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Inter-Relationships Among Doe's Weight, Litter Size, Litter Weight and Body Weight at Different Ages in Rabbits

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DATA on 2765 rabbits born in 464 litters during 3 consecutive production seasons at the Experimental Farm of the Faculty of Agriculture, Ain-Shams University, Shoubra Al-Khaima, Cairo, were used in this study. Records were taken at different ages from birth till 24 weeks of age. The within subclass phenotypic correlation coefficients among traits expressing prenatal and postnatal maternal performance of the doe and those showing post-weaning growth were calculated.

Doe's weight was generally positively phenotypically correlated with all traits measuring prenatal and postnatal maternal performance, namely ; litter size and weight at birth, litter size and weight at weaning and pre-weaning litter weight gain. The coefficients of correlations were generally low in their magnitudes. However, the phenotypic relationships between doe's weight and post weaning individual body weights at different ages were generally positive and of moderate magnitude. Significance was attained in most cases.

Correlation coefficients among litter size, litter weight and pre-weaning gain were positive, highly significant, and generally high in magnitude.

Litter size and litter weight were negatively phenotypically correlated with post-weaning body weights and gain. The degree of association decreased with advance in age.

Post-weaning body weights and gain were generally positively and strongly associated with each other and relationships were highly significant.

Traits measuring the maternal performance are of major importance in the efficiency of livestock production. The association between these traits and characters commonly selected for, in animal breeding programs, should be considered in the design of thes programs.

Litter size at birth is often used as a convenient criterion of fecundity in the polytocus species, while litter weight at birth can be, and is, viewed as an index, of the prenatal stage of life. On the other hand, litter size and weight at weaning as well as pre-weaning litter weight gain are usually used as a measure of postnatal maternal performance. This includes the quantity and quality of the mother's milk (Butler and Metrakos, 1950), maternal contact (Rosenberg *et al.*, 1970) and others.

The objective of this investigation was to estimate the phenotypic correlations between some production traits usually used as measures of prenatal and postnatal maternal performance in three different breeds of rabbits and their crosses. The relationships between these traits and individual post-weaning growth traits were also examined.

Material and Methods

Purebred rabbits of Bauscat, Chinchilla, Giza White and some of their crosses were produced during three consecutive production seasons from 1965/66 to 1967/68 at the Experimental Farm, Faculty of Agriculture, Ain-Shams University at Shoubra Al-Khaima, Cairo.

Data used in the present study consisted of the measurements taken on a total number of 2765 rabbits born in 464 litters during the three seasons, inclusive. Traits considered were doe's weight, litter size and weight (wt) at birth as measures of the prenatal maternal performance; litter size and weight at 4 weeks of age (weaning) and pre-weaning litter weight gain (birth-4 weeks) as measures of postnatal maternal performance; as well as individual body weights at 4-,12-,16-,20-,24 weeks and post-weaning gain (4-24 weeks) as measures of the post-weaning growth performance.

Since all the breed groups were not equally represented in the 3 seasons studied, the data were analysed on a within season basis. The data of each season were arranged into subclasses according to parity, age of doe and breed group when dealing with maternal performance traits, and according to parity, age of doe, breed group and sex when dealing with post-weaning growth traits. In order to avoid the correction for the aforementioned main effects, the within subclass phenotypic correlation coefficients were calculated among the traits considered.

Animals were fed *ad libitum* on a dry mash of about 16% total protein and 66% starch equivalent throughout the year. Egyptian clover was offered, when available. During summer, green corn plants and clover hay were supplie

Results and Discussion

Pre-weaning maternal traits

The phenotypic within subclass correlations between the various traits measuring the pre-weaning maternal performance are shown in Table 1.

TABLE 1. Within subclass phenotypic correlation coefficient among traits measuring maternal ability.

