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EFFECT OF FEED RESTRICTION AND MANAGEMENT ON THE BEHAVIOUR AND PERFORMANCE OF FEMALE RATS AND PUPS.

By

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SUMMARY

The present work was undertaken to study the effect of mating directly after parturition and feed restriction 50% of adlibitium) on the performance and behavioural patterns of both rat dams and pups. Twenty four adult female Wistar rats were divded into three groups each of 8 rats reared for 2 pregnancies and 2 lactation periods. During the first gestation, all the dams were normally treated and data recorded. After parturition mating was performed at the end of the nursing period which extended for three weeks.

In the second gestation period the three groups were exposed to different treatments, where group I was normally treated, group II fed ad libilum but mated directly after birth (one stress factor). While the dams of group III were fed on 50% of theadlibitum level in addition to mating directly after birth (two stress factors).

The results of the first gestation revealed no significant difference among the three groups in respect to all the measured parameters while during the second gestation the direct mating alone (group II) or the feed-restriction and direct mating (group III) lead to reduction in the litter size and pups' weight development and increased mortalities in the recorded behavioural patterns the effect extended to reduce the active nursing and increase the passive nursing in addition to lengthening the mother- pup contact. The effect of the two stress factors in the third group was more amplified than in the one stress factor in the second. Feed restriction added to the direct mating amplified the bad effect on the performance and behaviour.

INTRODUCTION

The effect of maternal malnutrition or undernutrition on fetal development has rightly remained a bulwark of human nutritional researches. Inevitably the advances in knowledge have been bespattered with badly designed researches and semantic problems.

But animal experiments showed unequivocally that restriction of maternal food intake during pregnancy is associated with a reduction in the birth weight of the offsprgns (Mc Cance and Widdowson, 1962). Food restriction seems particularly suitable as a stressful treatment in rodents. Since food shortage might be a common situation for an animal living under unpredictable environmental conditions (Bronson, 1984) also, in fact, it has been proposed as a major determinant of seasonal cessation of breeding in the house mouse (Bronson and Perrigo. , 1987).

Food restriciton not only affected the dam's current reproductive episode by retarding the growth of her offspring but also affected her further reproductive capability by lengthening the time of her next ovulation (Woodside, 1991). Effect of maternal food restriction on metabolic activity, and performance of the new born pups hal been studied by Kliewer and Rasmussen (1987) who reported, elevated milk and plasma corticosterone levels in malnourished (i.e., 50% food-restricted) lactating rats, and significant negative correlations between milk corticosterone levels and various measures of lactational performence.

Furthermore the fact that food restriction greatly suppresses growth, DNA and protein synthesis and curltails excretion of lysosomal hydrolases in liver, also indicates that metabolic activity is decreased by food restriction (Pegram et al., 1989). Several studies indicated that women who were under nourished at the of pregnancy may have an increased incidence of severe toxemia and low weight-infants (Kasius et al., 1955) although very severe maternal malnutrition is required to affect infant morbidity and mortality (Mc Canity et al., 1954). Jakson (1974) found that good nutrition of mother and child is critical for the development of the child and appears to be important for his health in later life and adequate nutrition during intrauterine life is critical for the birth of a healthy baby with a good prognosis.

Few studies have been made on the effect of feed restriction and maternal behaviour, where Massaro et al., (1977) reported that lactating rats spent more time in the nest with prenatally malnourished young, particuarly in the latter part of the suckling period. In addition Galler andTonkiss (1991) found that prenatal malnutrition increased the percentage of time spent in passive nursing.

Leon et al., (1983) mentioned that food restricted females spent more time in contact with th young than do ad libitum fed females and t effect appeared to result from the lower bo temperature of food restricted females rather th the nutritional status of the pups.

The aim of the present study is to investigate t effect of stress factors on the performance a behavioural patterns of both rat dams and pups.

MATERIAL AND METHODS

Experimental animals:

Twenty-four adult female Wistar rats of about 1(days old & 220-270g body weight and six mal of the same strain were used. They were reare during spring time in a small lab. animal house the Faculty of Vet. Med., Beni-Suef, Cair University,. The atmospheric temperature wa kept at 22-25°C and humidity at 40-60%.

