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EFFECTS OF ALCOHOL, PICA, AND HEAVY PHYSICAL WORK ON PREGNANT WOMEN AND THEIR OFFSPRING

by

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INTRODUCTION

During pregnancy, a woman has increased nutritional needs for her own body as well as those for the developing fetus. Her nutritional status greatly influences the health and well-being of the fetus. During the entire period of gestation, the environment of the fetus is that provided by the mother. This environment may be modified by physical, psychological, and social stresses which affect the unborn child.

The discovery of the adverse effect of heavy maternal drinking on the fetus ranks among the most significant research advances of the 1970's. Since alcohol has such a low density and such a high diffusion rate, it is transmitted quickly through the placental barrier. If this happens in the first trimester of fetal life when cells are rapidly dividing and forming, damage will occur not only in those cells, but also in the cells to be formed later. Clinical studies have shown that alcohol consumption during pregnancy has been associated with deficiencies in both prenatal and postanatal physical growth of the offspring (1,2). At least 40-50% of all women who drink heavily throughout pregnancy give birth to infants with fetal alcohol syndrome (FAS), which is characterized by mental retardation, growth failure and abnormalities in facial, anatomic and physiological features (2,3). Other alcohol-related embryotoxic effects are spontaneous abortion and stillbirth.

For many years physicians practicing in poverty areas and in developing nations have recognized that pica, a craving for unnatural foods or for nonfood items such as clay, laundry starch, or ice has been common among pregnant women. Pica frequently has been associated with nutrient deficiencies especially mineral malabsorption, but also has been ascribed to neurosis, superstition, mental aberration and social pressure (4,5). Babies born to women engaging in pica have been found to have lower ratings of general condition at birth than those whose mothers did not practice it. Complications of pica such as intestinal perforation, dental injury, intestional obstruction, achlorhydria, parasitic infection, and constipation can be a threat to the health of the pregnant woman.

Two studies (6,7) have been conducted in developing countries with pregnant women who engaged in hard physical labor, and who had lower than recommended calorie intakes during pregnancy. Those women had lower weight gains in early pregnancy, lower gestational weight gains, and lighter newborn infants than less active mothers who consumed similar low calorie intakes.

This literature review will include the influences of alcohol consumption on prenatal and postnatal development; the incidence and etiology of pica and its nutritional consequencies; and the effects of hard physical labor on nutritional status, maternal weight gains, and fetal risk. Risk factors associated with these conditions will be identified.

HEAVY ALCOHOL CONSUMPTION

Stillbirth and Neonatal Death

In research done at the University of Washington School of Medicine in 1976, Hanson et al. (3) studied 30 women who were chronic alcoholics to determine the effect of alcohol on the outcome of pregnancy. Pregnant alcoholics were matched for age, socio-economic status, education and race with a control group of 11 women. Four of the alcoholic women lost their babies before birth, and 3 babies died one week after birth, as compared to 1 control woman who lost her baby before birth. The alcoholic group had a 43% loss as compared to a 2% loss in the control group.

Kline et al. (8) studied the consumption of alcohol among 616 women in New York City who aborted spontaneously and 632 women who delivered at no less than 28 weeks gestation (controls). The amount and type of alcohol, frequency of drinking, and time of exposure were considered. Table 1 shows that 17% of the women who aborted spontaneously reported drinking alcohol twice a week or more during pregnancy, compared to only 8.0% of the controls. The statistical analysis showed that even moderate consumption of alcohol during pregnancy was a risk factor, and may have caused spontaneous abortions. Furthermore, drinking as little as twice a week, above a minimum dosage of one ounce absolute alcohol, was considered enough to endanger the fetus.

TABLE 1

Frequency (%) of alcohol consumption among cases and controls (8)

Frequency of alcohol consumption during pregnancy[1]	Percent distribution cases	controls
Never	42.7	43.8
Twice a month	28.9	37.8
Twice a week	11.4	10.3
2-6 days a week	13.1	6.6
Daily	3.9	1.4
Total	616	632

[1]Table excludes 7 cases and 11 controls with unknown frequencies of alcohol consumption either before or during pregnancy, 34 cases with unknown gestations at time of spontaneous abortion, and 14 controls with unknown gestations at time of interview.

In 1974-77, Harlap and Shiono, (9) used the medical records of 32,019 women at 13 clinics in Northern California (Permanente Birth Defects Study) to examine their use of alcohol. About 52% of the women were non-drinkers at the time of recruitment, 44.6% consumed less than one drink daily, and 2.4%, 0.4% and 0.1% consumed 1-2, 3-5, or more than 6 drinks daily. There were 1,503 spontaneous abortions, 714 in the first trimester, and 789 in the second trimester. Second trimester miscarriages were closely related to alcohol use (fig. 1).

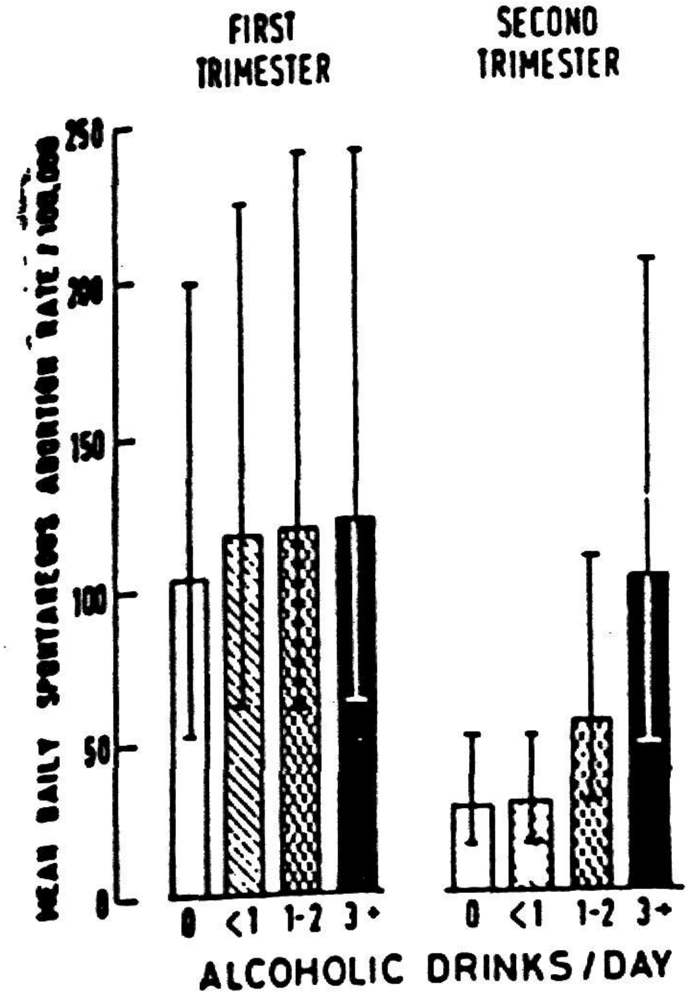

Fig. 1 Spontaneous abortion rate (/100 000 women at risk) by trimester and mean number of alcoholic drinks/day (9).

Prenatal and Postnatal Growth Retardation

Berkowitz et al. (10) studied 175 mothers of singleton, perterm infants and 313 mothers of singleton, term infants at Yale-New Haven Hospital. They observed that heavy alcohol consumption (an average of two or more drinks per day) during pregnancy was associated with an approximately 3-fold increase in preterm delivery, depending on the trimester of use. An intake of 14 or more drinks per week in each trimester was found to be associated with an increased risk of a preterm delivery.

It is now certain that alcohol crosses the placental barrier in approximately the same concentration as that in the mother (11). The developing fetus is ill equipped to handle and metabolize alcohol as its vital organs are not fully operational. The resulting destruction of cell tissue is particularly harmful as not only is the original cell damaged or destroyed, but all future cells that would have developed from it.

