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PREDICTION OF SOME GROWTH MEASUREMENTS USING REGRESSION MODELS IN TWO LINES OF DANDARAWI CHICKEN

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ABSTRACT: Growth performance is usually a fair indicator of subsequent growth rate of chickens. Consequently, the current study was conducted at the Poultry Research Farm, Assiut University on a total of 1272 pedigreed Dandarawi chicks from the 6th generation of selection for high body weight at 8 weeks of age to describe and predict some growth measurements (body weight, shank length and keel length) at different ages of birds by using regression models linear, quadratic, and cubic for males and females in two lines of Dandarawi chicken. Body weight at (day-old, 4, 8, 12, 16, and 20 weeks), shank length at (4, 8, 12, 16, and 20 weeks), and keel length at (8, 12, 16, and weeks) were recorded.

The results revealed that the selection for high body weight at 8 weeks of age in Dandarawi chicken led to remarkable improvement and increasing in growth measurements in the selected line compared to the control line, where the body weight at 8 weeks of age in the selected line was 955.4 gram, while it was 691.70 gram in the control line. As well as males were outperformed females in all growth measurements at all ages in this study. Also, the study indicated that there was highly significant relationship ($P<0.001$) between body weight and bird age, as well as between shank length or keel length and bird age and the three studied regression models almost very similar and had high coefficient of determination estimates (near to one).

It can be concluded that the selection program is considered a very important tool for achieving further improvement in growth measurements in Dandarawi chicken and the relationship between body weight and bird age was best described with cubic model for males and females in both lines of Dandarawi chicken which had the highest coefficient of determination estimates (0.958 for selected line and 0.951 for control line).

Keywords: Growth performance; prediction; regression; selection; Dandarawi chicken.

INTRORDUCTION

Growth refers to any change in the body size per unit time and is an essential feature of biological systems (Narinç et al., 2017). The growth performance of a bird is an outward expression of the bird's genetic makeup. Pinchasov, 1991 and Ojedapo et al., 2012, reported that growth is influenced by genetic and environmental factors. Also, variations in body weight within a flock can be attributed to both genotype and environmental factors (nutrition and management) affecting individuals (Ayorinde and Oke, 1995).

Most research on growth modeling was performed on a single growth phase that was available at a prepubertal age, such as broilers. However, multiphase growth models were necessary to describe and predict growth at any time of growth periods (Zuidhof, 2020).

Growth curves are very useful tools in poultry breeding that could be used to verify genetic improvement, adherence to a feeding and rearing program according to the reference condition as determined by a regression model (Sabbioni *et al.,* 1999). Furthermore, Ricklefs (1985) explained that the growth curve is useful for describing weight gain with age and for representing the development of body weight during growth using simple equations. Therefore, evaluating growth curve is of a particular importance in poultry breeding.

Mathematical equations called growth models had been used to depict the growth patterns of poultry (Narinç *et al.,* 2017). Growth curves were determined by regression models, and appropriate regression models can be evaluated and determined by the coefficient of determination (R^2) (Zuidhof, 2020).

Multiple regression analysis had been widely used to depict quantitative relationship among predicted variables such as body weight and predictor variables such as age and body measurements (El Full, 2005 and Cankaya, 2009). In poultry science, linear, quadratic and cubic functions had been commonly used to verify the growth patterns of birds (El Full, 2005 and Abdelfattah, 2006).

Several studies had been performed on chickens to predict body weight and other body measurements (Latshaw and Bishop, 2001; Grona *et al.,* 2009 and Ojedapo *et al.,* 2012). Also, Adeniji and Ayorinde, 1990 and Ojedapo *et al.,* 2012**,** stated that the body weight of birds can easily be predicted by any given value of shank thickness, body girth and length of body, shank, keel, drumstick using regression equations.

Consequently, the current study was performed as an attempt to predict some growth measurements and to choose the best appropriate regression model in two lines of Dandarawi chickens.

MATERIALS AND METHODS

This study was conducted at the Poultry Research Farm, Faculty of Agriculture, Assiut University. A total of 1272 pedigreed Dandarawi chicks breed from the 6^{th} generation of selection program for high body weight at 8 weeks of age used to study the growth performance and describe the growth pattern of birds by determining the fit regression model in the selected line for high body weight (SL) and control line (CL). The numbers of birds in the two lines were shown in Table 1. At hatching time, chicks were wing banded, brooded on the floor until 20 weeks of age. Birds were fed *ad libitum* on a starter diet (23% crude protein and 3100 Kcal/kg) from hatching up to 8 weeks of age, then they were fed on a grower diet containing (21% crude protein and 3200 Kcal/kg) up to 20 weeks of age and clean water was supplied *ad libitum*. The chemical composition of rations used during the experiment is presented in Table 2.