At mating-time the males were transferred to th female nests and breeding was considere successful by the presence of vaginal plugs an for sperms in the vaginal smear (Mc Guire et al. 1992).

Two weeks prior to the start of the experiment females were placed each in a breeding cage o 40x10x18cm bedded with a layer of fine saw dus of 2cm thickness. The litter was left undisturbe till weaning of the young at 21 days of age (Farri , 1967). The female rats were divided into three groups each of 8 rats for 2 pregnancies and 2 lactation periods. During the first pregnancy and lactation period, ad libitum feeding of the female rats was followed in order to record data under normal feeding conditions in each of the three groups. In the second pregnancy and lactation period the three groups were differently treated, in respect to the time of mating and plane of feeding, as shown in the following table.

Groups	Time of mating	Plane of feeding
I	After nursing	Ad libitum
II	Directly after birth	Ad libitum
III	Directly after birth	Restricted (50 % voluntary intake)

The litter size and the mortality of the pups in the different groups were recorded. From the beginning of the delivery and till the time of weaning (21 days), pups weight was recorded weekly to the nearest 0.1 g. to minimize any disturbance to the litter, that may adversely affect the normal behaviour of the rats, all the weights were obtainted after recording the behavioural observations.

Diets and plane of feeding:

The diets for pregnancy and Lactation, were formulated according to the nutrient requirements of the laboratory animals recommended by NRC (1979). The diets were physically composed in percentage of yellow corn, 65.0; soybean meal, 21.3; bran, 4.0; fish meal 6.0; bone meal, 3.0; salt, 0.7; and a vitamins and minerals premix was added at 2g/kg as recommended by the producing company, Farmer in order to satisfy the needs of rats. In lactation the rats needs more methionine and lysine than in pregnancy (NRC, 1979) so to the aforementioned formula 4.0 g methionine and 2.4 g lysine was added for every kg of the mixture.

All the groups were fed the diets ad libitum except the third group which was restrictly fed during the second gestation period at the level of 50% of the voluntary intake.

Behavioural Parmeters:

All observations were recorded three days weekly from the frist day postnatal to the day of weaning at a fixed time allover the experimental period and for 30 minutes aday. The following behavioural criteria and its representation according to Galler and Tonkiss (1991) were considered:

1- Active nursing, the mother croushed over pups in an active nursing position while pups were suckling . It was measured as the time spent by the pups suckling in active nursing (min./obs.).
2- Passive nursing, represnts the attempt of the pups in securing the nipples while the mother is sleeping or engaged in other activities.
3- Mother-pup contact refered to the number of pups made contact with the mother. The values assigned as follows: Zero (0), no pups in contact with the mother; 1, fewer than half of the pups made the contact; 2 half or more than half of the pups number got in contact with the mother.

The data were statistically analysed acording to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The aim of the present study was to assess the influence of feed restriction on female rats during pregnancy and lactation in addition to its effect on some behavioural patterna and pup performance.

the feed intake was restricted to the level of 50% of the free feeding which was followed in first gestation. During pregnancy the freely fed rats consumed 18g/ rat daily, while during the lactation period (21 days), each dam consumed 25/day.

In table (1) the first and second gestations of each of the three groups were presented. The statistical

analyses of the different performance parmeters among the first gestation of the three groups. (IG1, IIG1 & IIIG1) revealed no sifnificant differences either in that related to the dams or the pups.

However in the second gestation the treatment differed, that while the first group was treated normally (ad libitum feeding and late mating) the other two groups were either directly mated (IIG2) or restrictly fed associated with direct mating (III G2). In the first group there was no significant differences between the data of the first gestation and that of the second one as the rats were treated the same treatment. the dams of the second group concepted during the lactation period and nursing of the pups, this represented a stress factor on the dam's side leading to reduction in the size of the litter compared with the same group in the first gestation (6 pups in G1 & 5 in G2/ litter). However , no significant difference in pup weight development was noted between the two gestations. Concerning the mortality rate it was higher (20%) than in the first gestation weher was a viability of 100%.

These findings agreed with Daly and Wilson (1984) who mentioned that lactation during pregnancy reduces the time during which the female must meet the energetic demands of both suckling youngs and the litter in utero.