Jones et al. (11) observed 8 unrelated children of three different ethnic groups, all born to mothers who were chronic alcoholics during pregnancy, to determine patterns of malformation during childhood (table 2). All the children had prenatal and postnatal growth deficiency. Though the mean gestational age was 38 weeks, the mean birth length and weight were at the 50th percentile for gestation ages of 33 weeks and 34 weeks, respectively. Therefore, the degree of linear growth deficiency was more severe than the deficit of weight at birth. None of the patients showed catch-up growth after birth. After one year of age, the mean daily weight increment for the eight patients was 9 g as contracted to 26.6 g for upper-middle class Seattle children followed in the maternal and infant care program. Figure 2 shows the growth rate of the children compared to the 50th percentile of the Stuart Growth Charts. The observers concluded that maternal alcoholism can cause serious aberrant fetal development.

Pattern of anomalies (11)

	Patient no. and ethnic group								
	Native American (American Indian)			Black			White		Total
	1	2	3	4	5	6	7	8	
Growth features and performance:									
Developmental delay	+	+	+	+	+	+	+	+	8/8
Microcephaly	+	+	+	+	+	+	+	-	7/8
Prenatal growth deficiency	+	+	+	+	+	+	+	+	8/8
Postnatal growth deficiency	+	+	+	+	+	+	+	+	8/8
Craniofacial:									
Short palpebral fissures	+	+	+	+	+	+	+	+	8/8
Maxillary hypoplasia with relative prognathism	+	+	+	-	+	+	+	+	7/8
Epicanthal folds	+	-	-	-	+	-	+	+	4/8
Limbs:									
Joint anomalies[1]	+	-	-	+	+	-	+	+	5/8
Altered palmar crease pattern	+	-	+	+	+	-	+	+	6/8
Other:									
Cardiac anomaly	+	+	+	+	-	-	-	+	5/8

[1]Limitation of motion at elbow, interphalangeal and metacarpal-phalangeal joints, and hip dislocation.

[2]+ = present; - = absent.

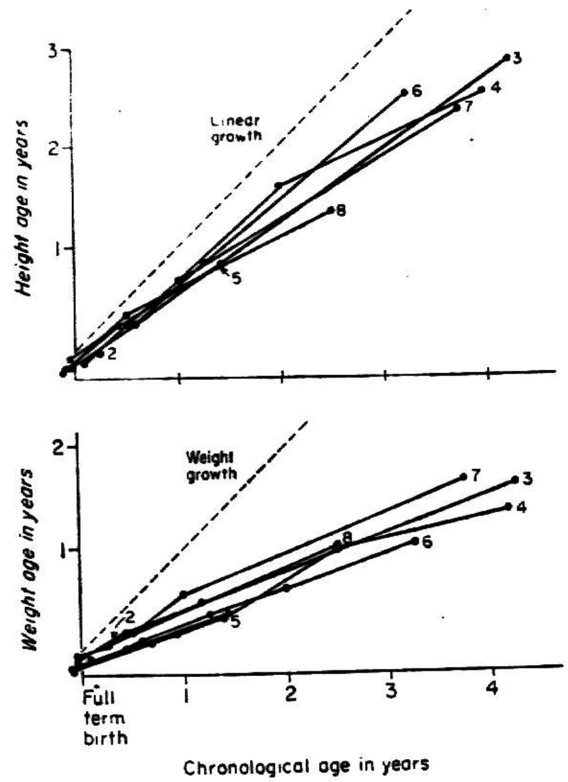

Fig. 2 Growth-rates for patients 2-8 (11). The dashed lines represents the normal growth-rates, derived from the 50th percentile of the Stuart Growth Charts.

Golden et al. (12) observed at birth and at a mean age of 12 months, the physical characteristics, growth, and development of 12 infants who were identified as possibly having fetal alcohol effects based on the maternal history of alcohol abuse and the neonatal physical examination. These observations were compared to those of 12 control infants matched for gestational age, sex, and race. The study infants had significantly more abnormal neurologic, facial, and cutaneous findings at follow-up than did the control infants (table 3). The heights, weights, and head circumferences of the study group were significantly less than those of the control group, both at birth and follow-up. In addition, nine study infants, but only two control infants, were small for gestational age at birth. Furthermore the heights, weights, and head circumferences of the study infants increased at significantly

TABLE 3

Number of infants with fetal alcohol effects at follow-up examination (12)

	Study Group	Control Group	P
Neurologic findings	5	0	<0.02
Hypotonia	3	0	<NS
Irritability	2	0	NS
Facial characteristics	9	4	<0.05
Eyes	7	1	<0.05
Short palpebral fissures	2	0	NS
Epicanthal folds	1	1	NS
Strabismus	5	0	<0.02
Ptosis	1	0	NS
Nose	9	1	<0.00
Short, upturned	8	0	<0.00
Hypoplastic philtrum	5	0	<0.02
Broad deep bridge	5	1	NS
Ears	2	0	NS
Posteriorly rotated	1	0	NS
Poorly formed	2	0	NS
Micrognathic mandible	4	3	NS
Cleft palate	0	0	NS
Lips	3	0	NS
Thin upper	3	0	NS
Cleft	0	0	NS
Cutaneous abnormalities	6	1	<0.03
Hirsutism	4	0	<0.03
Hemangioma	0	0	NS
Accessory nipples	1	1	NS
Abnormal palmar creases	3	0	NS
Nail hypoplasia	5	0	<0.02
Cardiac abnormalities	4	1	NS
Renal genital abnormalities	3	0	NS
Labial hypoplasia	3	0	NS
Hypospadius	0	0	NS
Skeletal abnormalities	0	0	NS
Pectus excavatum	0	0	NS
Limited joint movement	0	0	NS
Hip dislocation	0	0	NS
Muscular abnormalities			
Hernias	4	2	NS
Diaphragmatic	0	0	NS
Umbilical	0	2	NS
Inguinal	0	0	NS
Diastasis recti	3	0	NS

slower rates than did those of the control group, resulting in persistent growth retardation and microencephaly (table 4). At follow-up, eight study infants, but only one control infant had head circumferences below the fifth percentile ($P = <0.0005$, Fisher's exact test). Although intrauterine growth retardation can occur in pregnancies not complicated by maternal alcohol abuse, intrauterine growth retardation is a primary finding in infants with fetal alcohol effects.

TABLE 4

Growth measurements[1] (12)

	Study Group	Control Group	P
Height (cm)			
Birth	45.5 ± 1.8	48.0 ± 1.6	<0.013
Follow-up	67.0 ± 8.3	74.4 ± 6.3	<0.019
Increase	21.5 ± 7.1	26.4 ± 6.1	<0.05
Weight (kg)			
Birth	2.2 ± 3.9	2.9 ± 6.1	<0.01
Follow-up	6.9 ± 2.0	11.5 ± 3.9	<0.006
Increase	4.7 ± 1.8	8.6 ± 4.0	<0.01
Head circumference (cm)			
Birth	31.4 ± 1.8	33.3 ± 1.7	<0.024
Follow-up	41.8 ± 2.8	45.9 ± 1.9	<0.002
Increase	10.4 ± 2.4	12.6 ± 1.6	<0.01

[1]Values are means ± SD.

Hanson et al. (13) interviewed 1,529 mothers at two Seattle Hospitals during the fifth month of pregnancy in regard to their alcohol ingestion during and in the month prior to recognition of pregnancy. At the time of delivery, pairs of high-risk and control infants were examined by a pediatrician without knowledge of maternal drinking history. Of 163 infants examined, 11 showed clinical signs compatible with prenatal effect of alcohol on growth and morphogénesis. Nine of those 11 came from the high-risk drinking group. Seven infants who showed lesser alterations of growth and morphogenesis were reported to belong to women who were drinking an average of one ounce or more of absolute alcohol per day in the month prior to recognition of pregnancy. They concluded that both moderate and high levels of alcohol intake during early pregnancy resulted in growth alterations in infants (fig. 3).

