pattern in animal models of obesity and insulin resistance (Proietto, 1989). Once obesity is established, insulin resistance is seen in muscles and adipose tissues. This reduction in insulin action in adipose tissues...
may be a necessary adaptation for preventing further weight gain in obese subjects (Eckel, 1992).

The role of inorganic trace metals especially zinc (Zn) in the aetiology of obesity has not received much attention despite the fact that it promotes the food consumption, linear growth, synthesis of lean tissue and body wt. increase in children suffering from marginal to severe Zn deficiency (Gibson et al., 1989; McClain et al., 1985; Moran and Lyerly, 1985 and Bates et al., 1993). A higher intake of Zn results in increase in the subcutaneous fat in the children (Prentice, 1993) and this effect of Zn is unlikely to diminish after cessation of growth and, therefore, can be a possible factor contributing significantly in the aetiology of obesity. Zinc as a factor of obesity and obesity related diseases therefore deserves to be considered critically.

The studies on laboratory animals have suggested that Zn promotes the absorption of fat which was studied by feeding the animals on Zn – deficient diet. Koo and Turk (1977) reported that the deficiency of Zn in diet causes accumulation of lipids in mucosal epithelial cells of the intestine caused by the coalescing of nascent chylomicrons due to their instability. The bigger droplets so formed cannot pass through the lacteal and result in the reduction of absorption of dietary fat. Taneja and Arya (1994) observed that these lipid deposits induce two more additional effects; firstly they impose an inhibitory effect on gastric secretion and stomach emptying process through feedback mechanism, as a result of which stomach emptying rate decreases and the food stays in the stomach for a longer duration which keeps the animal in the state of satiety for a greater period forcing the animal to consume less food than those of Zn supplemented diet fed animals. Secondly, these
intestinal lipid deposits also provide resistance to the inflow of other nutrients from the intestinal lumen to the blood stream causing their malabsorption. This implies that bioavailability of Zn in diet promotes absorption of fat which in turn accelerates the stomach evacuation process. This change caused by Zn, elevates the food consumption (McClain et al., 1985), higher absorption of fatty acids (Koo and Turk, 1977), amino acids (Moran and Lyerly, 1985) and glucose (Taneja and Arya, 1992) in addition to the activation of protein and nucleic acid synthesis (William and Chesters, 1977; Hsu and Anthony, 1970).

These effects of Zn in fact are amplified in genetically (ob/ob) obese mice in which greater absorption and retention of Zn were observed than their lean control mice (Failla, 1983). Collipp (1984) reported that there was high concentration of Zn in liver and tricep muscles of ob/ob mice than their lean controls. Lopez et al. (1991) also associated obesity with an increase in Zn values of serum. This increased transfer of orally administered Zn from the lumen of gastrointestinal track to the blood plasma of obese mice has been attributed to altered characteristics of Zn metabolism as ob/ob mice have a greater potential of absorbing Zn from a simple solution and can absorb 60% more of glucose than those of lean control (Kennedy and Failla, 1987; Begin - Heick et al., 1985 and Lin et al., 1992). The relationship of Zn absorption and deposition of fat in ob/ob mice and high fat diet induced ICR mice has been shown by Chen et al. (1996) who had reported that the mice (ICR) fed a high fat diet containing Zn in greater amount resulted in a significantly higher gain in body wt., identical to obese mice than did their control counterparts fed a diet containing high fat but low amount of Zn in diet. This implies that dietary Zn supplementation increases body fat.
deposition via metabolic regulation of utilization of dietary fat and favouring the conditions for obesity.

On the other hand, Chandra and Kutty (1980) reported significantly reduced plasma levels of Zn in obese children and adolescents in their study. Also, Chen et al. (1991), reported that obese had lower serum zinc concentration.

On the contrary to this, Collipp (1984) has reported that Zn supplementation significantly decreased weight gain in obese children but this therapeutic approach did not show the same results in adults, although adult obese possessed the reduced level of plasma Zn (Atkinson et al., 1978) and elevated level of plasma copper (Atkinson et al., 1978 and Dreosti et al., 1982). Similarly, Levine and associates (1983) found that the concentrations of Zn in serum and femur of obese (db/db) mice were significantly lower than in lean mice.

