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Original article

Genetic study of *Dandarawy* chickens: I. Heritabilities and genetic correlations of body weight and weight gain

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Summary — Heritability values of body weight and weight gain at the ages of 1 d, and 4, 8, 12, and 16 wk were estimated from 57 half-sib families of a strain of the Egyptian breed *Dandarawy* representing 57 sires, 256 dams, and 1,605 offspring. Estimates were obtained for both of the sexes separately as well as for the two combined. The estimates of heritability ranged from 0.24 to 0.60 for males and females from sire components of variance, and 0.03 to 0.37 for males and females from dam components of variance. There were marked differences between heritability estimates from sire and dam components of variance and between males and females. The heritability estimates from sire components were generally higher than those from dam components, which indicated the importance of the additive genetic effect and possible sex-linked effects. It was also noticed that the environment had an effect on both body weight and weight gain which is reflected in heritability estimates from one age to another.

The results showed that there were highly significant correlations between body weights from 4 to 16 wk of age. There were no correlations between hatch weight and weights at the other ages. This indicates that it is possible to consider the hatch weight as a trait completely separate from the other traits in males, females, and the sexes combined. The highly significant genetic and environmental correlations showed that both genetic and environmental factors had the same influences on body weight from 4 to 16 wk of age. There were absent estimates of the genetic correlations especially with the dam components of variance in males and females. The correlations between weight gains at different periods showed highly significant estimates up to 12 wk of age. These correlations reflect the importance of both genetic and environmental effects on weight gain at the different periods. Our results indicate that it is possible to select for body weight and weight gain at an early rather than a late (16 wk) age because of the high correlations between the different ages.

***Dandarawy* chicken – body weight – weight gain – heritability – sex-linked effect – genetic correlation**

Résumé — Etude génétique de la race égyptienne de poulets *Dandarawy* : I. Héritabilités et corrélations génétiques du poids corporel et du gain de poids. *Les héritabilités du poids corporel et du gain de poids aux âges de 1 jour, 4, 8, 12 et 16 semaines ont été estimées à partir de données concernant 57 pères, 256 mères et 1605 descendants dans une souche de la race Egyptienne* Dandarawy. *Les données ont été analysées séparément pour les mâles et les femelles, puis pour les 2 sexes ensemble. Les héritabilités estimées dans chaque sexe à partir de la composante «père» varient de 0,24 à 0,60; celles estimées à partir de la composante «mère» varient de 0,03 à 0,37. Les héritabilités déterminées à partir de la composante «père» sont plus élevées que celles déterminées à partir de la composante «mère». Ce résultat indique l'importance de l'effet génétique additif, et la possibilité d'un effet lié au sexe sur le poids corporel et le gain de poids dans la souche*

Dandarawy. *Les variations des estimations d'un mois à l'autre indiquent l'importance de l'effet de l'environnement sur l'héritabilité du poids corporel et du gain de poids.*

Les résultats indiquent qu'il y a des corrélations hautement significatives entre le poids corporel de 4 à 16 semaines. Aucune corrélation significative n'apparaît entre le poids à l'éclosion et les autres poids, ce qui permet de dire que le poids à l'éclosion est complètement séparé des autres pour les mâles, les femelles et les 2 sexes ensembles. Les significations des corrélations montrent l'importance des effets génétiques et de l'environnement sur le poids corporel de 4 à 16 semaines d'âge. Les valeurs absentes des corrélations génétiques déterminées à partir de la composante mère chez les mâles et les femelles indiquent l'importance des autres effets génétiques que les effets additifs sur ces estimations. Les corrélations du gain de poids ont été hautement significatives d'une période à l'autre jusqu'à 12 semaines d'âge. Ces résultats montrent aussi le rôle de l'effet génétique et de l'environnement sur le gain de poids d'un âge à l'autre. Nos résultats indiquent la possibilité d'améliorer le poids corporel et le gain de poids à un âge plus précoce par la sélection car les corrélations sont significatives entre les mesures aux différents âges.

poulet* Dandawary – *poids corporel – gain de poids – héritabilité – liaison avec le sexe — corrélation génétique

Introduction

Several problems, especially concerning nutrition and disease, are encountered in Egypt when attempts are made to employ foreign strains in the field. At the Animal Production Department of Assiut University efforts have been directed toward improving the productivity of an old Egyptian breed named "*Dandarawy*" which exists in Upper Egypt. The productivity of this breed ranges from 110 to 122 eggs/yr; the egg weight ranges from 40 to 45 g; the age at first egg averages 212 to 218 days; and the adult body wt is 1 kg for females and 1.5–2 kg for males (Hassan *et al.,* 1973; Sharara, 1974; Abdellatif, 1977). No genetic information about this strain is now available, therefore a genetic study of certain productive traits seemed to be necessary before any breeding programme was to be undertaken. Thus we began the genetic evaluation of the strain in a series of studies by estimating the genetic parameters of various productive traits which would be useful in a breeding programme. First, we will discuss heritability estimates of body weight and weight gain.