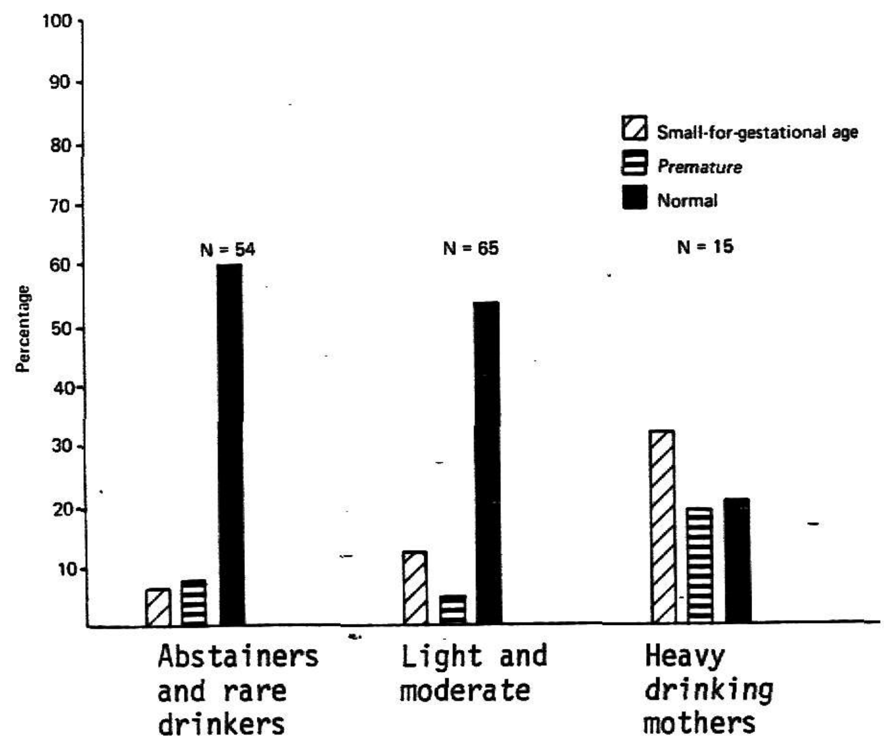

Fig. 3 Frequency of growth abnormalities in new born infants of drinking mothers (13).

Sokol (14) studied the medical records of 12,127 pregnant women who delivered during a 52-month period at the Cleveland Metropolitan General Hospital. He found that 240 women from the total number had pregnancy complications associated with maternal alcohol abuse. The birth weights of offsprings were significantly lower. Fetal distress during labor and neonatal depression, also were more common outcomes of pregnancy in women who abused alcohol (table 5).

TABLE 5

Estimates of the risk for adverse effects in the fetus or infant associated with heavy alcohol consumption by the mother during pregnancy (uncorrected for concomitant risk factors) (14).

Outcome	Risk ratio	Incidence (%)
Spontaneous abortion	2	30
Fetal alcohol syndrome	-	2.5
Cognenital anomalies	4	40
Low birthweight	2	25
Intrauterine growth retardation	2.5	10
Neonatal depression	1.5	20
Any abnormality	-	50

Ouellette et al. (2) reported on a prospective study at Boston City Hospital of 633 pregnant women who were alcoholics. Women were classified as abstainers and rare drinkers, moderate drinkers, and heavy drinkers. Infants born to heavy drinkers had twice the risk of abnormality as those born to abstainers or moderate drinkers ($P < 0.001$). Thirty-two of the infants born to heavy drinkers were found to have congential anomalies, as compared to 9% in the abstainers group and 14% in the moderate group ($P < 0.001$). This finding suggested that heavy drinking during pregnancy increased risk to the offspring. Figures 4 and 5 show the frequencies of congenital anomalies and growth abnormalities in new born infants of alcoholics.

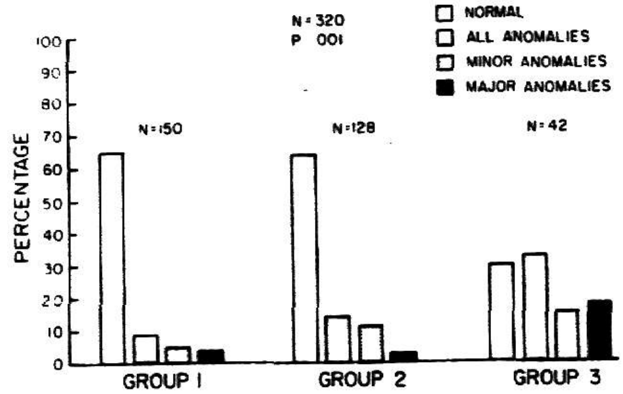

Fig. 4 Frequency of congential anomalies in newborn infants (2). Infants of heavy drinkers had more congenital anomalies, single and multiple, minor and major.

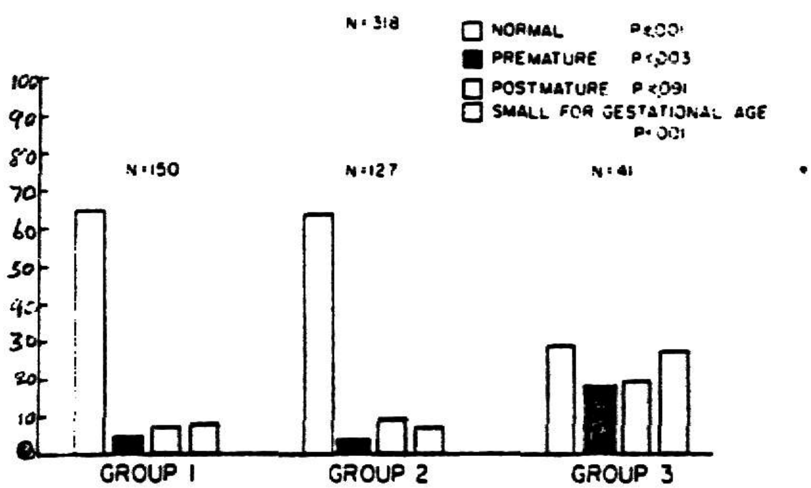

Fig. 5 Frequency of growth abnormalities in newborn infants (2). Infants of women who were heavy drinkers were smaller, and the risk of prematurity was increased.

Incidences of low birthweights or decreased birth weight and minor physical anomalies due to maternal alcohol consumption have been observed by various workers (15, 16, 17, and 18). Tables 6 show the effects of maternal alcohol consumption on the birthweights of infants. Figure 6 shows the effects of such consumption on birth length of infants.

TABLE 6

Adjusted infant birth weight by maternal drinking group[1] (16).

	Controls (n=50)	Abstinent alcoholics (n=49)	Drinking alcoholics (n=50)
Mean birth weight (gm)[2]	3,520	3,137	2,786
SD	419	466	485

[1]Adjustment made for maternal height, age and parity, gestational age, and sex of child. One subject whose gestational age was uncertain was excluded.

[2]Controls vs abstinent alcoholics: t = 1.85, $P < 0.05$; Controls vs drinking alcoholics: t = 3.81, $P < 0.05$; abstinent alcoholics vs drinking alcoholics: t = 1.79, $P < 0.05$.

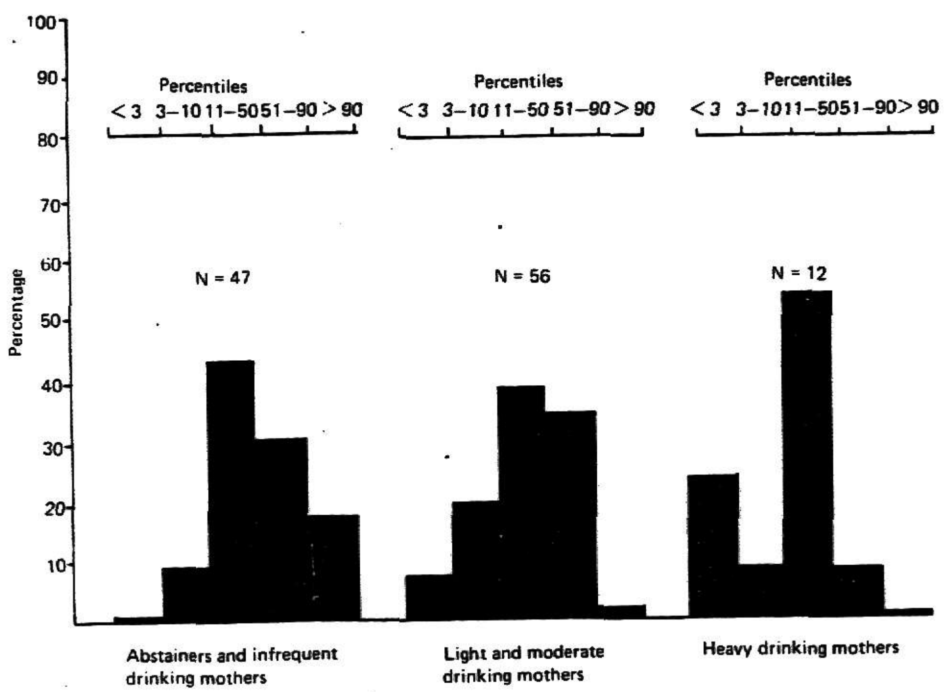

Fig. 6 Birth length in infants of drinking mothers (16).