Kennedy et al. (1986) proposed that chronic obesity is associated with marked depression of Zn concentration, but not necessarily the total quantity of this metal. Therefore, they determined concentration of the metal in liver of obese after extracting neutral lipids from them. They showed no significant differences in the neutral lipids and trace metal concentrations in livers of lean and obese mice at five weeks of age. However, at the age of 22 weeks, Zn, Cu and Mn concentrations in livers of obese mice were 75, 66 and 62% higher compared with the levels of lean mice, respectively. While Halstead and Smith (1972) reported that plasma Zn concentration in obese did not differ from the mean values for normal subjects, a negative correlation between B.M.I. and hair Zn concentration in adults has been demonstrated by Chen et al. (1988). Low
hepatic Zn and Cu concentrations have been reported in the severely obese SHR-corpulent rat (Failla and Michaelis, 1984), in the obese C57B/6J ob/ob mouse (Begin-Heick et al., 1985 and Kennedy et al., 1986) and in obese Zucker rat (Donaldson et al., 1987). Luque-Diaz et al. (1982) reported that obese patients show hyperzincuria, hypocuperuria, hypozincemia and hypercuperemia. These studies on obesity provide evidences in favour and against the role of zinc in its aetiology.

Further the obesity has long been accepted as a risk factor for non-insulin dependent diabetes mellitus (NIDDM) and the risk is related to both the duration and degree of obesity (WHO, 1985). In some instances obesity reduces the number of insulin receptors on the target cells, but in most cases, it produces resistance to the action of insulin. (WHO, 1985). Obesity appears to play no role in insulin dependent diabetes mellitus (IDDM) pathogenesis (Keen, 1985). Although many hypothesis have been suggested for the development of NIDDM in obese, the most widely accepted cause is the resistance of body to insulin resulting in the decrease of oxidative glucose disposal and increase in fatty acid oxidation (Cooney and Strolien, 1994) due to excessive availability of fat. The most likely mechanism for the inhibition of glucose oxidation is that increased fatty acid oxidation elevates intramitochondrial acetyl Co-A concentration which inhibits the activity of pyruvate dehydrogenase complex (Randle et al., 1988). Lipid oxidation is increased in obese patients presumably because of increased availability of fat stores and it has been reported that administration of insulin cannot reduce lipid oxidation in obese patients to same extent as in control subjects (Groop et al., 1992). The sensitivity of supression of lipolysis by insulin appears to be normal in obese subjects. However, even after maximal supression of lipolysis by high
insulin levels, fat oxidation remains higher in obese subjects compared with normal subjects (Groop et al., 1992). These reports reflect that intracellular pool of triglycerides increases in all the tissues of obese. The metabolism of triglycerides might be extremely important in controlling the amount of lipid and glucose oxidation in insulin resistant obese subjects.

The reduction in non-oxidative glucose disposal present in obese and reduction of its deposition as glycogen in cells have been attributed to the inherent defects in insulin signal transduction, but there is also some evidence that fatty acid acetyl Co-A can inhibit glycogen synthase (Wititsunwannakul and Kim, 1977). This implies that there may be a mechanism by which increased fatty acid availability can directly decrease non-oxidative metabolism without the necessity for genetic predisposition to reduce glycogen synthesis. The operation of this glucose/fatty acid cycle is now well established in humans (Groop et al., 1991, a,b) and it is also clear that provision of extra fatty acids by infusion can induce insulin resistance similar to that seen in obese subjects (Yki–jarvinen et al.,1991; Nuutila et al., 1992). The increased availability of fatty acids may also increase gluconeogenesis in liver and reduce sensitivity of inhibition of liver glucose output to insulin (Blumenthal, 1983 ; Bevilacqua et al., 1987 and Greenaway et al., 1992).

NIDDM, therefore, is a heterogenous disease characterized by an absolute or relative deficiency of insulin and insulin resistance. Clinical manifestation include hyperglycemia, glucosuria, altered protein, fat and carbohydrate metabolism and chronic complication resulting from micro and macrovascular pathology. Accepted
aetiological factors include genetics, viral infections, autoimmunity and obesity, the latter, of which clearly contributes to insulin resistance (Walter et al., 1991).

There are evidences that diet of NIDDM does not vary in any marked way from non –NIDDM except in quantity (ARC/MRC, 1974) and that diabetes is not associated with the high intake of any of the major nutrients (WHO, 1985). However the diabetic subjects exhibit significant alterations in trace elements' status when compared with control subjects. Out of these trace elements Zn and Cu stand out clearly (Walter et al., 1991) as excess zinc/copper bioavailability aggravates obesity which in turn induce the insulin resistance.