The second gestation of the third group which received only 50% of the free feeding level and mating was performed directly after parturition (III G2) showed significant difference in litter size when compared with the first gestations of the same group (6.6 and 5.4 respectively).

The bad effect of the two stress factors may be attributed to the influence of feed restriction on ovulation and early embryonic viability leading to reduction in liver pups. This in addition to what is mentioned by Leon et al (1983) that feed restriction changes the hormonal status lactating female rats at least during the weeks postpartum while the feed rest regimen is in effect..

Fig. (1) shows the pup weight development groups during the second gestation period, the dams were differently treated. It was from both the figure and the data in table (1 the body weight development in the pups third group as result of the second gest seemed to be the least when compard wit other two groups. Comparing the results wi the first gestation of the same group (III G was found that feed restriction of the severly affected pup weight development w the average pup weight at birth was 4.5g whi the first gestation of the same group it reat 5.2. the influence of feed restriction of d extended up to the 3rd week of suckling (wea time) and its effect was reflected on the growt the pups as the recorded weight was 24. compared with that of the first gestation wh was 29.49g. (at the age of 3 weeks.

This result agreed with Oberkotter a Rasmussen (1992) who mentioned that mater feed restriction influences both the volume milk produced and its composition and th negatively affects the total nutrient outp available to the pups. It was stated also Rasmussen and Fischbeck (1987) that fewer pu per litter were born by dams receiving 60% of t ad libitum intake of control rats, but mean pu weights at birth were similar in both groups . (course it is the composition of the diet and its sufficiency which determine the effect in additio to the restriction.

The statistical analyses of the recorded weigh data during the weaning period for the pups fron both the first and second gestations revealed significant differences at $P<0.05$ (Table 1).