Baran et al. (19) also observed the effect of alcohol consumption during pregnancy on maternal calcium metabolism in pregnant rats by adding ethanol to their drinking water from day 6 to day 19 of pregnancy. Alcohol consumption decreased serum levels of calcium, and phosphorus and also lowered tubular reabsorption of phosphate. By comparison, alcohol administered to nonpregnant female rats for the same time period resulted in alcohol blood levels of 129 mg/dl and had no effect on serum calcium, phosphorus, tubular reabsorption of phosphate, or fasting urinary calcium/creatinine. The authors concluded that alcohol ingestion during pregnancy, a time of increased calcium requirement, produced biochemical changes consistent with secondary hyperparathyroidism (fig. 7).

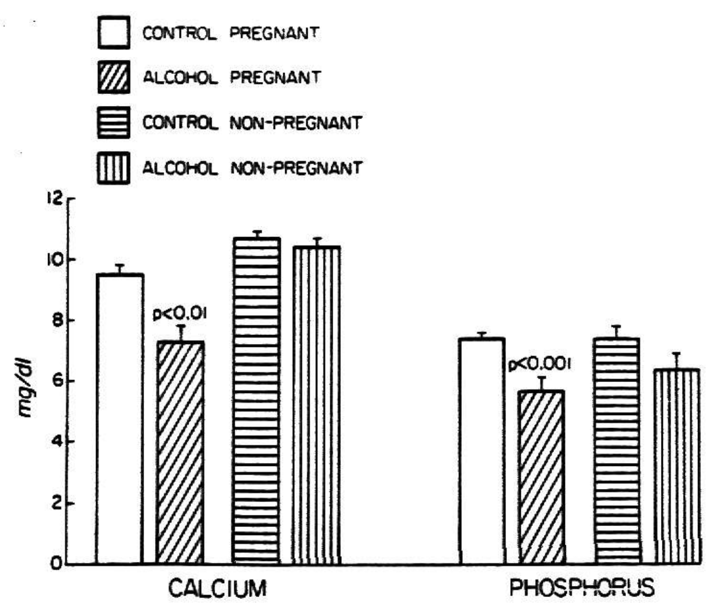

Fig. 7 Effect of alcohol on serum calcium and phosphorus levels in pregnant rats. Values in the pregnant groups represents the mean ± SEM of levels in 22 rats. Values in the nonpregnant groups represent the mean ± SEM in six rats (19).

Sandor et al. (20) studied 76 children of 7 Caucasian and 69 North America Indian mothers, who were diagnosed as having fetal alcohol syndrome because their mothers had histories of heavy maternal alcohol consumption during pregnancy. The ages of the children ranged from birth to 18 years, and there were 43 males and 33 females. Cardiac malformations were detected in 31 patients (41%), functional murmurs in 12 (16%), and ventricular septic defects in 20 (26%) of the children (table 8).

TABLE 7

Cardiac malformations in the fetal alcohol syndrome (20).

	Number	Percent of Total
Patients with cardiac malformations	31	41
Patients with functional murmurs	12	16
Ventricular septal defects	20	26

Mental Retardation

In children with FAS, the central nervous system dysfunction may be a result of microcephaly and abnormal brain development. In the course of development, the brain goes through several periods of rapid growth during which it is extremely vulnerable to exogenous insults. In humans, the period of rapid development known as "the brain spurt" begins at mid-gestation, peaks in the third trimester, and ends by the third postnatal year (11,21).

Impaired brain growth in neonatal rats exposed to ethanol was observed by Diaz et al. (22). Infant rat pups fed through intragastric cannulas from postnatal day 4 through day 18 showed a 19% reduction in total brain weight when ethanol was included in their diet on days 4 through 7. The reduction in brain weight occurred even though body growth in the experimental rats was equal to that of their littermate controls. The ethanol-exposed animals were markedly hypoactive, and throughout the period of the study they showed poor motor coordination and were hyperresponsive. The investigators concluded that these brain and behavioral effects appeared similar to those seen in fetal alcohol syndrome. Figure 8 shows the difference between a brain from a control pup and one from an ethanol-exposed pup. Differences in head circumferences of infants of drinking mothers are shown in figure 9.

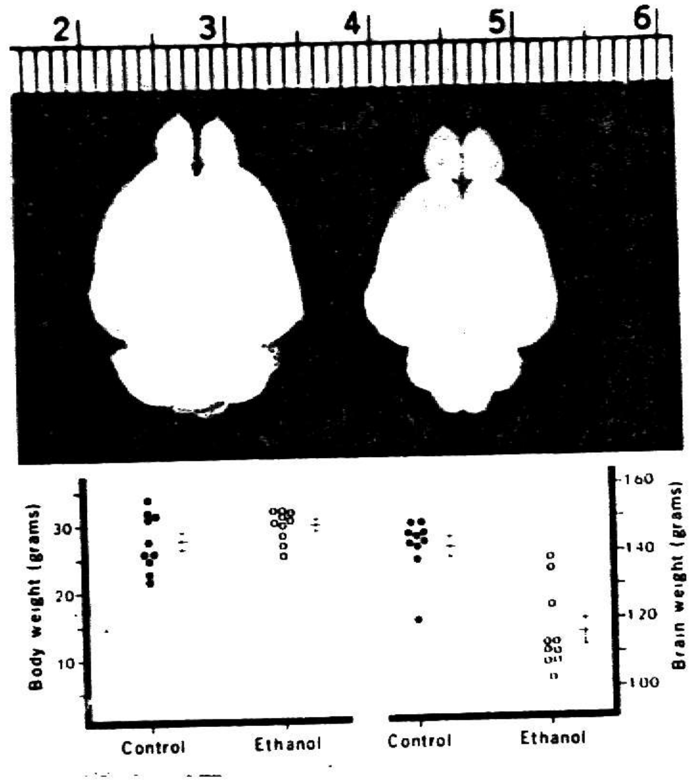

Fig. 8 Representative brains from two 18-day-old rat pups of comparable body weight. The brain at left was removed from a control pup; the brain at right, from an ethanol-exposed pup. (B) Body and brain weights for 18-day-old control and ethanol-exposed pups. The mean and the standard error is indicated by bars for each data set (22).