There is a strong relationship between Zn ions and insulin. In addition to known role of Zn in insulin biosynthesis, storage and release from β-cells of pancreas (Roth and Kirchgessner, 1981), the ion is also a component of enzyme implicated in the mechanism of insulin action (Malmqvist et al., 1979; Hexum, 1974; Faure et al., 1992 and Gehm et al., 1993) and in glucose metabolism (Wolman et al., 1979). Transfer of either glucose or protein via gluconeogenesis to the tissue is although facilitated by glucose transporters under the control of insulin hormone (Roth and Kirchgessner, 1981), but Arquilla et al. (1978) and Ezaki (1989) reported Zn mimicks insulin activity in stimulating glucose transport and glucose oxidation by pentose phosphate pathway in rat adipocytes. Similarly, Coulston and Dandona (1980) documented the glucose incorporation into lipids stimulated by Zn. Shisheva (1992) observed that the effect of Zn in these cells is five fold greater than that of insulin. They deduced that Zn provides stimulatory effect for glucose transport in the muscles because latter had a predetermined use in metabolism (Wolman et al., 1979).
Not only this, Zn activates the genes of growth hormones during the early period of growth leading to the enhanced promotion of preadipocytes differentiation, resulting in increased number of adipocytes. This is based on the observation on the activation of ovine-metallothionine ovine growth hormone transgene (ONT-1a-OGH) by ZnSO₄. The activation of transgene by ZnSO₄ results in 10-30 fold induction of circulating growth hormone level. The inactivation of transgene on removal of exogenous Zn leads to the growth hormone to basal level within 24 hours (Pomp et al., 1992; Chow et al., 1994). The enhanced population of adipocytes responds by filling the triacylglycerol droplets creating an environment of fat deposition that eventually leads to the observed state of obesity (Pomp et al., 1996).

Kang (1997), observed that the amount of fat deposition in tissues of mice depends upon the amount of Zn present in diet, suggesting the importance of Zn and fat ratio as an essential criterion in the etiology of obesity. The increase in fat deposition in tissues caused by Zn possibly occurs due to increased sensitivity of glucose transporters located on cells’ membrane through intestine into adipocytes, an effect identical to hyperinsulinemia (Kopelman, 1994).

Hyperinsulinemia is a common pattern in many experimental models of obesity. Once obesity is established, insulin resistance develops in muscles and adipose tissues. This reduction in insulin action in adipose tissues and muscles may be a necessary adaptation for preventing further weight gain in obese subjects (Eckel, 1992). The hyperinsulinemia has been reported to cause hypertriglyceridemia and hypoalphalipoproteinemia (Laws and Reaven, 1992). In cultured hepatocytes, insulin seems to inhibit VLDL secretion (Durrington et al., 1982) which reduces the
competition of VLDL with chylomicrons for lipolysis by enzyme lipoprotein lipase in post prandial state (Brunzell et al., 1973). Indeed, VLDL concentration increases in the post prandial state and insulin resistance leads to inability of insulin to shut down hepatic VLDL secretion which contributes to the aggravation of post prandial triglyceridemia and impairs the tolerance to dietary fat. In most situations where triglycerides levels are elevated, LDL elevates and reduces HDL cholesterol level (Despres, 1993). The presence of greater concentration of dense LDL is predictive of an increased coronary heart disease risk (Austin et al., 1988, 90).

Thus, the literature suggests that excess Zn in body results in increased growth of adipocytes and aggravates insulin activity promoting glucose disposal and accumulation of fats in tissues. Once the tissues are saturated with fats, their loading is inhibited due to release of glucocorticoids through hypothalamus pituitary adrenal axis which makes the insulin receptors insensitive to insulin, causing insulin resistance (Brindley et al., 1981; Cushman et al., 1983; Strolien et al., 1986 and Brindley and Rolland, 1989). The insulin resistance results in hyperinsulinemia as a compensation for the resistance (Hall et al., 1995, b). The epidemiological studies have revealed that insulin resistance causes glucose intolerance, hyperinsulinemia, increased levels of VLDL, triglycerides, decreased levels of HDL and hypertension.