The mortality of the neonates of the

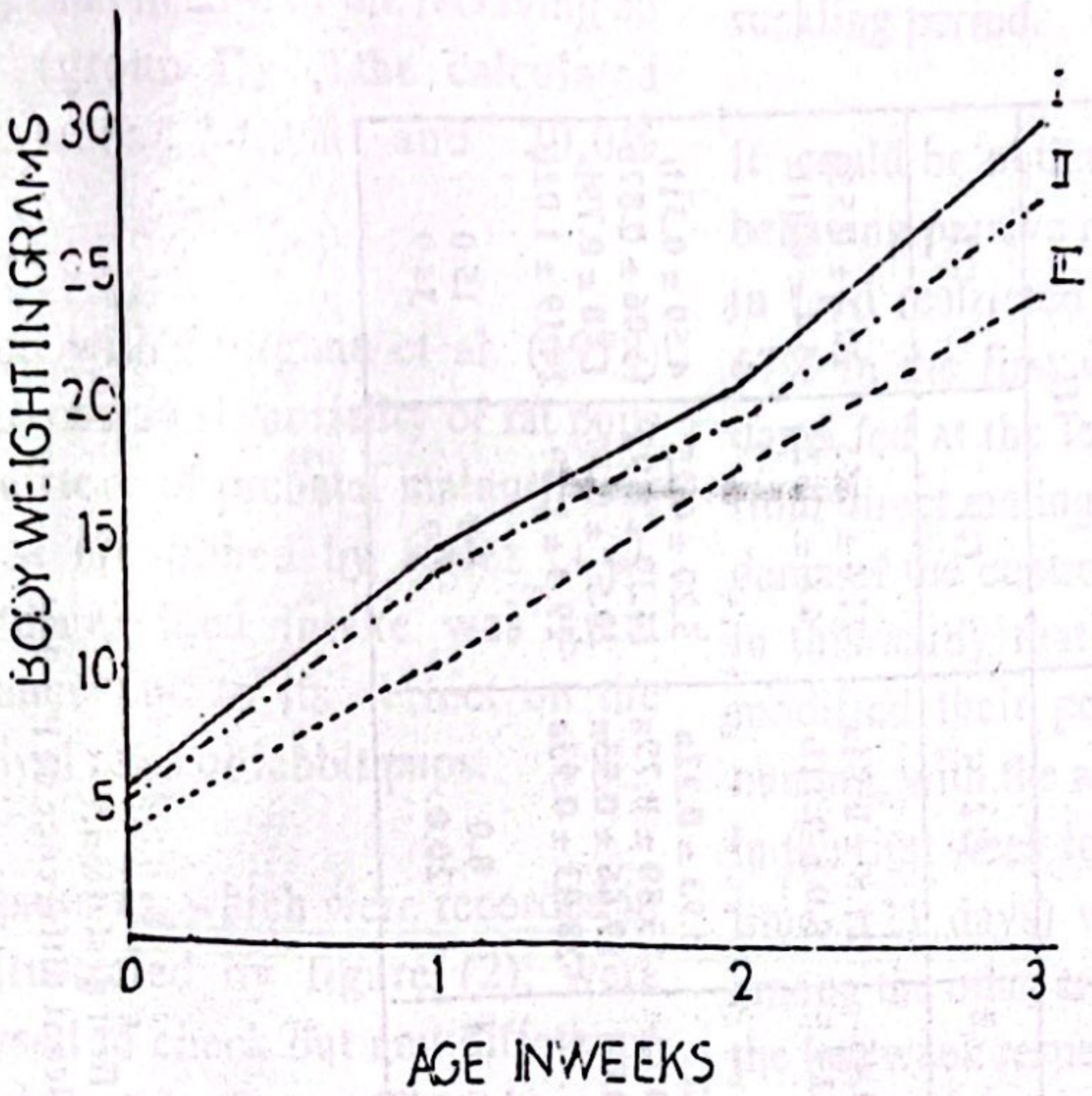

Fig.(1): Body weight development of rat pups (of G2) in the three groups during the weaning period (3 weeks).