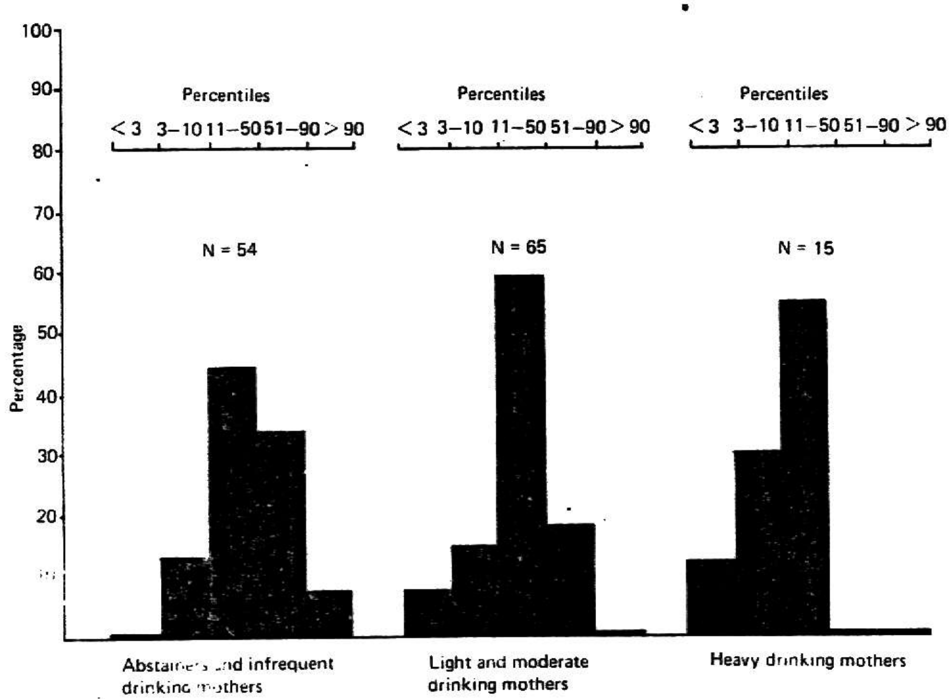

Fig. 9 Head circumference in infants of drinking mothers (22).

Shaywitz et al. (23) evaluated 87 children who were referred to the Learning Disorders Unit of the Yale New Haven Hospital for medications after prenatal exposure to ethanol. Mothers of 15 of the children had a history of heavy drinking during pregnancy. The 11 boys and 4 girls ranged in age from 6 1/2 to 18 1/2 years. Birth weights ranged from 1.580 to 3.150 grams, medium weight 2.213 grams. All growth measurements were low: head circumference, tenth percentile; height, tenth percentile; and weight, twenty-fifth percentile. All were found to have intelligence in the average range (IQ 82-113), yet they had experienced persistent academic failure. The data suggested that such academic failure could be due to effects of ethanol on the central nervous system, and that alcohol exposure in utero may be the cause for lack of concentration in childhood. Table 8 shows the features of fetal alcohol syndrome observed in the 15 children.

TABLE 8

Morphologic and psychologic characteristics in 15 children with the expanded fetal alcohol syndrome (23).

	Number affected
Growth deficiency	
Prenatal (2,500 gm)	10
Postnatal	
Height[1]	
Fifth percentile	7
Twenty-fifth percentile	6
Weight[2]	
Fifth percentile	4
Twenty-fifth percentile	7
Head circumference[2]	
Tenth percentile	9
Twenty-fifth percentile	5
Facial stigmata[3]	15
Short palpebral fissures[4]	13
Associated findings[5]	
Joint anomalies	7
Hearing loss	5
Renal anomalies	1
Cardiac anomalies	1
Intellectual ability	
IQ-80-85	1
IQ-86-95	1
IQ-96-113	5
$\bar{X}$=98.2	9

[1]Based on NCHS Growth Charts, 1977.

[2]Based on Tanner.

[3]Two prominent dysmorphic features - short up-turned nose, hypoplastic philtrum, broad nasal root, thinner upper vermilion, relative prognathia in adolescence, epicanthal folds, hypoplastic maxilla

[4]Based on Chouke.

[5]Based on Clarren and Smith.

Quellette et al. (2) reviewed of 633 pregnant women at Boston University Medical School the drinking habits, and the outcome of pregnancy. They found a variety of abnormalities among the babies of women who drank heavily. Seventeen percent of the classified "heavy drinkers" bore children with serious birth defects indicative of fetal alcohol syndrome (FAS). In contrast, only

3% of the children of non-drinking mothers showed signs of serious birth defects. Postnatal observations of the children indicated that the FAS group was jittery, unable to nurse well, had smaller heads and brains, and poorer muscle tone than the normal children.

Prevention

Hanson et al. (13) observed that the most pronounced fetal damage from maternal alcohol consumption appeared to occur during the month prior to the recognition of pregnancy, and increased proportionally with the average daily alcohol intake of the mother. They found that although decreased alcohol consumption at any time during pregnancy limited fetal damage, interventions aimred only at women already pregnant had limited value for that pregnancy. They suggested that the important emphasis in FAS prevention efforts must be to increase public awareness of the syndrome through educational programs, and to identify and interrupt maternal drinking prior to conception.

Rosett et al. (24) suggested that supportive intervention to prevent fetal alcohol effects should include assistance with the control of drinking as well as with other social problems. They were of the opinion that pediatricians, obstetricians, and other health professionals should coordinate efforts and develop programs for identification and treatment of heavy drinking. They also suggested abstinence from all alcohol from time of conception through delivery and lactation.

Little et al. (25) reported that as a result of her previous findings and that of other researchers on adverse effects of alcohol abuse on infants, a project called "Pregnancy and Health Program" was started in Seattle. The program was aimed at developing strategies for preventing the fetal alcohol syndrome and for intervening in alcohol abuse during pregnancy. Those strategies were developed for public education through various media, as well as professional education of physicians, nurses, social workers, psychiatrists, teachers, and alcohol counsellors wo need to be knowledgeable about the effects of alcohol on the outcome of pregnancy. Reports on the Pregnancy and Health Program indicated that most women welcomed the opportunity to obtain an accurate assessment of the risks of alcohol consumption during pregnancy. This shows that effective programs can be developed to educate pregnant women on the dangers of alcohol consumption during pregnancy.

Definition and Incidence

Danford (5) indicated that "pica" was a medieval Latin word meaning magpie, a bird which picks up all sorts of things. Other related terms that he listed included das Gelusten der Schwangern Frauen (the hunger of pregnant women), geophagy (consumption of soil or clay) and cachexia Africana (wasting away in Africans). At the present time, pica is defined as an abnormal craving for certain food or nonfood substances. It is frequently associated with deficiencies of minerals or other nutrients, but it also may result in excessive intake of some nutrients.

The incidence of pica has been difficult to establish. Diagnosis is complicated by inconsistent definitions of pica and reluctance of persons to admit to the practice. In 1982, Danford (5) reviewed the incidence of pica among populations of children and women (both pregnant and nonpregnant) from various areas of the United States (Table 9). The percentages of the populations with pica ranged from 10 to 66 for children, from 28 to 55 for pregnant women, and from 15 to 57 for nonpregnant women. Oftentime, pica has been associated with low income blacks in the southern United States, but white women in lower socioeconomic groups also practice pica. Reasons given by women for eating clay and cornstarch are: relief of nausea, relief of nervousness, tradition, to prevent the baby being marked, pleasure, like the crunchiness, stimulates the appetite, helps the baby to have a lighter color, quiets hunger pains, crave it, and a desire for approval of peers (26).

TABLE 9

Incidence of pica in the United States (5).

Study	Number of subjects	Description and/or age of group	Percentage population with pica
1937, Baltimore	30	retarded children	50
1950, Mississippi	331	pregnant women, black	44
1957, Baltimore	386	black, 6 mo.	27
	398	white, 6 mo.	17
1962, Washington DC	486	black, 1-6 years	32
	294	white, 1-6 years	10
1963, Washington DC	859	children, low income	55
		children, high income	30
1966, Boston interview	439	children, 1-6 years	15
Mail survey	277	children, 1-6 years	20
1966, England	40	institutionalized, psychotic, 3-13 years	66
1967, Georgia	200	pregnant women	55
1968, Chicago	987	pregnant women	35
1969, Chicago	500	pregnant women	24
1971, California	25	Spanish American, pregnant women	38
	10	Spanish American, nonpregnant women	15
	21	Spanish American children	32
1979, Mississippi	56	nonpregnant women	57
	115	children	16
	33	males	0
	27	adolescents	0
	112	pregnant women	28
1981, Boston (41)	991	institutionalized, retarded, 11-89 years	26

The incidence of pica was high among infants and children (1-6 years) of clay-eating and starch-eating women. Such children were found to eat dirt, pieces of paper, flakes of paint and plaster and whatever else they could grasp by hand (4, 5). However, geophagy in infancy also may be motivated by a desire to explore the outside world.