The heritability estimates of body weight and weight gain as summarized by Kinney (1969) ranged from 0.35 to 0.54, which are moderately high, whereas Kaatz (1967) showed that the decrease in heritability estimates at 10 wk of age was due to high environmental components.

In fowls, for sex-linked traits theory implies that estimates of heritability from dam components of variance are higher with males than with females, while for sire components of variance the reverse is true (Thomas *et al.,* 1958; Abdel-Gawad, 1970; Bernon & Chambers, 1985).

On the other hand, Siegel and Essary (1959), Gaffney (1964), and Goodman (1973) concluded that heritability estimates of body weight were higher from the sire components of variance than the dam components, but Amer (1965), Marks and Siegel (1971), and Vaccaro and Van Vleck (1972) showed that heritability estimated from dam components of variance was higher than that from sire components of variance.

In Egypt, in *Fayoumi* chickens, several workers estimated the heritability of body weight. El-Masri (1959) found that it was 0.02, 0.02, and 0.11 at 8 wk of age from the sire, dam, and sire–dam components of variance, respectively. Abdel-Gawad (1961) showed that heritability estimates ranged from 0.10 to 0.79 at 1 d to 12 wk of age from the sire and sire–dam components of variance. Amer (1965) found similar results and added that the environment had an effect on heritability estimates at the early ages.

Many workers reported correlations of body weight and weight gain at different ages (Marks, 1979; Chambers *et al.*, 1981, 1984). Kinney (1969) summarized those correlations, which were relatively high and positive. Martin *et al.* (1953) showed that the high genetic correlations between weights at 6, 9, and 12 wk of age were more persistent during the growth period than other correlations (phenotypic and environmental), and the genetic effect did not vary from one age to another, although environmental effects were greatly different from one age to another. Merritt (1966) and Pym and Nicholls (1979) mentioned a high genetic correlation between 5 wk and 9 wk body weight from the sire–dam components of variance for males and females. Aman and Becker (1983) found a similar result for 6 wk and 7 wk body weight from the sire component of variance.

In the present study we estimate the correlations between body weight and weight gain at different ages in *Dandarawy* chickens to verify the roles of both genetic and environmental effects from hatch to 16 wk of age. These values will help in design of programmes for improving both body weight and weight gain by selection at an early age.

Materials and Methods

Animals

From a population of *Dandarawy* chickens maintained at the poultry farm of Assiut University, 57 sires and 570 dams (leg banded) were randomly mated in different breeding pens (10 dams/sire) to obtain pedigreed chicks. After 2 wk of egg collection, all hens that produced fewer than 5 eggs were eliminated; thus we had 256 dams that produced more than 5 eggs. Accordingly, the number of dams/sire and the number of progeny/dam was different from one family to another. The chicks were weighed to the nearest gram and wing banded at 1 d. They were brooded on the floor at a constant temperature (35°C) until 8 wk of age, then moved to the rearing house (open system). They were fed *ad libitum* on a commercial ration containing 18% total protein and 2,800 kcal/kg. The photoperiod was 24 h during the wk 1 and 10 h afterwards. The chicks were weighed to the nearest gram at 4, 8, 12, and 16 wk of age. A total of 1,605 chicks from the different families completed their record up to 16 wk of age.

Statistical procedures

Components of variance were obtained by nested analysis of variance with unequal numbers of dams and progeny in each sex separately. The statistical model in this case was :

$$Y_{ijk} = \mathcal{M} + \alpha_i + \beta_{ij} + e_{ijk},$$

where Y_{ijk} is the record of the k+h progeny of the j+h dam mated to the i+h sire; $\mathcal{M}$ is the population mean; α_i is the effect of the i+h sire; β_{ij} is the effect of the j+h dam mated to the i+h sire; and e_{ijk} the uncontrolled environmental and genetic deviations attributable to the individuals (Becker, 1975).