Birds were kept under the same managerial treatment and environmental conditions throughout the experimental period. The chicks were vaccinated against Newcastle disease at 1, 4, 8 weeks of by using

Hitchner B1 and Lasota in drinking water. At 9 and 18 days of age the chicks were vaccinated against Gumboro disease in drinking water. At 8 weeks of age, the chicks were vaccinated against fowl pox by transfixion into the wing web.

Growth Traits:

Body weight at day- old, 4, 8, 12, 16, and 20 weeks of age (BW_0, BW_4, BW_8, BW_{12}, BW_{16}, and BW_{20}, respectively) were recorded individually with a scale of 5 g of precision. Other body measurements were also taken with the use of measuring tape calibrated in centimeters which included shank and keel length. The shank length was the distance between hock and tarsal joint was recorded at 4, 8, 12, 16, and 20 weeks of age (ShL_4, ShL_8, ShL_{12}, ShL_{16}, and ShL_{20}, respectively) and the keel length was the distance from the anterior to the posterior of sternum bone edge was recorded at 8, 12, 16, and 20 weeks of age (KL_8, KL_{12}, KL_{16}, and KL_{20}, respectively).

Statistical analysis:

Data of body weight, shank length, and keel length at different ages were analyzed by using the following General Linear Model (GLM) of SAS 9.2 (SAS institute, 2009).

$Y_{ijk} = \mu + L_i + S_j + (LS)ij + e_{ijk}$,

Where, Y_{ijk}= observation of any individual for each variable, μ= population mean, L_i= effect of line (i= 1, 2), S_j= effect of sex (j= 1, 2), $(LS)_{ij}$= the interaction (line ×sex), and e_{ijk}= experimental error. The **differences between means of all growth traits were tested by Duncan's multiple range test (Duncan, 1955)** at level 5%.

Regression analysis models:

In the present study, the age was used as an independent variable, while the body weight (BW), shank length (ShL), and keel length (KL) were considered as a dependent variable. Linear, quadratic and cubic models were as following models (Heinrichs *et al.*, 1992):

Linear regression model: $\hat{Y}_i = a + b_1x_i + e_i$

Quadratic regression model: $\hat{Y}_i = a + b_1x_i + b_2x_i^2 + e_i$

Cubic regression model: $\hat{Y}_i = a + b_1x_i + b_2x_i^2 + b_3x_i^3 + e_i$

Where $\hat{Y}_i$ is the predicted dependent variable (body weight, shank length, and keel length), when $\mathbf{x_i}$ represents the independent variable (age), a is the intercept represents the estimate of dependent variable when the independent variable is zero, b_1, b_2, b_3 are the regression coefficients associated with independent variable and e_i is the random error.

Regression equations were determined for each line and the coefficient of determination (R^2) used to compare the accuracy of prediction. The regression analysis was carried out using the procedure of non-linear models (PROC NLIN) of SAS software (SAS, 2009).

RESULTS AND DISCUSSION

Growth performance:

Least squares means ± standard errors of growth measurements at different ages as affected by line, sex and their interaction in Dandarawi chicken are presented in Tables 3, 4, and 5.

The results of body weight (in table 3) revealed that the birds in the selected line had superior body weight and was highly significantly different (P<0.001) from control line at the different ages. As well as males had heavier body weight and were highly significantly different (P<0.001) from females at all ages of the study. The present results were agreed with that found by Younis *et al.* (2013); Abou El-Ghar and Abd El-Karim (2016); Hermiz and Abdullah, (2020); Rizk *et al.* (2022); and Abdelhady *et al.* (2022).

The results of shank length (in table 4) showed that the birds in the selected line had a longer shank with highly significantly different (P<0.001) of control line at the different ages. Also, males had a longer shank were highly significantly different (P<0.001) from females at all ages of the study. Similar results were mentioned by Abd El-Ghany (2006); Younis *et al.,* (2013); Ramadan *et al.,* (2014); Abou El-Ghar and Abd El-Karim (2016); and Abdelhady *et al*., (2022).

Considering keel length, it was noted that the differences between lines and sexes were highly significant ($P<0.001$) where birds in the selected line had longer keel than that of the control line, and males also had longer keel than females at all ages of the study. These findings are consistent with the results of Younis et al. (2013); Abd El-Karim and Ashour (2014); Ramadan et al. (2014); Abou El-Ghar and Abd El-Karim (2016); and Abdelhady et al. (2022).