Though the data on rats/mice having genetic disorder or transgenic animal models gave support to a positive role of zinc in the aetiology of diabetes but there are contradictory reports on the status of zinc in diabetic subjects. D’ Ocon et al. (1987) reported that obesity only affected Zn levels in diabetes and increased them in a
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statistically significant way. They observed that the healthy humans showed a negative correlation between Zn and insulin levels and positive between Cu and insulin.

Oster et al. (1994) studied the increased mineral intake associated with hyperphagia on trace element accumulation which was evaluated by feeding control and diabetic rats high carbohydrate diets which varied in Zn, Cu and Mn concentrations. They observed that the diabetic rats were hyperphagic and had higher liver Zn, Cu and Mn concentrations than those of the control rats and the rise of these elements in liver were independent of gender.

Failla and Kiser (1983) and Craft and Failla (1983) observed a three fold greater Zn in STZ-diabetic rats which was persistent despite pair feeding of Cu, Zn and Mn to diabetic and control rats.

Boquivist et al. (1969) observed a lower level of zinc in the blood plasma of diabetic subjects and nearly six fold increase in urinary zinc excretion indicating the development of Zn deficiency in diabetic patients due to its excessive loss in urine. The results of these workers have been supported by more recent studies (Collipp, 1984; Chen et al., 1988; Kinlaw, 1983; Mateo et al., 1975 and Walter, 1991).

On the contrary, Pidduck et al. (1970) observed normal and Schlinger et al. (1988) observed increased serum and plasma levels of Cu in diabetic individuals. Due to variation in Zn and Cu concentration, Zn and Cu ratio were taken in account to assess the state of these elements. Zinc concentrations and zinc /copper ratio were found lower in diabetic subjects (Walter et al., 1991). They observed that diabetic subjects without any complication had Cu concentration intermediate between control and diabetic with H.B.P. Sjogren et al. (1986) found that despite elevated plasma Cu
levels, type I diabetic subjects had lowered concentration of Cu in muscle biopsies compared with control subjects. Cu being an essential micronutrient, its deficiency has been associated with defective glucose tolerance and insulin activity (Hassel et al., 1982; Fields et al., 1984 and Saggerson et al., 1976) Experimental data of Hassel et al. (1982) suggest that impairment of glucose tolerance can be secondary to Cu deficiency. Russian diabetics were found to have low blood Cu levels but those with gangrene had high levels (Kuleshova, 1973).

According to Ripa and Ripa (1994), it is frequent to find in hypertensive subjects with low levels of plasmatic zinc, Zn which enters the composition of zinc enzyme "angiotensin – converting enzyme" (ACF), takes part in arterial pressure regulation also through influences on others hormonal systems, which carry complex action on circulation (glucocorticoids, catecholamines). Moreover plasmatic zinc reduction causes a proportional decrease of plasmatic and tissue A.C.F. activity and arterial hypertension. Zinc administration in invitro and vivo, clearly increases ACF action, with normalization of altered parameters due to Zn deficit.

By a 24 recall methodology; dietary intake of microelements was studied by Davydenko et al. (1995,b) in arterial hypertensive volunteers (Systolic AP>160 mm Hg and/or diastolic AP>90 mm Hg). They recorded a data which suggested, that high levels of Ca and Zn were related with the higher levels of A.H.

Davydenko et al. (1995,a,b) established correlation between low intake of Cu, high content of zinc and prevalence of ischemic heart disease and such risk factors for its onset as dyslipoproteinaemia, arterial hypertension and excessive body mass.

Contrary to it, Reunanen et al. (1996) concluded from their experimental studies
that high serum Cu and low serum Zn were associated with increased cardiovascular mortality.

Vivoli et al. (1995) observed an altered Cu and Zn status in hypertensive humans and supported the hypothesis that imbalance of Zn and Cu status might be involved in human hypertension. They based this concept owing to the inverse relationship between Zn and diastolic blood pressure in hypertensive volunteers.