Components of variance of the sexes combined were obtained by a mixed model. The statistical model for the analysis was :

$$Y_{ijkl} = \mathcal{M} + \gamma_i + \alpha_j + \beta_{jk} + e_{ijkl},$$

where Y_{ijkl} is the record of the l^{th} progeny of the i^{th} sex of the k^{th} dam mated to the j^{th} sire; $\mathcal{M}$ is the population mean; α_j represents the random effect and β_{jk} the fixed effect in this model, and e_{ijkl} the uncontrolled environmental and genetic deviations (Harvey, 1977).

The method for estimating heritability was, as indicated by Becker (1975) :

$$h_s^2 = \frac{4\sigma_S^2}{\sigma_S^2 + \sigma_D^2 + \sigma_W^2}$$

$$h_D^2 = \frac{4\sigma_D^2}{\sigma_S^2 + \sigma_D^2 + \sigma_W^2}$$

$$h_{(S+D)}^2 = \frac{2(\sigma_S^2 + \sigma_D^2)}{\sigma_S^2 + \sigma_D^2 + \sigma_W^2}$$

where σ_S^2 is the covariance of half-sibs; σ_D^2 is the covariance of full-sibs minus the covariance of sire half-sibs; σ_W^2 contains the remainder of the genetic variance and the environmental variance. Standard errors of heritabilities derived from components of variance were determined according to the method of Dickerson (1960), which was modified by Becker (1975). The heritability estimates (+ SE) were calculated for males, females, and the combined sexes for body weight and weight gain from 1 d to 16 wk of age.

The genetic and environmental correlations were estimated according to the general formula of correlations :

$$r = \frac{\mathrm{cov} \cdot xy}{\sqrt{\sigma x^2 \cdot \sigma y^2}}$$

after substitution of the genetic and environmental components of the variance so as to determine the genetic and environmental correlations from the sire, dam, and sire–dam components of variance and covariance (Becker, 1975).

Results

Table I presents the body weight and weight gain means + SD from 1 d to 16 wk of age for males, females, and the combined sexes. The hatch means in males and females were equal, but from 4 to 16 wk of age, the male means were 13–20% higher than females for body weight and 15–20% higher for weight gain. The weight gain increased progressively from 1 d to 12 wk of age, but the rate of increase was reduced at 16 wk of age.

The results of the analysis of variance indicate that the mean number of progeny/dam was 6.1, the mean number of dams/sire was 6.8, and the mean number of progeny/sire was 28.0. The least-squares analysis of the differences between sires, dams, and the combined sexes are presented in Table II. It was noted in the analysis that there were highly significant differences between sires from 1 d to 16 wk of age for all the traits studied. In addition, the differences between dams were highly significant for all traits except

Table I. Body weight and weight gain means + SD (g).

	Males	Females	Combined sexes
Body weight			
One day	28.7 ± 2.8	28.7 ± 2.8	28.7 ± 0.4
4 weeks	187.5 ± 33.5	163.6 ± 28.7	174.7 ± 32.0
8 weeks	373.1 ± 80.5	316.5 ± 58.6	344.1 ± 76.1
12 weeks	699.8 ± 156.2	537.1 ± 126.3	601.8 ± 156.2
16 weeks	918.7 ± 181.4	738.6 ± 123.6	825.7 ± 188.3
Weight gain			
0-4 weeks	157.8 ± 33.5	134.8 ± 28.7	146.0 ± 32.4
4-8 weeks	186.7 ± 58.6	152.9 ± 45.9	169.5 ± 56.1
8-12 weeks	296.7 ± 92.1	220.6 ± 91.8	257.7 ± 108.2
12-16 weeks	248.9 ± 75.3	201.5 ± 71.8	223.9 ± 80.1

Number of males = 779 Number of females = 826

Table II. Significance of sire, dam, and sex effects in a combined least-squares analysis of variance (F values).

S.V.	d.f.	Body weight					Weight gain			
		one day	4 weeks	8 weeks	12 weeks	16 weeks	0-4	4-8	8-12	12-16
Sire	56	4.28**	3.42**	4.30**	4.13**	6.31**	2.69**	4.03**	3.17**	3.14**
Dam	200	1.46**	1.17**	0.98	1.24**	1.00**	1.14**	0.80	1.32**	0.90
Sex	1	0.15	184.86**	230.74**	320.16**	476.04**	106.88**	150.24**	203.24**	128.51**
Error (mean squares)	1 347	5.2	847.6	4 440.3	16 978.9	20 347	1 315.7	2 529.7	8 533.1	4 743

** $P < 0.01$

body weight at 8 wk of age and weight gain from 4–8 and 12–16 wk of age. The differences between the sexes were highly significant for all traits except body weight at hatching time.