Also, there were significant interactions between line and sex for all studied traits. It was noted that the body weight of males and females in the selected line was higher than that of the corresponding in the control line, as well as shank and keel length of males and females in the selected line were longer than that of corresponding in the control line (Tables 3,4, and 5). In contrast, Abd El-Karim and Ashour (2014) and Ashour et al. (2015) found non-significant interaction between line and sex considering body weight.

Regression analysis:

With respect of the three regression models to predict body weight at any age for the two lines of Dandarawi chicken (Table 6), it noticed that the three studied models of the two lines (selected and control) almost considerably similar and had high R^2 estimates (close to one) which ranged from 0.922 to 0.988 in the selected line and from 0.925 to 0.980 in the control line. Accordingly, all the regression models were best fitting to describe body weight. According to the coefficient of determination (R^2), it found that the cubic regression model was the best model to predict body weight at any age for males and females of the two lines due to its higher value of (R^2) than either linear or quadratic models as presented in Table 5. Similar results found by (El Full, 2005 and Abdelfattah, 2006).

Our results indicated that body weight increased more rapidly at the early age than at the late age, thereafter it decreased and the relationship between age and body weight is confirmed by using the regression analysis for the two lines that were highly significant ($P<0.001$). El Full, (2005); and Abdelfattah, (2006) indicated similar results. Also, Sonaiya *et al.,* (1986) and Ojedapo *et al.,* (2012) found that age was a major factor in determining growth evolution.

Figure (1) showed the fit of the three regression models for predicting body weight at any age of males and females per line. From this figure, it could be clearly stated that the cubic model was the appropriate model to describe and accurately predict body weight of both sexes in the two lines at any age.

Regarding the three studied regression models for predicting shank length at any age in the two lines of Dandarawi chicken as shown in Table 7, it found that the coefficient of determination (R^2) ranged from 0.790 to 0.902 in the selected line, where in the control line it ranged from 0.777 to 0.886. Depending on the coefficient of determination (R^2), quadratic and cubic regression models had similar and higher estimates of (R^2) than linear model, so it could be stated that these models were the fit models to predict shank length by age of males in the selected line, while for females and pooled selected line it noticed that cubic model could be the best fit model to describe and predict shank length that had higher (R^2).

As for control line, the cubic model was the best model to predict shank length at any age for males and females when it had higher value of (R^2) than linear and quadratic, but for pooled line quadratic and cubic could be consider the best fitting models to predict shank length due to its similar value of (R^2) (Table 6). The highly significant regression analysis ($P<0.001$) for all regression models reflects the dependence of shank length on age. These results were in harmony with that mentioned by El Full, (2005) and Abdelfattah, (2006).

Figure (2) showed the fit of the three regression models for predicting shank length from the age of males and females per line. From this figure, it could be approximately stated that the cubic model was the best model except for males in the selected line and pooled control line when noticed that the cubic and quadratic could be the fit regression models to describe and more accurately predict the shank length.

Comparison of the three studied regression models to predict keel length at any age in the two lines of Dandarawi chicken are shown in Table 8. It noticed that (R^2) ranged from 0.720 to 0.878 for the selected line, when in the control line it ranged from 0.612 to 0.765. According to the coefficient of determination (R^2), quadratic and cubic regression models had similar and higher estimates of (R^2) than linear model, so it could be stated that these models were the best fit models to describe and predict keel length by age except females in the control line, where all the studied models (linear, quadratic, and cubic) had considerably similar (R^2) estimates (0.765) indicated that all models describing and predicting accurately keel length as indicated in Table 8. The highly significant regression analysis ($P<0.001$) for all regression models reflects the dependence of keel length on age. These results agreed with that reported by Abdelfattah, (2006).

From figure 3, it noted that the quadratic and cubic model were the fit models except for females in the control line when noticed that all studied regression models could be the appropriate models to depict and to accurately predict the keel length.

In general, from the results of the regression analysis in the present study, it could be stated that there was a similarity between growth measurements in their regression models, thus it could be possible to use body measurements (shank and keel length) as a good indicator to predict body weight indirectly when it was difficult to weigh the birds in the field at the different weeks. Similar conclusion reported by Pasternak and Shalev (1983); Abdellatif and Horst (1994); and Abdelfattah, (2006).

Ultimately, it can be concluded that the selection program for high body weight at 8 weeks of age in Dandarawi chicken tended to remarkable improvement and increasing growth measurements in the selected line compared to the control line. Depending on the coefficient of determination (R^2), cubic model was found the best fit model for predicting body weight depending on bird age for males and females in both lines of Dandarawi chicken which had the highest value of (R^2). It could be approximately stated that the cubic and quadratic models could be the best regression models to predict the shank length and keel length.

Table (1): Number of birds in each line and sex.