During the past several years, there has been growing interest (Hall, 1995,a) in the hypothesis that hyperinsulinemia and/or resistance to metabolic effects of insulin may contribute to increased blood pressure in human essential hypertension, especially when associated with obesity (Modan et al., 1985; Ferrannini et al., 1990; Reaven and Hoffman, 1987 and De Fronzo and Ferrannini, 1991). A key line of evidence supporting this hypothesis is the observation that there is a correlation between hyperinsulinemia, insulin resistance and blood pressure in obese subjects (Modan et al., 1985; Ferrannini et al., 1990; Reaven and Hoffman, 1987 and Landsberg, 1992). A metabolic abnormality associated with obesity and/or hypertension first causes the development of insulin resistance which in turn leads to compensatory hyperinsulinemia which later, is postulated to increase blood pressure through various actions such as stimulating the sympathetic nervous system or decreasing the ability of kidney to excrete sodium (Modan et al., 1985; Ferrannini et al., 1990 and Reaven and Hoffman, 1987). Hall et al. (1995,b) have demonstrated that at least one species in which chronic insulin infusion raises blood pressure: the rat. They have shown that in rats insulin infusion increased blood pressure measured with intra-arterial catheters 24 h a day using computerized method. Hyperinsulinemia caused a
more rapid rise in mean arterial pressure and heart rate in SHR compared to WKY rats (Brands et al., 1994). Thus hyperinsulinemia elevates blood pressure in several strains of rats through mechanisms that are still unclear.

The obesity, NIDDM and cardiovascular diseases (CVD) are therefore central to hyperinsulinemia caused by stress hormone glucocorticoids whose levels are abnormally high in these disorders (Brindley and Rolland, 1989). The glucocorticoids are known to induce the formation of metallothioneine, which promotes the absorption of Zn from the intestine and transport it to the tissues across the membrane (Begin-Heick et al., 1985). Its abnormally high level is, therefore, responsible for the increased uptake of Zn which might be playing an important role in the aetiology of these disorders depending on the genetic predisposition. The high Zn uptake effects the Cu concentration in tissues due to Zn–Cu antagonistic reaction at absorptive site (Haschke et al., 1985). The high absorption of Zn induces de novo synthesis of thionein in liver which binds to Cu in intestinal mucosa and prevents the Cu for serosal transfer (Fischer et al., 1981) leading to the deficiency of Cu.

Rodents have been used extensively to study the pathophysiology and metabolic consequences of copper deficiency. Generally, in the vast number of cases animal deficiency of Cu was induced at weanling and occasionally in utero with offspring weaned to deficient diets. In such studies, rodents exhibit a wide variety of defects, most notably cardiovascular. Such finding include abnormal electrocardiograms (ECG), connective tissue abnormalities in blood vessels, cardiac hypertrophy, disturbances in fatty acid profiles & norepinephrin metabolism, glucose intolerance, hypotension, hypercholesterolemia, pleural effusion and ventricular
The dramatic rise of obesity, diabetes, hypercholesterolemia, hypertension and cardiovascular disorders (CVD) and their onset in relatively young age in Indian population during the last two decades may not be associated exclusively with lifestyle of Indians but also through agricultural boom with the excess use of trace elements in the agriculture practices in which Zn stands out prominently. This is evidenced by higher Zn concentration in Indian food items (Agte et al., 1994) and higher tissue Zn concentration in normal humans (Taneja et al., 1998) compared with those of some other countries (Chen et al., 1988; Biro et al., 1996 and Ballew and Sugarman, 1995). If this is so, then management of environmentally contaminated food with excess zinc would be essential to contain obesity and obesity related diseases. This can be targeted by Cu supplementation singly or in association with Zn binding agents like myoinositol hexaphosphate (phytic acid) and monohydrogen phosphate. Cu supplementation would increase Cu level and Zn binding factors by reducing Zn bioavailability by forming Zn-Cu phytate complex in intestine. However intake of excess Cu or Zn binding factor for a longer duration can induce Wilson's disease or Zn deficiency syndrome. Thorough investigation on all aspects of human health is, therefore, imperative before the remedial measures be initiated. Accordingly following aspects were undertaken during present investigations entitled, "Studies on the Involvement of Zinc in Obesity, Diabetes and Hypercholesterolemia in Humans".
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1. Zn and Cu status in healthy, NIDDM and their descendant, hypertensive and hypercholesterolemic adult patients of North Indian population.

2. Does excess Zn in diet cause increased amount of fat deposition in the body of genetically non obese mice fed on equicalorie diet?

3. Does excess Zn intake results in ionic imbalance in non-obese mice?

4. Does excess Zn intake results in non-insulin dependent diabetes and hypercholesterolemia in genetically non-obese mice?

5. Can ionic imbalance caused by environmental factors be restored?

6. Does restoration of ionic balance ameliorate or reduce the severity of NIDDM and hypercholesterolemia?

The information in all these aspects obtained on experimental model, mice have been discussed with the data on human population.