Traits	Season	Litter size at birth	Litter wt. at birth	Litter size at weaning	Litter wt. at weaning	Birth-4 week gain in litter wt.
Doe's wt.	1965/66	0.180	0.269*	0.230	0.432**	0.418
	1966/67	0.026	0.096	0.048	0.004	0.012
	1967/68	0.350**	0.380**	0.087	0.136	0.057
Litter Size at birtht	1965/66		0.907**	0.874**	0.623**	0.509**
	1966/67		0.809**	0.450**	0.223	0.085
	1967/68		0.850**	0.568**	0.299**	0.133
Litter wt at birth	1965/66			0.826**	0.728**	0.603**
	1966/67			0.645**	0.455**	0.298*
	1967/68			0.592**	0.457**	0.274**
Litter Size at weaning	1965/66				0.806**	0.736**
	1966/67				0.842**	0.779**
	1967/68				0.816**	0.752**
Litter wt at weaning	1965/66					0.986**
	1966/67					0.986**
	1967/68					0.980**

*P < 0.05 ** P < 0.01

Doe's weight was found to be generally positively phenotypically correlated with all traits measuring prenatal and postnatal maternal performance. The coefficients of correlation were generally moderate or low in magnituds (Table 1). Results reported by Wanis (1958) and Afifi *et al.* (1976 a and b) showed similar trends.

Litter size is a "complex" trait in the sense that several component traits contribute to its variation (Land and Falconer, 1969). The two principal components are the number of eggs shed at ovulation (ovulation rate) and the proportion of the surviving fertilized eggs represented by the live young at birth (intra-uterine survival). The positive coefficient of correlation obtained in the present study between doe's weight and litter size at birth may indicate that both of these components are positively influenced by doe's weight.Doe's weight in turn is determined by several factors affecting the prenatal stage of her young such as: the dam's gene complement, the exposition to reasonable plane of nutrition before and during pregnancy besides any environmental factors influencing the condition of the dam during pregnancy and parturition. On the other hand, litter size at weaning was considered as a measure of the pre-weaning maternal care. This would contain any common environment or cage effects associated with behaviour (Hafez, 1963; Rosenberg *et al.*, 1970). Therefore, the positive phenotypic correlations obtained between doe's weight and litter size at weaning should be considered in the design of breeding plans

aiming at the improvement of body weight in mammals, assuming that genetic and environmental correlations between the 2 traits were also positively correlated.

The positive correlation between doe's weight and litter weight at birth (Table 1) was expected since litter weight at birth is the end product of many factors most of which are classified as environmental from the point of view of the young where they are genetically determined from the point of view of the mother (Rut ledge *et al.*, 1972; Hanrahan and Eisen, 1974). Uterine environment, size of dam, litter size, ambiant temperature and physiological performance of the mother to nurse her young during pregnancy are examples for such factors (Hafez, 1963). Litter weight at weaning and pre-weaning litter weight gain were usually used as a convenient measure for the mother milking ability in most mammals (Rutledge *et al.*, 1972; Nagai *et al.*, 1975 in mice; Cox and Willham , 1962 and Ahlschwede and Robison, 1971 in Swine). This includes both quantity and quality of the milk (Butler and Metrakos, 1950). Therefore, the positive correlation obtained in the present study between doe's weight and each of litter weight at weaning and pre-weaning litter weight gain indicate that selection directed towards increasing doe's weight might influence the postnatal maternal performance measured as the weight of a litter at weaning or the pre-weaning weight gain of a litter in the same direction. This result must be considered with caution in the absence of similar genetic and environmental relationships.

Highly significant positive phenotypic correlation coefficients of 0.907, 0.809 and 0.850 (Table 1) were found between litter size at birth and litter weight at birth. The direction and magnitude of this correlation is in good agreement with most of those reported in the literature. El-khishin *et al.* (1951) obtained a significant positive correlation coefficient of 0.989 and 0.972 between litter size and litter weight at birth in Giza white and Bauscat rabbits, respectively. Kawinska and Niedzuradek (1967) reported a correlation cofficient between size and weight of the new born litters of 0.823. Moreover, Afifi *et al.* (1976a) found that litter weight at birth increased significantly with the increase of litter size at birth.