As for heritability estimates of body weight and weight gain for males, females, and the combined sexes (Table III), differences were observed between heritability estimates in the sexes from sire and dam components of variance. The estimates ranged from 0.24 to 0.60 for males and females from the sire component of variance, and from 0.03 to 0.37 for males and females from the dam component of variance. The heritability estimates of the sexes combined ranged from 0.02 to 0.58 before elimination of sex effect and ranged from 0.0 to 0.76 after elimination of sex effect from the sire, dam, and sire–dam components of variance.

The values of heritability of the combined sexes before and after elimination of sex effect showed no great differences for sire, dam, and sire–dam components of variance, and the estimates had the same trend. The results showed that heritability estimates of weight gain were not consistent and their values were lower than those of the body weight.

The genetic and environmental correlations of body weight are shown in Table IV. It was noticed that the genetic correlations between hatch weight and weights at different ages had low and negative values compared with the other estimates. The genetic correlations between body weights from 4 to 16 wk of age had positive and highly significant values for males, females, and the sexes combined estimated from the sire, dam, and sire–dam components of variance, and for females estimated from the dam components of variance. Missing estimates were due to negative components of variance.

The environmental correlations between hatch weight and body weight at different ages showed negative and small values (Table IV). The environmental correlations of body weight from 4 to 16 wk of age were highly significant and positive for males, females, and the combined sexes estimated from the sire, dam, and sire–dam components of variance. These correlations were more persistent than genetic correlations at the various ages.

The genetic and environmental correlations of weight gain at the different periods of age are presented in Table V. The majority of the genetic correlations between weight gain from one period to another had highly significant and positive correlations for males, females, and the combined sexes estimated from the sire, dam, and sire–dam components of variance. The missing estimates correspond to the negative variances in the analysis of variance.

Environmental correlations of weight gain from one period to another had unstable estimates. Highly significant and positive correlations were noticed during the periods of growth until 12 wk of age for males, females, and the combined sexes estimated from the sire, dam, and sire–dam components of variance.

Discussion

The significant differences between sires showed that in our local strain *Dandarawy,* additive genetic factors had a great effect on body weight and weight gain, and the significant differences between dams for the majority of the traits studied may also reflect additive genetic effects. Bernon and Chambers (1985) reported similar findings.

Heritability estimates from sire components of variance were higher than those from dam components, confirming the importance of additive effects, since dam components include more non additive genetic and common environmental effects than sire components (ignoring sex-linked effects). These results agree with those mentioned by Siegel and Essary (1959); Gaffney (1964); Goodman (1973); Becker (1975); Pym and Nicholls (1979); and Bernon and Chambers (1985).

Heritability estimates for males based on dam components of variance were higher than those of females, which may correspond to the fact that variance due to sex-linked genes coming from the dam is not present in females but is present for males, which

Table III. Heritability estimates (+ SE) from sire, dam, and sire–dam components of variance for body weight and weight gain.