Pica has been reported in various parts of Africa, Iran, Turkey, South America and India as well as in the United States. In Johannesberg, South Africa, Sayers et al. (27) found that 11% of their black male and 33% of their black female outpatient population reported consumption of ash or earth. They concluded that pica was related to low socioeconomic status of adults.

Nutrient Deficiency

It has been suggested that pica is related to a craving generated by nutrient deficiency (5, 21, 27 and 28). Vermeer et al. (30) investigated clay-eating in 229 individuals in 50 black households in rural Holmes County, Mississippi. During the period of the study, 25 sources of geophagical clays were discovered and most of the sources were associated with rural settlements throughout the county. Clay-eating was found to occur among 57% of the women (either pregnant or women who had borne children) and 16% of the children (age 13 or less) of both sexes, but not among the adult males or adolescents. The average daily concumption of clay was 50 g. Their results indicated that clay-eating was not correlated with hunger or anemia, but suggested that it might contribute to the common problem of hypertension.

Psychological Factors

Pica also is thought to be related to neurosis, superstition, and mental aberration. Some workers (28, 29) believe that the frequent incidences of clay eating among black women in the South could be suggestive of compulsive behavior, which might be due to certain pressures, particularly during pregnancy. Bass et al. (26) found that women in Tennessee practiced pica in secret because they did not want their husbands to know about it.

Cultural Factors

Pica has been found to be associated with cultural and familial factors (4, 5). Earth eating, irrespective of cravings, has frequently been associated with religious beliefs. For example, Muslims may consume the chalk dust that is accumulated from erasing sentences from the Koran written on a board; this was done out of respect for the book, or because they thought it could be a blessing and protection, especially to a pregnant woman. Pica also has been associated with superstition and social pressure. For example, in some parts of Africa it is believed that magical properties of the soil promote well-being. This belief results in the consumption of earth to promote fertility and to increase lactation in women. The consumption of earth during the first trimester of pregnancy was believed to suppress nausea, and in some African cultures young girls were taught in childhood that during pregnancy the consumption of earth was desirable (5).

Nutritional Consequences

Edwards et al. (29); Danford, (5) and Vermeer & Frate (30), found that individuals with pica consumed less milk, meat, fewer vitamin C-rich sources and a smaller variety of foods than normal subjects. Vermeer & Frate (30), Edwards et al. (29) and Hook (28) observed that geophagia was associated with diets low in calories, thiamin, niaclin, and zine.

Edwards et al. (29) compared the effect of clay and cornstarch intake in 46 pregnant and non-pregnant Negro women, and 20 pregnant and non-pregnant controls from similar socioeconomic backgrounds. Their diets, blood and excreta was analyzed and the condition of their infants at birth was determined. Calorie intakes of the pregnant clay and cornstarch eaters decreased during a 24 hour period when the women were asked to omit clay and cornstarch from their diets (table 10). Protein intakes were low in all groups except the non-pregnant controls. However, intakes of vitamin A, thiamin, riboflavin, niacin, and ascorbic acid compared favorably with recommended allowances. The average daily intakes of calcium and iron were considerably below the recommende allowances, except in a few instances. Although serum protein and glucose levels were within normal range, hemoglobin concentrations were low in the clay-eaters. On the average, the rating of infants of control mothers was higher than that of the infants of clay and cornstarch eating-mothers (table 11) Complications during pregnancy included twice as many cases of hypertension and edema in clay-cornstarch eaters as in control mothers (table 12). Also, 44% of the clay-cornstarch eaters were anemic as compared to 7% of the controls.

TABLE 10

Calories, protein, calcium, and iron in diets and excreta of clay- and cornstarch-eaters and controls[1] (29).

Source	Clay-eaters				Pregnant Cornstarch-eaters		Controls	
	Pregnant		Non-pregnant					
	Additive[2]	No Additive	Additive	No additive	Additive[3]	No additive	Pregnant	Non-pregnant
Number of subjects	20	20	3	3	7	7	7	8
Calorie intake	2013	1410	1343	1293	2525	1692	1390	1825
Protein								
In diet (gm./day)	41	31	30	27	47	19	38	55
Dietary nitrogen (gm./day)	6.5	5.4	4.8	4.2	7.5	3.0	6.1	8.8
Urinary nitrogen (gm./day)	3.9	3.6	6.3	5.9	1.6	2.2	4.2	5.1
Fecal nitrogen (gm./day)	1.1	1.6	1.3	1.2	1.5	0.6	0.9	1.3
Calcium								
In diet (gm./day)	0.81	0.43	0.14	0.92	0.85	--	1.00	0.61
Consumed as additive[4]		--		--	--	--	--	--
Urinary (gm./day)	0.08	0.08	0.12	0.09	0.05	--	0.08	0.06
Fecal (gm./day)	0.20	0.21	0.26	0.42	0.13	--	0.51	0.31
Iron								
In diet (mg./day)	6.6	6.6	13.7	4.6	2.4	1.4	4.0	9.7
Consumed as additive (mg./day)	8.3	--	10	--	--	--	--	--
Fecal (mg./day)	5	7	14	15	4	--	5	3

[1]Because there was only one non-pregnant cornstarch-eater, data are omitted.

[2]Clay

[3]Cornstarch

[4]9-12 mg. per day

TABLE II

Condition at birth of infants of clay- and cornstarch-eaters and controls (29).

Criteria	Infants of Clay-eaters		Infants of Cornstarch-eaters		Infants of Controls	
	Average	Range	Average	Range	Average	Range
Number of full-term infants	22		12		28	
Birth weight (lb.)	7.5	5.0- 9.8	7.0	5.2- 8.1	7.1	5.4- 9.8
Birth length (in.)	19.3	17.5-22.0	18.8	17.0-20.0	19.2	17.0-21.5
Head size (in.)	13.1	12.0-14.5	12.8	11.5-14.5	13.1	11.0-14.5
Chest size (in.)	12.8	11.5-14.5	12.7	12.0-14.5	12.7	11.5-14.0
Length of gestation (months)	8.9	8.0-9.0	9.0	9.0	8.7	8.0- 9.0
Classification of infant						
Good	6		4		22	
Fair	11		5		3	
Poor	2		2		1	
Very poor	3		1		2	
Premature births	2		0		4	
Stillbirths	1		2		1	
Infant deaths with 4 days	4		3		3	

TABLE 12

Complications experienced during pregnancy by clay- and cornstarch-eaters and controls (29).

Subjects	Number of Subjects[1]	Pre-eclampsia		Hypertension		Edema		Nutritional Anemia[2]	
		Number of cases	Per-cent	Number of cases	Per-cent	Number of cases	Per-cent	Number of cases	Per-cent
Clay-eaters	22	1	5		11	3	11	6	27
Cornstarch-eaters	12	1	8		8	1	8	2	17
Controls	28	2	7		7	2	7	2	7

[1]Only women who delivered infants at the hospital are included.

[2]Moderate or severe

Geophagia in the form of clay-eating is often observed during pregnancy in the human population. Patterson and Staszak (31) studied the effects of geophagia (Koalin or clay ingestion) on the maternal blood and embryonic development of 36 Sprague-Dawley female rats. Their diets were divided into: control diet; 20% Koalin diet; and iron-supplemented 20% koalin diet. Prior to fertilization and throughout the gestation period, the diets were fed 37-68 days, 69-95 days, and 96-117 days respectively. There was a significant reduction in birth weight of the pups of Koalin fed rats. Those rats which received an iron supplement maintained hematocrit, hemoglobin, red blood cell levels and twin pups were within normal range of weight. The rats fed the unsupplemented Koalin diet showed significant reductions in hemoglobin, hemotocit, and red blood cell levels, which indicated maternal anemia. On the other hand, Vemeer and Frate (30) observed that hematocrit levels of black women of rural Holmes County, Mississippi, who practiced geophagia were similar to those of nonpractioners.