Line	Offsprings		Total
	Females	Males	
Control Line (CL)	304	294	598
Selected Line (SL)	327	347	674
Total	631	641	1272

Table (2): The calculated analysis of the rations used during the experiment.

Calculated analysis	Ration type	
	Starter	Grower
	0-8 weeks	8-20 weeks
Crude protein (%)	23	21
Energy (Kcal/kg)	3100	3200
Crude fiber (%)	3.8	3.5
Crude fat (%)	5.6	5.8
Calcium (%)	1.05	0.95
Phosphorus (%)	0.5	0.48
Moisture (%)	12	12

Table (3): Least squares means ± S.E and significance test of body weight (g) at day-old, 4, 8, 12, 16 and 20 weeks of age as affected by line, sex and their interaction for Dandarawi chicken.

		BW_0	BW_4	BW_8	BW_{12}	BW_{16}	BW_{20}
Lines							
CL		33.91 ± 0.13^b	289.80 ± 1.96^b	691.70 ± 3.69^b	1090 ± 7.81^b	1286 ± 10.89^b	1385 ± 8.88^b
SL		37.98 ± 0.12^a	395.96 ± 2.48^a	955.4 ± 5.15^a	1421.1 ± 8.63^a	1563.3 ± 12.83^a	1709.9 ± 11.59^a
Sex							
F		35.41 ± 0.14^b	316.51 ± 2.21^b	743.92 ± 4.54^b	1146.52 ± 8.85^b	1326.80 ± 8.16^b	1489.69 ± 8.37^b
M		36.71 ± 0.15^a	375.11 ± 3.39^a	917.54 ± 7.18^a	1371.26 ± 13.57^a	1718.61 ± 20.22^a	1954.5 ± 37.18^a
Interaction (line x sex)							
CL	**F**	33.51 ± 0.17^d	272.81 ± 1.90^d	639.97 ± 3.41^d	998.19±5.58	1197.78 ± 6.10^d	1348.70 ± 5.47^d
	M	34.33 ± 0.19^c	307.31 ± 3.17^c	745.19 ± 4.98^c	1238.70±10.3	1591.30 ± 12.69^b	1747.83 ± 15.59^b
SL	**F**	37.17 ± 0.16^b	357.14 ± 2.13^b	840.57 ± 2.68^b	1338.44±4.77	1488.42 ± 5.68^c	1660.37 ± 4.20^c
	M	38.73 ± 0.17^a	432.55 ± 3.34^a	1063.57 ± 4.89^a	1603.24±10.24	1969.57 ± 15.91^a	2204.74 ± 15.80^a
Significances							
Line		***	***	***	***	***	***
Sex		***	***	***	***	***	***
Line*Sex		*	**	**	NS	**	**

Means with a different superscript within each effect within the same column are significantly different.
BW: Body Weight, CL: Control line, SL: Selected line, F: Females, M: Males.
*:P≤ 0.05, **:P≤ 0.01, ***:P≤ 0.001, N.S: Not significant.

Table (4): Least squares means ± S.E and significance test of shank length (cm) at 4, 8, 12, 16 and 20 weeks of age as affected by line, sex and their interaction for Dandarawi chicken.

		ShL_4	ShL_8	ShL_{12}	ShL_{16}	ShL_{20}
Lines						
CL		4.56±0.02^b	6.62±0.02^b	7.63±0.04^b	8.28±0.04^b	8.88±0.04^b
SL		5.41±0.03^a	7.37±0.03^a	8.54±0.04^a	9.23±0.05^a	9.94±0.04^a
Sex						
F		4.86±0.03^b	6.71±0.03^b	7.63±0.03^b	7.63±0.03^b	9.24±0.04^b
M		5.16±0.03^a	7.31±0.03^a	8.68±0.05^a	9.63±0.09^a	10.56±0.12^a
Interaction (line x sex)						
CL	**F**	4.41±0.03	6.38±0.03^d	7.23±0.03^d	8.03±0.03^c	8.78±0.04^c
	M	4.72±0.04	6.86±0.03^c	8.27±0.05^b	9.13±0.07^b	9.93±0.10^b
SL	**F**	5.28±0.04	7.02±0.03^b	8.14±0.02^c	8.98±0.03^b	9.80±0.03^b
	M	5.54±0.03	7.70±0.03^a	9.42±0.06^a	10.61±0.08^a	11.32±0.08^a
Significances						
Line		***	***	***	***	***
Sex		***	***	***	***	***
Line*Sex		NS	**	**	**	*

Means with a different superscript within each effect within the same column are significantly different. ShL: Shank Length, CL: Control line, SL: Selected line, F: Females, M: Males.
*:P≤ 0.05, **:P≤ 0.01, ***:P≤ 0.001, N.S: Not significant.