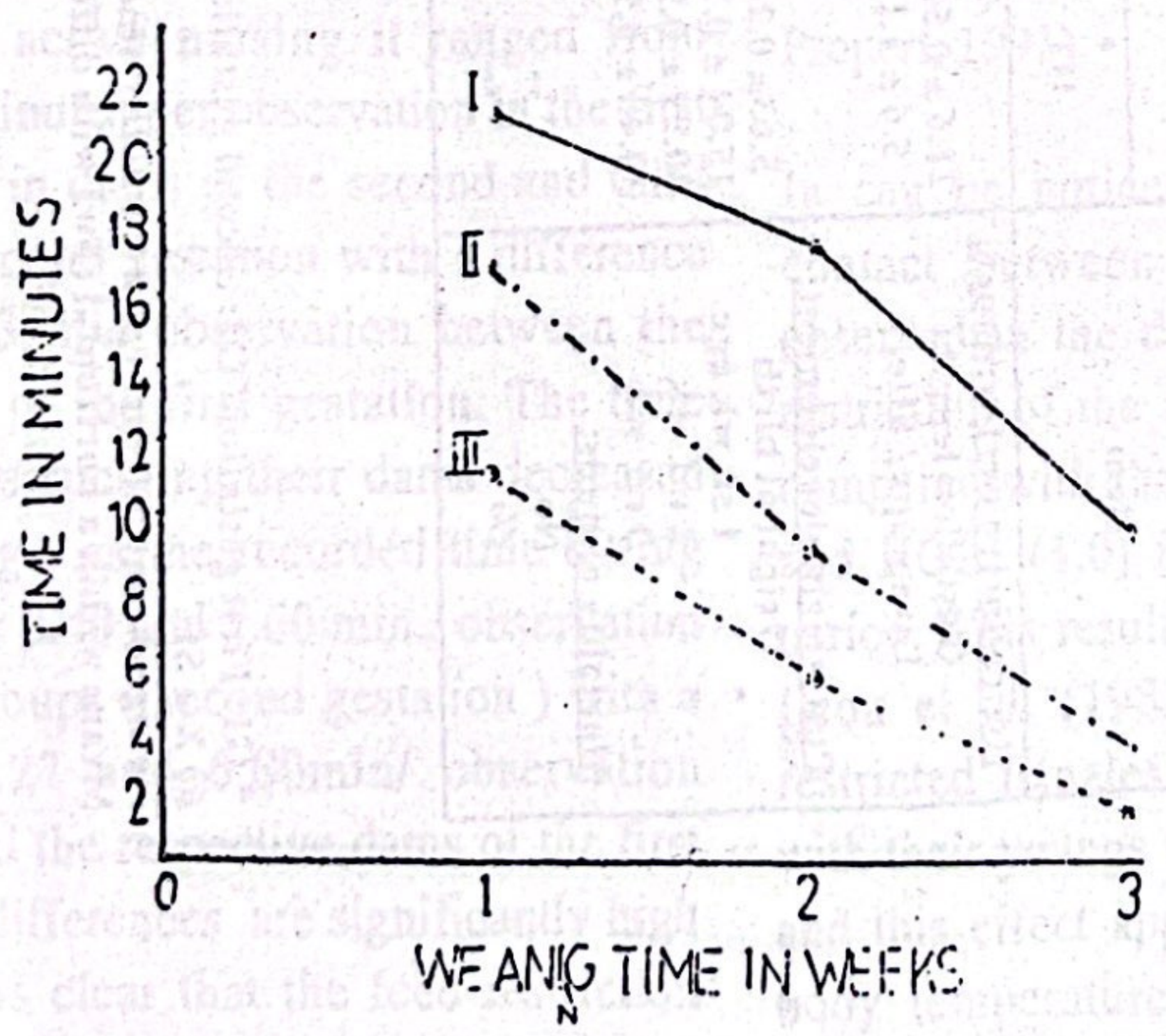

Fig.(2): Active nursing of female rats in the three gorups (G2).

Table (1): Reproductive performance, pup weight development (g) and mortality in the different groups and gestations.

Item	Groups I		II		III	
	* G1	G2	G1	G2	G1	G2
Reproducive performance:						
Gestation length	21.6 ± 0.55@	22.0 ± 0.71a	21.8 ± 0.45	21.8 ± 0.84a	21.6 ± 0.55	20.4 ± 0.55a
Live pups / litter	5.6 ± 1.14	6.4 ± 0.55a	6.0 ± 1.23	5.0 ± 0.71b	6.6 ± 1.52	5.4 ± 0.41b
Pup weight development:						
Weight at birth	5.63± 0.28	5.55 ± 0.37a	5.21± 0.22	4.93 ± 0.22a	5.20 ± 0.25	4.50 ± 0.31b
" 1 st wk age	15.04 ± 0.72	14.83 ± 0.68a	14.33 ± 0.72	13.80 ± 0.79a	14.39 ± 0.95	11.06 ± 0.87b
" 2 nd wk "	20.99 ± 0.98	21.21± 1.03a	20.33 ± 0.89	19.66 ± 0.95a	20.57 ± 0.89	17.8 ± 0.79b
" 3 rd wk "	30.48 ± 0.91	30.86 ± 1.17a	29.45 ± 1.27	28.03 ± 0.93a	29.4 ± 1.80	24.19 ± 1.02b
Mortality of pups:						
No.	--	--	--	8.0	1.0	15.0
%	--	--	--	20.0	1.9	34.9

* G1: First gestation. G2: second gestation.
@ X ± SE.
No significant differences were noted among the three groups during the first gestation.
Means within a horizontal rows with different superscrips indicate significant difference at P < 0.05.

feed-restricted dams (group III) was significantly higher (at $P<0.05$) than in case of the receiving ad libitum feeding (group II). , the calculated mortality rats were 34.9% and 20.0% respectively.

The results agreed with Morgane et al. (1978) who found that the postnatal mortality of rat pups increased with a history of prenatal malnutrition, in addition it was mentioned by Hafez et al. (1986) that maternal feed intake was great practical importance due to its effect on the viability and survival rates of rabbit pups.

The behavioural patterns, which were recorded in table (2) and illustrated by figure (2), were statistically analysed to check out any difference among the experimental groups. The observed behavioural parameters were active nursing, passive nursing and mother-pup contact, which were with ni significant difference among the first gestation of the three groups (IG1, IIG1 & III G1) as they were no differently treated. During the second gestation, different treatments were applied.