	Sire				Dam				Sire + Dam			
	Males	Females	Comb. 1	Comb. 2	Males	Females	Comb. 1	Comb. 2	Males	Females	Comb. 1	Comb. 2
Body weight												
one day	0.42 ± 0.01	0.60 ± 0.01	0.58 ± 0.05	0.63 ± 0.12	0.37 ± 0.14	0.03 ± 0.11	0.20 ± 0.08	0.08 ± 0.03	0.40 ± 0.08	0.31 ± 0.06	0.39 ± 0.03	0.23 ± 0.03
4 weeks	0.26 ± 0.08	0.24 ± 0.07	0.35 ± 0.03	0.39 ± 0.09	0.27 ± 0.15	0.03 ± 0.12	0.09 ± 0.06	0.03 ± 0.02	0.27 ± 0.07	0.10 ± 0.06	0.22 ± 0.03	0.13 ± 0.02
8 weeks	0.28 ± 0.08	0.37 ± 0.08	0.34 ± 0.03	0.46 ± 0.10	0.30 ± 0.14	0.11 ± 0.11	0.02 ± 0.05	——	0.29 ± 0.07	0.13 ± 0.06	0.18 ± 0.03	0.11 ± 0.02
12 weeks	0.43 ± 0.10	0.32 ± 0.08	0.43 ± 0.04	0.53 ± 0.11	0.27 ± 0.14	0.08 ± 0.12	0.12 ± 0.06	0.05 ± 0.02	0.35 ± 0.07	0.20 ± 0.07	0.28 ± 0.03	0.17 ± 0.03
16 weeks	0.50 ± 0.01	0.62 ± 0.01	0.52 ± 0.04	0.76 ± 0.13	0.19 ± 0.13	0.06 ± 0.10	0.04 ± 0.05	0.00 ± 0.02	0.35 ± 0.10	0.29 ± 0.05	0.28 ± 0.02	0.18 ± 0.03
Weight gain												
0-4 weeks	0.33 ± 0.09	0.25 ± 0.07	0.35 ± 0.03	0.27 ± 0.07	0.29 ± 0.14	0.02 ± 0.12	0.11 ± 0.06	0.03 ± 0.02	0.31 ± 0.07	0.11 ± 0.06	0.23 ± 0.03	0.09 ± 0.02
4-8 weeks	0.14 ± 0.07	0.31 ± 0.07	0.24 ± 0.02	0.32 ± 0.08	0.21 ± 0.14	0.13 ± 0.11	0.08 ± 0.05	——	0.18 ± 0.07	0.09 ± 0.06	0.08 ± 0.02	0.08 ± 0.02
8-12 weeks	0.28 ± 0.08	0.24 ± 0.07	0.38 ± 0.03	0.38 ± 0.09	0.23 ± 0.14	0.15 ± 0.12	0.15 ± 0.06	0.06 ± 0.03	0.26 ± 0.07	0.19 ± 0.07	0.27 ± 0.03	0.15 ± 0.02
12-16 weeks	0.22 ± 0.07	0.17 ± 0.06	0.23 ± 0.02	0.26 ± 0.07	0.08 ± 0.13	0.15 ± 0.13	0.02 ± 0.05	——	0.15 ± 0.07	0.16 ± 0.07	0.10 ± 0.03	0.07 ± 0.02

Comb. 1 : Heritability estimates before the elimination of sex effect.
Comb. 2 : Heritability estimates after the elimination of sex effect by the mixed model (according to HARVEY, 1977).

Table IV. Genetic and environmental ocrrelations of body weight for males, females, and the combined sexes.

Age	Sex	Hatch weight			4 weeks			8 weeks			12 weeks			16 weeks		
		S	D	S + D	S	D	S + D	S	D	S + D	S	D	S + D	S	D	S + D
								Genetic correlations								
Hatch weight .	M				− 0.07	− 1.70	− 0.29	− 0.14	——	− 0.58	− 0.05	——	− 0.23	− 0.10	——	− 0.24
	F				− 0.20	——	− 0.36	− 0.32	——	− 0.36	− 0.35	− 0.45	− 0.34	− 0.39	——	− 0.40
	M + F				− 0.11	− 0.66	− 0.26	− 0.25	− 1.70	− 0.41	− 0.15	− 0.71	− 0.31	− 0.19	− 0.97	− 0.31
4 weeks	M	− 0.16	− 0.03	0.05				0.89	——	0.79	0.84	——	0.83	0.79	——	0.84
	F	− 0.14	− 0.12	− 0.11				0.96	− 1.02	0.98	0.61	——	0.75	0.59	0.29	0.68
	M + F	− 0.16	− 0.09	− 0.06				0.90	1.29	1.02	0.77	0.90	0.81	0.71	1.26	0.78
8 weeks	M	− 0.03	0.07	0.11	0.65	0.71	0.73				0.96	− 1.75	0.99	0.94	− 0.72	1.00
	F	− 0.04	− 0.12	− 0.14	0.68	0.73	0.74				0.85	——	0.82	0.88	− 1.31	0.81
	M + F	− 0.05	− 0.04	− 0.03	0.69	0.70	0.70				0.88	1.23	0.88	0.86	1.47	0.90
12 weeks . . .	M	− 0.17	− 0.05	− 0.02	0.57	0.66	0.69	0.65	0.75	0.78				0.97	− 0.77	1.00
	F	− 0.27	− 0.28	− 0.29	0.63	0.61	0.60	0.68	0.72	0.74				1.00	——	0.90
	M + F	− 0.18	− 0.11	− 0.08	0.68	0.69	0.69	0.74	0.76	0.78				0.98	1.13	0.97
16 weeks . . .	M	− 0.07	− 0.02	− 0.01	0.47	0.57	0.60	0.59	0.70	0.73	0.86	0.89	0.89			
	F	− 0.07	− 0.15	− 0.18	0.54	0.51	0.51	0.62	0.71	0.74	0.80	0.84	0.86			
	M + F	− 0.05	− 0.03	− 0.03	0.61	0.61	0.68	0.70	0.71	0.69	0.86	0.89	0.89			
								Environmental correlations								