Table (5): Least Squares Means ± S.E and significance test of keel length (cm) at 8, 12, 16 and 20 weeks of age as affected by line, sex their interaction for Dandarawi chicken.

		KL_8	KL_{12}	KL_{16}	KL_{20}
Lines					
CL		7.38±0.03^b	8.34±0.04^b	8.97±0.04^b	9.70±0.04^b
SL		8.20±0.03^a	9.39±0.05^a	10.27±0.04^a	11.15±0.04^a
Sex					
F		7.50±0.02^b	8.39±0.03^b	9.32±0.04^b	10.25±0.04^b
M		8.11±0.03^a	9.47±0.06^a	10.32±0.09^a	11.45±0.18^a
Interaction (line x sex)					
CL	**F**	7.13±0.03^d	7.93±0.03^c	8.73±0.03^d	9.61±0.04^d
	M	7.63±0.04^c	9.01±0.05^b	9.78±0.06^c	10.54±0.13^c
SL	**F**	7.84±0.03^b	8.99±0.03^b	10.06±0.03^b	11.01±0.03^b
	M	8.53±0.04^a	10.29±0.07^a	11.39±0.08^a	12.55±0.10^a
Significances					
Line		**	***	***	***
Sex		**	***	***	***
Line*Sex		**	**	**	**

Means with a different superscript within each effect within the same column are significantly different.
KL: Keel Length, CL: Control line, SL: Selected line, F: Females, M: Males. **:P≤ 0.01, ***:P≤ 0.001.

Table (6): Regression models for predicting body weight by age in each line and sex.

Model	Line	Sex	Coefficients				Prediction Functions	R^2	Sig.
			a	b_1	b_2	b_3			
Linear	**Selected Line (SL)**	**Males**	14.96	124.48			$\hat{Y}$= 14.96+124.48x	0.971	***
Quadratic			-2.46	134.25	-0.69		$\hat{Y}$= -2.46+134.25x-0.69x^2	0.973	***
Cubic			32.29	71.97	10.1	-0.42	$\hat{Y}$= 32.29+71.97x+10.1x^2-0.42x^3	0.985	***
Linear		**Females**	74.89	87.48			$\hat{Y}$= 74.89+87.48x	0.961	***
Quadratic			-17.53	125.36	-1.97		$\hat{Y}$= -17.53+125.36x-1.97x^2	0.978	***
Cubic			26.60	69.22	6.24	-0.28	$\hat{Y}$= 26.60+69.22x+6.24x^2-0.28x^3	0.988	***
Linear		**pooled**	87.72	93.81			$\hat{Y}$= 87.72+93.81x	0.922	***
Quadratic			-14.58	139.04	-2.51		$\hat{Y}$= -14.58+139.04x-2.51x^2	0.948	***
Cubic			25.24	82.40	6.28	-0.31	$\hat{Y}$= 25.24+82.40x+6.28x^2-0.31x^3	0.958	***
Linear	**Control Line (CL)**	**Males**	-12.46	97.17			$\hat{Y}$= -12.46+97.17x	0.964	***
Quadratic			-1.91	91.72	0.36		$\hat{Y}$= -1.91+91.72x+0.36x^2	0.964	***
Cubic			34.59	34.58	9.73	-0.36	$\hat{Y}$= 34.59+34.58x+9.73x^2-0.36x^3	0.978	***
Linear		**Females**	48.88	69.93			$\hat{Y}$= 48.88+69.93x	0.963	***
Quadratic			-8.30	92.31	-1.14		$\hat{Y}$= -8.30+92.31x-1.14x^2	0.972	***
Cubic			26.65	50.56	4.74	-0.20	$\hat{Y}$= 26.65+50.56x+4.74x^2-0.20x^3	0.980	***
Linear		**Pooled**	49.34	75.32			$\hat{Y}$= 49.34+75.32x	0.925	***
Quadratic			-14.12	101.97	-1.44		$\hat{Y}$= -14.12+101.97x-1.44x^2	0.937	***
Cubic			28.53	46.83	6.69	-0.28	$\hat{Y}$= 28.53+46.83x+6.69x^2-0.28x^3	0.951	***

M: Males, F: Females, Pooled: (males+ females), $\hat{Y}$: predicted or dependent variable (body weight), x: independent variable (age), a: intercept, (b_1, b_2, b_3): regression coefficients, R^2: coefficient of determination, Sig: significance, ***: significantly different at $P \leq 0.001$.

Table (7): Regression models for predicting shank length by age in each line and sex.