Litter size at birth was found to be phenotypically highly significant and positively correlated with litter size at weaning (Table 1). Sovljanski (1965), Fraser (1966), Omtvedt *et al.* (1966) and others, reported significant correlation of high magnitude between litter size of pigs at birth and number of piglets survived till weaning. However, litter size at weaning is largely dependent upon the maternal care provided by the mother to her young during the pre-weaning growth period.

The phenotypic correlation coefficients obtained in this study between litter size at birth and litter weight at weaning and pre-weaning litter weight gain were positive and ranged between 0.223 and 0.624 for litter size at birth and litter weight at weaning; and between 0.133 and 0.509 for litter size at birth and pre-weaning litter weight gain (Table 1). These estimates are in

agreement with those reported on pigs by Mazaraki (1962) who found that litter size at birth was positively and significantly correlated ($P < 0.01$) with litter weight at weaning (ranged from 0.531 to 0.614).

Highly significant positive phenotypic correlation coefficients (Table 1) were found to exist between litter weight at birth and litter size at weaning, litter weight at weaning and pre-weaning litter weight gain. The coefficients of correlation were generally large in magnitude. In consistent with these results, Omtvedt *et al.* (1966) observed that as the litter weight of pigs at birth increased, the number of pigs weaned and litter weaning weight and consequently pre-weaning litter weight gain increased.

The large phenotypic correlation coefficients obtained between litter size at weaning and litter weight at weaning and pre-weaning litter weight gain (Table 1) indicate that as the number of individuals survived till weaning increases, the amount of meat weaned tends to be higher. Similarly, Afifi *et al.* (1976a) found a significant positive relationship between litter size and litter weight at weaning time.

The phenotypic correlation of 0.986, found to exist between litter weight at weaning and pre-weaning litter weight gain in the present study, agrees in direction and magnitude with most of those reviewed in the literature. However, it should be noticed that both traits are directly influenced and positively correlated with the post-natal maternal ability (Legates, 1972).

Post-weaning growth traits

The phenotypic correlations of the present study between doe's weight and post-weaning individual body weights at different ages studied were generally positive and moderate in magnitude (Table 2). The same trend was detected in the literature consulted. Wanis (1958) found that the correlation coefficient between doe's weight and average weight of its bunnies at weaning was positive and highly significant in 2 seasons. Ghany *et al.* (1961) observed a positive phenotypic relationship between body weights of the dams and growth of their offspring.

Highly significant negative phenotypic correlation coefficients (Table 2) were found between litter size at birth and bi-weekly post-weaning body weights from 4 to 24 weeks of age .The estimates of the present study were generally moderate in magnitude and agree closely in direction with most the estimates reported earlier. Ghany *et al.* (1961) indicated that individuals from small litters had higher post - weaning body weights than those from large litters. Darwish (1969) found a highly significant coefficient of -0.754 for the correlation between litter size at birth and body weight at weaning. Similar findings were also reported by kobozieff *et al.* (1950) in mice, Bently and Taylor (1965) in rats and Omtvedt *et al.* (1966) in pigs.

TABLE 2. Within subclass phenotypic correlation coefficient

Traits	Season	Weaning (4-wk.) body wt.	6-wk. body wt.	8-wk. body wt.
Deo's wt.	1965/66	0.131**	0.148*	0.139*
	1966/67	0.087	0.450**	0.401**
	1967/68	—0.004	0.127*	0.144*
Litter Size at Birth	1965/66	—0.626**	—0.479**	—0.395**
	1966/67	—0.335**	—0.406**	—0.342**
	1967/68	—0.563**	—0.566**	—0.501**
Litter wt. at Birth	1965/66	—0.440**	—0.317**	—0.269**
	1966/67	—0.235**	—0.362**	—0.329**
	1967/68	—0.396**	—0.436**	—0.372**
Litter Size at Weaning	1965/66	—0.640**	—0.502**	—0.417**
	1966/67	—0.205**	—0.390**	—0.403**
	1967/68	—0.562**	—0.642**	—0.596**
Litter wt. at Weaning	1965/66	—0.113*	—0.028	—0.010
	1966/67	—0.240**	—0.017	—0.088
	1967/68	—0.051	—0.249**	—0.264**
Weaning (4-wk) Body wt.	1965/66		0.858**	0.748**
	1966/67		0.763**	0.660**
	1967/68		0.859**	0.751**
6-wk Body wt.	1965/66			0.909**
	1966/67			0.835**
	1967/68			0.879**
8-wk. Body wt.	1965/66			
	1966/67			
	1967/68			
10-wk Body wt.	1965/66			
	1966/67			
	1967/68			
12-wk Body wt.	1965/66			
	1966/67			
	1967/68			
16-wk. Body wt.	1965/66			
	1966/67			
	1967/68			
20-wk. Body wt.	1965/66			
	1966/67			
	1967/68			
24-wk. Body wt.	1695/66			
	1966/67			
	1967/68			