Concerning the active nursing it ranged from 16.60 to 11.27 minutes per observation in the first week of nursing in dams of the second and third groups during second gestation with a difference of 3.10 and 9.73 min observation between the respective dams of the first gestation. The time spent by the pups suckling their dams decreased with advanced age, as the recorded time during the last week was 3.40 and 1.60 min./ observation in the last two groups (second gestation) with a difference of 3.27 and 6.80min/ observation between them and the respective dams of the first gestation. These differences are significantly high at $P<0.05$, so it is clear that the feed restriction decreased the time spent by pups in the active nuring. This was supported by Massaro et al. (1977) who reported that lactating rats spent more time in the nest with prenatally malnourished youngs, particularly in the latter part of the suckling period.

It could be noticed that the percentage of dams behaving passive nursing was considerably higher in feed restricted dams (IIIG2) which recorded 67% in the first week of suckling, while in the dams fed at the level of ad libitum but suffering from direct mating , IIG2 recorded 53% and in the dams of the control group IG2 40%. It was found in this study that feed restricted dams (IIIG2) modified their percentage in behaving passive nursing, with the advanced age of pups, from 67% in the first week to 93% at the end of the weaning time (21 days) which were the highest values among the other two groups (67.0 and 73.0 during the last week respectively).

Galler and Tonkiss (1991) stated that such suckling during passive mursing may not be nutritive, but it may serve to increase apportunities for contact or wormth. In addition the percentage of time the dam spent in the nest and the amount of contact between dam and pups were significantly increased following the history of many generations of malnutrition (Galler and Propert, 1991).

In can be noticed (Table 2) that the highest contact between mother and her pups was observed in the dams suffering from 50% feed restriction of the ad libitum IIIG2 (1.8) when compared with the other two groups I G2 (1.1) and IIG2 (1.0) in the first week of suckling period. This result agreed with that obtained by Leon et al. (1983) who mentioned that food restricted females spend more time in contact with their youngs than do ad libitum fed females and this effect appears to result from the lower body temperature of food restricted females rather than the nutritional status of the pups.

The recorded data of the mother-pup contact phenomena during the weaning time revealed that

Table (2): Behavioural patterns in the experimental female rats of the different groups.

Behavioural patterns	Groups I		II		III	
	G1	G2	G1	G2	G1	G2
Active nursing (n / obs)						
1 st week	20.6 ± 2.95	21.2 ± 3.63a	19.70 ± 3.72	16.6 ± 5.76b	21.00 ± 2.18	11.27 ± 3.26c
2 nd "	15.70 ± 3.64	17.4 ± 3.50a	12.80 ± 2.70	5.93 ± 2.71b	13.00 ± 3.89	5.20 ± 3.10b
3 rd "	7.13 ± 2.23	9.0 ± 3.60a	6.87 ± 2.00	3.40 ± 2.00	8.40 ± 2.38	1.60 ± 1.50b
Passive nursing (% of dams)						
1 st week	29.0	40.0	27.0	53.0	30.0	67.0
2 nd "	33.0	40.0	37.0	63.0	35.0	73.0
3 rd "	60.0	67.0	60.0	73.0	57.0	93.0
Mother-pup contact (score)						
1 st week	1.6 ± 0.5	1.1 ± 0.5	1.5 ± 0.5	1.0 ± 0.7	1.7 ± 0.5	1.8 ± 0.6
2 nd "	1.5 ± 0.6	1.0 ± 0.5	1.3 ± 0.7	0.9 ± 0.7	1.5 ± 0.5	1.5 ± 0.6
3 rd "	0.5 ± 0.3	0.6 ± 0.7	0.5 ± 0.6	0.5 ± 0.3	0.7 ± 0.6	1.1 ± 0.5

No significant differences were noted among the three groups during the first gestation.
Means within the same raw having different superscrips are significantly different ($P < 0.05$).

the values decreasd as the age of pups advanced in all the groups during first and second gestation period. the present findings support the hypothesis that lactation under conditions of dietary restriction exerts a negative effect upon maternal behvaiour and pups performance of rats.

As a conclusion, the maternal feed restriction and/ or direct mating act (s) stress factor (s) as affecting the viability and survival of rat pups and altered the maternal behaviour of dams towards their youngs.

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