Model	Line	Sex	Coefficients				Prediction Functions	R^2	Sig.
			a	b_1	b_2	b_3			
Linear	**Selected Line (SL)**	**Males**	4.03	0.43			$\hat{Y}= 4.03+0.43x$	0.846	***
Quadratic			2.88	0.72	-0.02		$\hat{Y}= 2.88+0.72x-0.02x^2$	0.876	***
Cubic			2.98	0.69	-0.01	0.000	$\hat{Y}= 2.98+0.69x+0.01x^2+0.000x^3$	0.876	***
Linear		**Females**	4.47	0.28			$\hat{Y}= 4.47+0.28x$	0.875	***
Quadratic			3.42	0.52	-0.01		$\hat{Y}= 3.42+0.52x-0.01x^2$	0.899	***
Cubic			2.64	0.80	-0.04	0.001	$\hat{Y}= 2.64+0.80x-0.04x^2+0.001x^3$	0.902	***
Linear		**Pooled**	4.62	0.29			$\hat{Y}= 4.62+0.29x$	0.790	***
Quadratic			3.18	0.63	-0.02		$\hat{Y}= 3.18+0.63x-0.02x^2$	0.838	***
Cubic			2.25	0.97	-0.05	0.001	$\hat{Y}= 2.25+0.97x-0.05x^2+0.001x^3$	0.842	***
Linear	**Control Line (CL)**	**Males**	3.52	0.38			$\hat{Y}= 3.52+0.38x$	0.842	***
Quadratic			2.14	0.72	-0.02		$\hat{Y}= 2.14+0.72x-0.02x^2$	0.885	***
Cubic			1.48	0.97	-0.04	0.001	$\hat{Y}= 1.48+0.97x-0.04x^2+0.001x^3$	0.886	***
Linear		**Females**	3.81	0.26			$\hat{Y}= 3.81+0.26x$	0.841	***
Quadratic			2.55	0.54	-0.01		$\hat{Y}= 2.55+0.54x-0.01x^2$	0.878	***
Cubic			1.07	1.07	-0.06	0.001	$\hat{Y}= 1.07+1.07x-0.06x^2+0.001x^3$	0.887	***
Linear		**Pooled**	3.95	0.27			$\hat{Y}= 3.95+0.27x$	0.777	***
Quadratic			1.03	1.11	-0.06	0.001	$\hat{Y}= 1.03+1.11x-0.06x^2+0.001x^3$	0.846	***
Cubic			1.03	1.11	-0.06	0.001	$\hat{Y}= 1.03+1.11x-0.06x^2+0.001x^3$	0.846	***

Pooled: (males+ females), $\hat{Y}$: predicted variable (shank length), x: independent variable (age), a: intercept, (b_1, b_2, b_3): regression coefficients, R^2: coefficient of determination, Sig: significance, ***: significantly different at $P \leq 0.001$.

Table (8): Regression models for predicting keel length by age in each line and sex.

Model	Line	Sex	Coefficients				Prediction Functions	R^2	Sig.
			a	b_1	b_2	b_3			
Linear	**Selected Line (SL)**	**Males**	5.69	0.36			$\hat{Y}$= 5.69+0.36x	0.749	***
Quadratic			4	0.66	-0.01		$\hat{Y}$= 4+0.66x-0.01x^2	0.759	***
Cubic			4	0.66	-0.01		$\hat{Y}$= 4+0.66x-0.01x^2 x^3 was excluded term.	0.759	***
Linear		**Females**	5.75	0.27			$\hat{Y}$= 5.75+0.27x	0.877	***
Quadratic			5.25	0.35	-0.003		$\hat{Y}$= 5.25+0.35x-0.003x^2	0.878	***
Cubic			5.41	0.31		-7.18^{e-5}	$\hat{Y}$= 5.41+0.31x-7.18^{e-5} x^3 x^2 was excluded term.	0.878	***
Linear		**Pooled**	6.24	0.25			$\hat{Y}$= 6.24+0.25x	0.720	***
Quadratic			5.42	0.39	-0.005		$\hat{Y}$= 5.42+0.39x-0.005x^2	0.723	***
Cubic			5.42	0.39	-0.005		$\hat{Y}$= 5.42+0.39x-0.005x^2 x^3 was excluded term.	0.723	***
Linear	**Control Line (CL)**	**Males**	5.55	0.27			$\hat{Y}$= 5.55+0.27x	0.671	***
Quadratic			3.82	0.58	-0.01		$\hat{Y}$= 3.82+0.58x-0.01x^2	0.689	***
Cubic			3.82	0.58	-0.01		$\hat{Y}$= 3.82+0.58x-0.01 x^2 x^3 was excluded term.	0.689	***
Linear		**Females**	5.48	0.21			$\hat{Y}$= 5.48+0.21x	0.765	***
Quadratic			5.71	0.17	0.001		$\hat{Y}$= 5.71+0.17x+0.001x^2	0.765	***
Cubic			5.64	0.19		3.32^{e-5}	$\hat{Y}$= 5.64+0.19x+3.32^{e-5}x^3 x^2 was excluded term.	0.765	***
Linear		**Pooled**	5.89	0.19			$\hat{Y}$= 5.89+0.19x	0.612	***
Quadratic			5.20	0.31	-0.004		$\hat{Y}$= 5.20+0.31x-0.004x^2	0.616	***
Cubic			5.20	0.31	-0.004		$\hat{Y}$= 5.20+0.31x-0.004x^2 x^3 was excluded term.	0.616	***