* $P < 0.05$ ** $P < 0.01$

among. doe's wt., litter trails, weaning and post-weaning body weights.

10-wk. body wt.	12-wk. body wt.	16-wk. body wt.	20-wk. body wt.	24-wk. body wt.	4-24 wk. gain in wt.
0.125	0.172	0.131	0.144	0.205**	0.178*
0.252**	0.237**	0.335**	0.331**	0.360**	0.268**
0.111	0.119*	0.081	0.183*	0.196*	0.200**
—0.409**	—0.399**	—0.447**	—0.270**	—0.294**	—0.034
—0.268**	—0.289**	—0.256**	—0.246**	—0.231*	—0.129
—0.454**	—0.406**	—0.272**	—0.338**	—0.307**	—0.151
—0.302**	—0.340**	—0.340**	—0.186*	—0.194*	0.009
—0.301**	—0.302**	—0.232*	—0.167	—0.111	—0.010
—0.346**	—0.301**	—0.201**	—0.246**	—0.172*	0.050
—0.440**	—0.468**	—0.458**	—0.296**	—0.312**	—0.042
—0.379**	—0.304**	—0.237*	—0.189*	—0.180	—0.105
—0.531**	—0.474**	—0.283**	—0.333**	—0.279**	—0.133
—0.115	—0.214**	—0.209**	—0.113	—0.096	0.008
—0.011	0.024	0.076	0.094	0.062	0.009
—0.244**	—0.218**	—0.086	—0.115	—0.052	—0.007
0.689**	0.601*	0.607**	0.468**	0.511**	0.150*
0.687**	0.651**	0.588**	0.546**	0.480**	0.248**
0.665**	0.597*	0.382**	0.466**	0.482**	0.233**
0.781**	0.611**	0.640**	0.490**	0.571**	0.282**
0.746**	0.676**	0.587**	0.549**	0.516**	0.363**
0.774**	0.718**	0.517**	0.553**	0.546**	0.355**
0.894**	0.660**	0.727**	0.546**	0.638**	0.408**
0.861**	0.801**	0.716**	0.624**	0.550**	0.429**
0.906**	0.824**	0.563**	0.622**	0.628**	0.480**
	0.791**	0.836**	0.641**	0.728**	0.536**
	0.923**	0.827**	0.716**	0.613**	0.490**
	0.910**	0.626**	0.664**	0.676**	0.556**
		0.821**	0.576**	0.696**	0.544**
		0.884**	0.788**	0.663**	0.548**
		0.684**	0.783**	0.799**	0.721**
			0.742**	0.865**	0.728**
			0.902**	0.827**	0.747**
			0.857**	0.748**	0.716**
				0.751**	0.659**
				0.930**	0.873**
				0.705**	0.863**
					0.926**
					0.969**
					0.964**

Significant ($P< 0.01$) negative phenotypic correlation coefficients were detected between litter weight at birth and individual post-weaning body weights. The magnitude of the coefficients decreased gradually from nearly moderate (-0.440) between litter weight at birth and weaning weight to small (-0.111) between litter weight at birth and weight at 24 weeks of age (Table 2).