The relationship of pica to iron deficiency has been noted, but it has been accepted generally that the iron deficiency is incidental or that pica causes iron deficiency. Crosby (4) suggested that clay chelates iron and prevents its absorption. Thomas et al. (32) studied the effect of laundry starc on the intestinal absorption of inorganic iron and on hemoglobin levels in rats. Laundry starch significantly bound the amounts of inorganic and hemoglobin iron at pH levels similar to that of the upper small intestine. This caused inhibition of inorganic iron absorption from isolated duodenal loops, as well as from the intestion of normal non-anemic rats. It also reduced the intestinal absorption of inorganic and hemoglobin iron in anemic rats. The results suggested that ingestion of a large quantity of laundry starch could inhibit iron absorption in man, and contribute to the development of iron deficiency anemia.

Gelfand et al. (33) observed that geophapia was associated with life-threatening hyperkalemia in five patients with chronic renal failure. All five patients (three women, two men) were blacks and had been born in the southeastern United States. According to their dietary intake records, the patients ingested 10-800 grams of clay or soil at a single time which led to the absorption of large amounts of potassium from ingested clay. Table 13 shows the levels of serum potassium and the accompaning complications.

TABLE 15

Geophagia-associated hyperkalemia in patients with chronic renal failure (33).

Patient Age(yr)/Sex	Birthplace	Cause of renal failure	Geophagia: Type	Geophagia: Frequency	Geophagia: Amount gm	Hyperkalemia: Maximum serum K+, mEq/liter	Hyperkalemia: Complications
45/M	North Carolina	Nephroscelerosis	Clay	2-3/mo	2-800	9.8	Cardiac arrest
33/M	North Carolina	Diabetic glomerulo-sclerosis	Clay	1-2/mo	200	6.7	Hospitalization
65/F	Virginia	Diabetic glomerulo-sclerosis	Soil	Daily	10-50	5.7	***
44/F	North Carolina	Nephrosclerosis	Clay	1-2/mo	150	9.8	Frequent hospitalizations with paralysis, cardiac arrhythmias, and disorientation
59/F	North Carolina	Chronic glomerulo-nephritis	Clay	1/mo	100	7.7	Hospitalization

Vessal et al. (34) used radiographic examinations to study the effects of geophagia on the bowels. Random samples of clay were obtained from Fars Province, Southern Iran, mixed in sugar syrup and given to 18 volunteers with breakfast. X-rays of the abdomen were taken after 10 minutes, 2 hours, and 12 hours. In addition, x-ray examinstions of the abdomen were done at Sadi Hospital, Iran, of 100 children between ages 8 and 12 who were examined because they were suspected to practice geoplagia. The x-ray films showed ingested clay in the stomach of the volunteer group, and after 12 hours in their colons. Certain opaque particles from ingested clay also were seen in the colons of the children examined in the hospital. Cases of iron deficiency amenia and retarded bone age also were noted in the children in the hosptial. The researchers concluded that accumulation of indigestible materials in the digestive tract could prevent absorption of essential nutrients such as iron by chelation of such nutrients. Accumulation over long periods could also cause intestinal obstruction which may lead to severe health problems.

Karayalim and Lanzkowsky (35) investigated by hemoglobin electrophoresis who ate 4-6 ounces (115-170g) of "Comet" (cornstarch) per day. The serum zinc level of the patient check was found to be about 2 ug/g comet powder, which indicated his zinc level was low. After two months of therapy with 225 mg oral zinc sulfate, his serum zinc level was 153 ug/dl, and at 4 months the concentration was even higher.

HARD PHYSICAL WORK

Nutritional Status of the Mother

Dietary intake during pregnancy has been reported to influence strongly the health of the mother, and the growth rate of the fetus (36). Nutrient such needs are further increased by hard physical labor. In some societies, certain daily domestic jobs require strenuous physical work such as carrying water a long distance, carrying firewood from the bush, pounding-grinding, and engaging in farm activities during farming seasons.

Paul and Muller (7) observed Gambian pregnant women who engaged in heavy argicultural duties during the rainy season. They found that these women had average daily dietary energy intakes of 1500 kcal throughout the year, as compared to internationally accepted FAO/WHO (37) recommended intakes of 2350 kcal for moderately active 50 kg pregnant women. Protein, calcium, vitamin A, vitamin C and riboflavin intakes were also low.

Furthermore, Tafari et al. (6) observed Ethiopian pregnant women who were engaged in heavy physical work, and who had restricted their calorie and protein intakes due to superstitious beliefs. These women had lower than recommended calorie intakes during pregnancy. Thus, hard physical labor resulted in increased nutritional needs of the mother, coupled with inavailability of nutrients leads to maternal starvation (7). However, a prenatal dietary supplementation program in Gambia reported by Prentice et al. (38) improved nutritional status during pregnancy. The food supplement produced a net increase in energy intake of 431 kcal/day, and a final mean energy intake of 1,898 kcal per day, even though it was still lower than FAO/WHO recommendations.

In order to show how hard physical activity during pregnancy affects the nutritional status of the mother, Blackburn and Calloway (39) studied the resting and working metabolic rates and physical fitness of 21 mature pregnant women at various intervals during the last half of pregnancy. The study was repeated with 16 of the women again 8-12 weeks postpartum. Their basal metabolic rates (BMR) at 20-28 weeks of gestation was 21% higher than post-partum values, although the BMR, was increased only 15% during the last weeks of gestation. Per minute energy expenditure continued to increase from the 20th-40th weeks of gestation. This increase in energy cost of work appeared to equal the gain in body weight during pregnancy. The prolonged rate of recovery suggested that oxygen uptake might be increased for a longer period after work in the gregnant women. Sufficient energy level is required during pregnancy to maintain positive nitrogen balance. Gross energy cost during pregnancy is estimated to be 80,000 kcal, an average of 300 kcal per day increase above the non-pregnant allowance (RDA, 9th Edition, (40)).

Pregnancy Weight Gains

Maternal body weight has been reported to influence the growth rate of the fetus (36). Tafari et al. (16) observed 181 pregnant women from less than 12 weeks gestation until delivery in Addis Ababa University, Ethiopia. Weight gains were significantly lower in mothers who engaged in strenuous physical labor than in those who were less active during pregnancy. The mothers who engaged in heavy labor had mean pregnancy weight gains of 3.3 ± 2.4 kg, as compared with 5.9 ± 3.3 kg for the less active mothers ($P < 0.001$). Table 14 shows the influence of physical work and maternal weight in early pregnancy on birth weight and maternal weight gain. Most mothers who engaged in heavy physical labor had much smaller pregnancy weight gains, independent of the weights of their fetuses, than did less active ones. The non-fetal component of their pregnancy weight gains was much more affected than birth weight. This shows that as the mother's physical activity increased, their body weights decreased.

TABLE 14

Influence of physical activity and maternal weight in early pregnancy on birth weight and maternal weight gain[1] (6).

Maternal weight in early pregnancy and physical activity	Birth weight (g) Mean ± SD	Non-fetal component of maternal weight gain[2] (g) Mean ± SD
Under 49 kg		
Hard work	3096 ± 312 (23)[3]	3813 ± 1790 (23)
Light work	3300 ± 386[b] (18)	6771 ± 4217[c] (18)
49-58 kg		
Hard work	3034 ± 342 (33)	3457 ± 3151 (33)
Light work	3198 ± 361[b] (28)	5960 ± 3273[d] (28)
Over 58 kg		
Hard work	3129 ± 534 (8)	1559 ± 2250 (8)
Light work	3345 ± 419[a] (20)	5165 ± 4110[b] (20)

[1]Significance of difference: a = $p < 0.1$, b = $p < 0.05$, c = $p < 0.005$.

[2]Non-fetal component of maternal weight gain - total pregnancy weight gain minus birth weight of infant.

[3]Number of patients is given in parentheses.

Blackburn and Calloway (41) also observed energy expenditure and food consumption of mature pregnant and lactating women. They noted that additional energy costs and weight changes during pregnancy were strongly associated with hard physical work.

Birthweight of Infant

Both maternal pregnancy body weight and dietary intake have strong influences on the growth rate of the fetus. Tafari et al. (6) observed the effects of maternal undernutrition and heavy physical work during pregnancy on birthweights of infants of 130 women from Addis Ababa, Ethiopia. Full term infants of mothers who engaged in heavy labor weighed 3068 ± 355 g at birth compared with 3270 ± 386 g for the newborn of less active mothers

(P < 0.01). Thus women who engaged in hard physical labor and who had lower than recommended calorie intakes during pregnancy had lighter newborn infants than less active mothers on similar low calorie intakes. Table (15) shows the maternal characteristics and infant birth weight for the two categories of physical work.