M = Males F = Females S = Sires D = Dams

Table V. Genetic and environmental correlations of weight gain for males, females, and the combined sexes.

Age	Sex	0-4 weeks			4-8 weeks			8-12 weeks			12-16 weeks		
		S	D	S + D	S	D	S + D	S	D	S + D	S	D	S + D
					Genetic correlations								
0-4 weeks	M				0.71	—	0.93	0.73	0.34	0.70	0.57	—	0.27
	F				0.92	– 1.39	0.93	0.20	—	0.52	0.65	—	0.06
	M + F				0.77	—	1.10	0.57	0.69	0.60	0.41	—	0.31
4-8 weeks	M	0.32	0.41	0.44				0.84	—	1.19	0.66	– 0.37	1.21
	F	0.27	0.38	0.43				0.68	—	0.65	1.06	—	0.34
	M + F	0.35	0.38	0.39				0.67	—	0.84	0.71	0.51	0.79
8-12 weeks	M	0.28	0.40	0.44	0.02	0.18	0.23				0.62	—	1.08
	F	0.42	0.35	0.32	0.10	0.18	0.23				0.76	– 0.89	– 0.01
	M + F	0.46	0.46	0.46	0.13	0.20	0.23				0.64	—	0.29
12-16 weeks	M	– 0.11	0.15	0.24	0.02	0.17	0.22	– 0.17	0.02	0.06			
	F	– 0.34	– 0.18	– 0.11	– 0.16	0.07	0.17	– 0.55	– 0.37	– 0.28			
	M + F	– 0.03	0.05	0.08	0.04	0.13	0.17	– 0.14	0.03	0.11			
					Environmental correlations								

M = Males F = Females S = Sires D = Dams increases the numerator of heritability for males but not females from the dam component of variance. Merritt (1966) and Becker (1975) reported similar conclusions for the differences between the sexes estimated from the dam components of variance.

On the other hand, in the female progeny the generally higher value of the sire component than that of the dam component of variance may also suggest that part of the variance is due to sex-linked genes.

Fluctuations of heritability estimates from one month to another may show the importance of environmental conditions during the growth period and their effects on heritability values; Kaatz (1967) found a similar result.

Comparison between the estimates in this study and those reported in the literature is difficult because of the differences between our population and the other populations, which had a history of selection and breeding programmes that did not exist in our population.

Lower estimates of correlations between body weight at hatch and body weights at later ages lead to the conclusion that hatch weight had no effect on later body weight, and that body weight at hatch must be considered as a separate trait. Kinney and Shoffner (1965) reported a similar result.

Significant correlations between body weights within and across sexes reflect the importance of genetic effects on body weight during the growth period from 4 to 16 wk of age. Martin *et al.* (1953) indicated the same effect of genetic factors on body weight. Genetic effects depend mainly on the fact that the genes that affected body weight at the different ages were the same and had pleiotropic effects. In addition, the genetic correlations show that additive genetic effects greatly affect body weight during the growth period (Becker, 1975; Falconer, 1981). The absent estimates, especially with the dam components of variance, indicate the importance of genetic effects other than the additive genetic effects on body weight (Becker, 1975; Pym and Nicholls, 1979; Aman and Becker, 1983).

The environmental correlations of body weight from 4 to 16 wk of age, which had all the environmental and non additive genetic effects, showed more persistent estimates than the genetic correlations. Thus, this result indicates that the environmental factors affecting body weight were the same and did not vary from period to period during growth.

The higly significant correlations indicated the possibility of improving body weight by selection at an early age. Aman and Becker (1983) showed a similar conclusion.

The genetic correlations of weight gain at different periods of age for males, females, and the combined sexes estimated from the sire, dam, and sire–dam components of variance confirm the persistence of the same genetic influences on weight gain from one period to another. The highly significant correlations agreed with those mentioned by Kinney (1969) for weight gain at various ages.

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