Litter size and litter weight at weaning were found to be negatively correlated with post-weaning individual body weights in general (Table 2). Similarly, Wanis (1958) and Darwish (1969) found that weaning weight of the rabbit decreased significantly ($P< 0.01$) as litter size at weaning increased. The same picture was shown by Mckcown and MacMahon (1956) in Guinea pigs (weights at 28 days of age were inversely related to litter size).

It is worth nothing that estimates obtained for the phenotypic correlation coefficients between both litter size and litter weight either at birth or at weaning at one hand, and post-weaning weights on the other hand show that the effects of both litter size and litter weight on growth diminish with advance in age.

Body weight at weaning was found to be phenotypically significantly positively correlated with subsequent body weights measured bi-weekly till 24 weeks of age (Table 2). The estimates of the coefficients are generally large in magnitude and agree closely with most of those reported in the literature. Ghany *et al.* (1961) obtained an estimate of 0.921 for coefficient of correlation between body weight at 30 days and at 180 days of age. In addition, Medvedev (1959) reported that the greater the body weight of the pig at weaning, the greater the subsequent body weights will be.

The phenotypic correlation coefficients obtained between bi-weekly body weight measured from 6 to 24 weeks of age,were positive and highly significant (Table 2). The coefficients were generally large in magnitude and agree fairly well with those shown in the literature cited. El-Bendary (1961), Ghany *et al.* (1961) and Venge (1963) found positive and highly significant correlations between body weights of rabbits measured at different ages.

The phenotypic correlations among the growth traits obtained in this study were generally in close agreement with those reviewed in the literature. However, the positive phenotypic correlation between 2 traits does not necessarily indicate that selecting one of these traits will lead to improvement in the other correlated one, because phenotypic correlation is not always a reliable estimate of the genetic relatiooship existing between traits. For instance sometimes the environmental effects upon 2 traits could be so strong and positively correlated that a negative genetic correlation is masked and a positive phenotypic correlation results. Therefore, working out the genetic correlation between any 2 traits is necessary before deriving a conclusive idea about their relationship. However, the present results could be valued in planning a preliminary selection program for the improvement of meat production from rabbits.

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علاقات بين وزن الأم ــ عدد ووزن ولادة البطن ووزن الجسم عند أعمار مختلفة فى الأرانب

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أستخدمت فى هذه الدراسة بيانات ٢٧٦٥ أرنبا ولدت فى ٤٦٤ بطنا خلال ثلاثة مواسم انتاجية متتالية فى محطة التجارب بكلية الزراعة ، جامعة عين شمس بشبرا الخيمة بالقاهرة . أخذت هذه البيانات خلال مراحل مختلفة من العمر من وقت الميلاد حتى عمر ٢٤ أسبوع .

بصفة عامة كان وزن الأم مرتبطا ارتباطا موجبا مع جميع الصفات التى تقيس مستوى أداء الأمهات قبل وبعد الفطام والتى تتمثل فى عدد ووزن ولدة البطن عند الميلاد وعند الفطام ــ مقدار الزيادة فى وزن ولدة البطن من وقت الميلاد حتى الفطام عند عمر ٤ أسابيع . الا أن معاملات الارتباط كانت فى مجملها صغيرة القيمة .

تلاحظ وجود ارتباط موجب بين وزن الأم وأوزان نسلها عند الفطام وبعد الفطام حتى عمر ٢٤ أسبوع . وكانت قيم معاملات الارتباط متوسطة ومعنوية فى أغلب الأحوال .

كانت معاملات الارتباط بين صفات عدد ووزن ولدة البطن والزيادة فى وزن هذه الولدة موجبة ــ معنوية وكبيرة القيمة بصفة عامة . بينما كانت هذه المعاملات بين عدد ووزن ولدة البطن من جانب وبين وزن الجسم والزيادة فيه من جانب آخر سالبة ومعنوية وبقيم تؤكد أن هذا الارتباط السالب يضعف بتقدم العمر .

ارتبطت أوزان الجسم فى الأعمار المتتالية ببعضها وبمقدار الزيادة فى هذه الأوزان ارتباطا موجبا وقويا ذا معنوية عالية .