TABLE 15

Maternal characteristics and infant birth weight in two categories of physical activity (6).

	Physical activity during pregnancy	
	Hard work	Light work only
Height (cm)	155.1 ± 5.4 (64)	156.8 ± 5.8[a] (66)
Weight in early pregnancy (kg)	50.3 ± 6.1 (64)	54.3 ± 8.5[b] (66)
Daily dietary intake		
Calories (kcal)	1540 ± 448 (29)	1641 ± 367[a] (13)
Protein (g)	44.8 ± 13.7 (29)	49.1 ± 12.9[a] (13)
Weight gain at term (g)	6494 ± 2802 (64)	9214 ± 3722[c] (66)
Infant birth weight (g)	3068 ± 355 (64)	3270 ± 386[b] (66)

[1]A-l values are means.
[2]Significance of differences: a = p > 0.01, b = p < 0.01, c = p < 0.001.

Edwards et al. (42) observed that insufficient food energy greatly affected weight gain of the mother, and growth of the fetus. They compared 354 underweight pregnant women with marched control subjects of normal weight for pregnancy outcome and fetal growth patterns. Analysis of rates of weight gain by trimester showed that 12.7% of the underweight women and 17.7% of the controls gained weight. Furthermore, there was a twofold increase in delivery of low birth weight infants in pregnant underweight women. The mean weight of the infants at birth was 2,977 g as compared to 3,208 g for the controls. At 12 months of age, 31% of the infants of underweight women and 19% of the infants of the controls had weight-for-length correlations below the twenty-fifth percentile, indicating low weight for length.

Metabolic adjustments for inadequate maternal food intakes and heavy energy output during pregnancy can affect the growth rate of the fetus and the birth weight of the infant. Miettinen et al. (43) observed the effect of maternal starvation for 5 days on circulating fluids and glucose, and lactate turnover in fasted newborn dogs at 0, 3, 6, 9 and 24 hours age. Maternal starvation reduced the birthweight of the puppies by 23% (232 $\pm$ 6 g versus 300 $\pm$ 10 g). Fetal ketone body concentration was 3.33 μmole/ml which parallaled the marked hyperketonemia level of 5.78 μmole/ml. After birth, maternal canine starvation also caused significantly lower fasting blood glucose values in the pups at 3 hours of age compared to controls. Plasma free fatty acids (FFA) and glycerol levels were reduced significantly at 3 hours of age. Glycerol concentration remained depressed at 6 and 9 hours, and plasma triglycerides levels were elevated significantly. A significant rise in blood alanine concentration was observed at 3, 6, and 24 hours of age in the experimental pups. In spite of a low blood glucose value at 3 hours of age, the glucose production rate (GRP) in the experimental pups was the same as in the controls. Their data suggested that during starvation, the mother was unable to provide sufficient substrates for normal fetal growth. Maternal and fetal nutrient deficiency might have resulted also in decreased neonatal blood glucose levels together with reduced lipolysis in the immediate newborn period. Elevated fetal plasma ketone body levels and an unaltered fetal blood glucose concentration at the time of birth might suggest that the fetuses received alternate fuels from the mother during the extended period of maternal starvation.

Paul and Muller (7) measured food intake in 31 pregnant and lactating women from Gambia to determine the effect of seasonal variations in dietary intake during pregnancy and lactation. The subjects were selected from an antenatal clinic at Kereba village, and were followed from the 4th month of pregnancy to the 7th month of lactation. The women who normally had dietary energy intakes averaging 1500 kcal/day were found to have only 1200 kcal/day during the farming season. The infants born to these women had a mean birth weight of 2.9 ± 0.4 kg, with a range of 2.2 - 3.4. There were 3 preterm infants. However, Prentice et al. (38) found that for Gambian women enrolled in a dietary supplementation program there was a decrease in the proportion of babies weighting less than 2.5 kg at birth. The proportion decreased from 19.7% to 6.4% over the entire year, and from 28.2% to 4.7% during the wet season.

There are other ways by which high level of maternal physical work during pregnancy can affect fetal growth. Pernoll et al. (44) showed that the oxygen debt incurred by mild maternal exercise is increased during pregnancy. Fetal heart rates change during such exercise, which may indicate fetal hypoxia (45). Naeye (46) found that periodic hypoxia produced by intermittent hard physical work could affect fetal growth because the fetus would be forced to make adjustments to changing levels of oxygenation. Oxygen balance of the mother is essential for the healthy growth of the fetus.

SUMMARY AND CONCLUSION

Heavy alcohol consumption, incidence of pica, and hard physical labor during pregnancy all have adverse effects on mothers and their infants. Increased risk of spontaneous abortion among women who consumed at least one drink a day, or one ounce absolute alcohol at least twice weekly provided evidence that alcohol intake at certain levels may interfere with pregnancy maintenance. Risk factors such as spontaneous abortion, stillbirth, neonatal death, low birth weight, prenatal and postnatal growth retardation, congential abnormalities, and mental retardation were especially high during the first and second trimesters. Decreased alcohol consumption at any time during pregnancy may limit fetal damage.

The practice of pica, an abnormal craving for certain food or nonfood substances, during pregnancy tends to be more common among women from low socio-economic backgrounds. Such practices are associated with missing nutrients in the diet, superstition, religious beliefs, or the desire to improve survival rates of infants. Accumulation of these indigestible materials in the digestive tract have been shown to prevent absorption of minerals or other nutrients. Moreover, complications such as pre-elampsia, hypertension, anemia and nutritional anemia also have occurred. Cases of low birth weight, premature birth, stillbirth and neonatal death of infants have been common among pregnant women who consumed large amounts of clay and/or cornstarch.

Although there is increased calorie need during pregnancy to meet the increased energy need of the mother for optimal growth of the fetus, such need is further increased with hard physical labor. Studies of pregnant women from some developing countries revealed that hard physical labor with low calorie intake and other essential nutrients in the diets led to low pregnancy weight gain, negative nitrogen balance, maternal starvation, and low birth weight infants. However, food supplementation programs for such women have improved greatly their pregnancy weight gains and the weights of their inf

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EFFECTS OF ALCOHOL, PICA, AND HEAVY PHYSICAL WORK ON PREGNANT WOMEN AND THEIR OFFSPRING

by

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Heavy alcohol consumption, incidence of pica, and hard physical labor during pregnancy all have adverse effects on mothers and their infants. Increased risk of spontaneous abortion among women who consumed at least one drink a day, or one ounce absolute alcohol at least twice weekly provided evidence that alcohol intake at certain levels may interfere with pregnancy maintenance. Risk factors such as spontaneous abortion, stillbirth, neonatal death, low birth weight, prenatal and postnatal growth retardation, congential abnormalities, and mental retardation were especially high during the first and second trimesters. Decreased alcohol consumption at any time during pregnancy may limit fetal damage.

The practice of pica, an abnormal craving for certain food or nonfood substances, during pregnancy tends to be more common among women from low socio-economic backgrounds. Such practices are associated with missing nutrients in the diet, superstition, religious beliefs, or the desire to improve survival rates of infants. Accumulation of these indigestible materials in the digestive tract have been shown to prevent absorption of minerals or other nutrients. Moreover, complications such as pre-elampsia, hypertension, anemia and nutritional anemia also have occurred. Cases of low birth weight, premature birth, stillbirth and neonatal death of infants have been common among pregnant women who consumed large amounts of clay and/or cornstarch.

Although there is increased calorie need during pregnancy to meet the increased energy need of the mother for optimal growth of the fetus, such need is further increased with hard physical labor. Studies of pregnant women from some developing countries revealed that hard physical labor with low calorie intake and other essential nutrients in the diets led to low pregnancy weight gain, negative nitrogen balance, maternal starvation, and low birth weight infants. However, food supplementation programs for such women have improved greatly their pregnancy weight gains and the weights of their infants.