In the cubic model the excluded terms were not entered because the tolerance limits for entering variables were reached. Pooled: (male females), $\hat{Y}$: predicted variable (keel length), x: independent variable (age), a: intercept, (b_1, b_2, b_3): regression coefficients, R^2: coefficient determination, Sig: significance, ***: significantly different at P≤ 0.001.

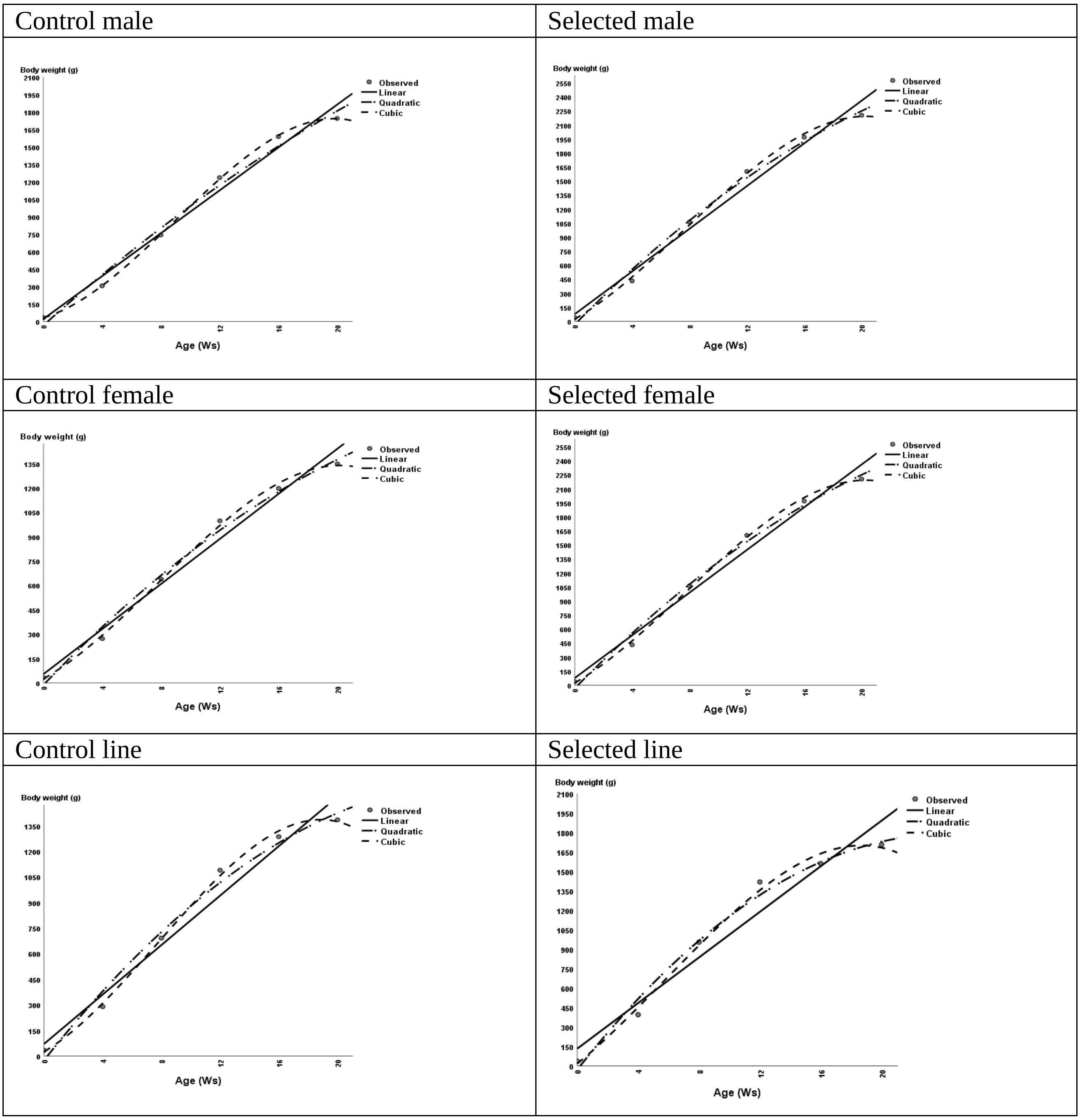
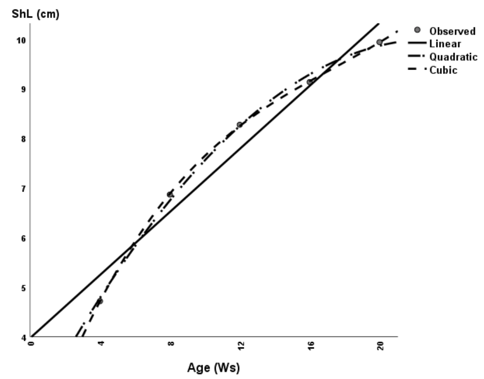
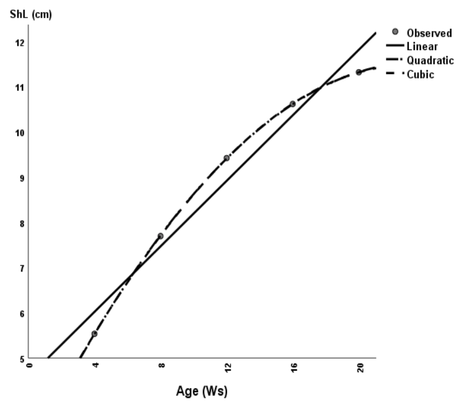


Figure (1): Curves of body weight for selected and control lines in each sex for different regression models.

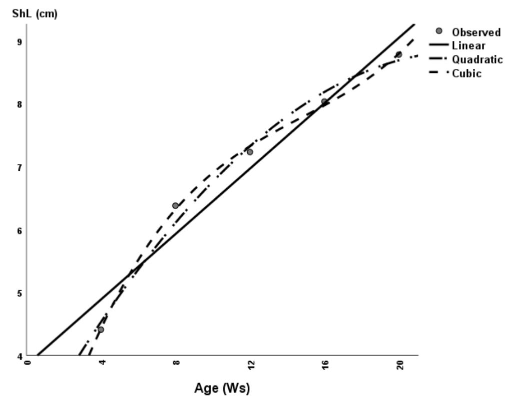
Control male



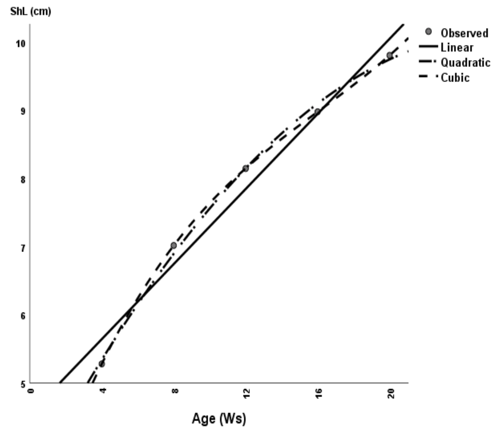
Selected male



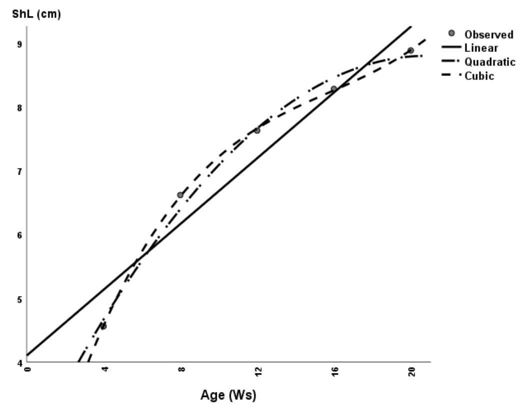
Control female



Selected female



Control line



Selected line

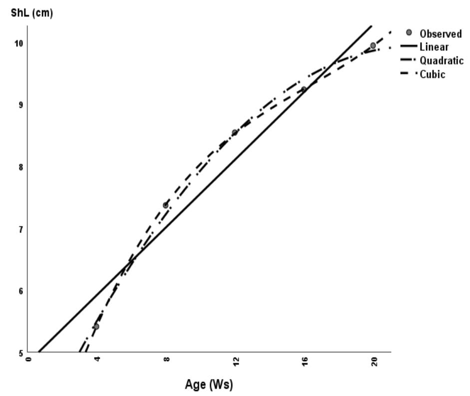


Figure (2): Curves of shank length for selected and control lines in each sex for different regression models.

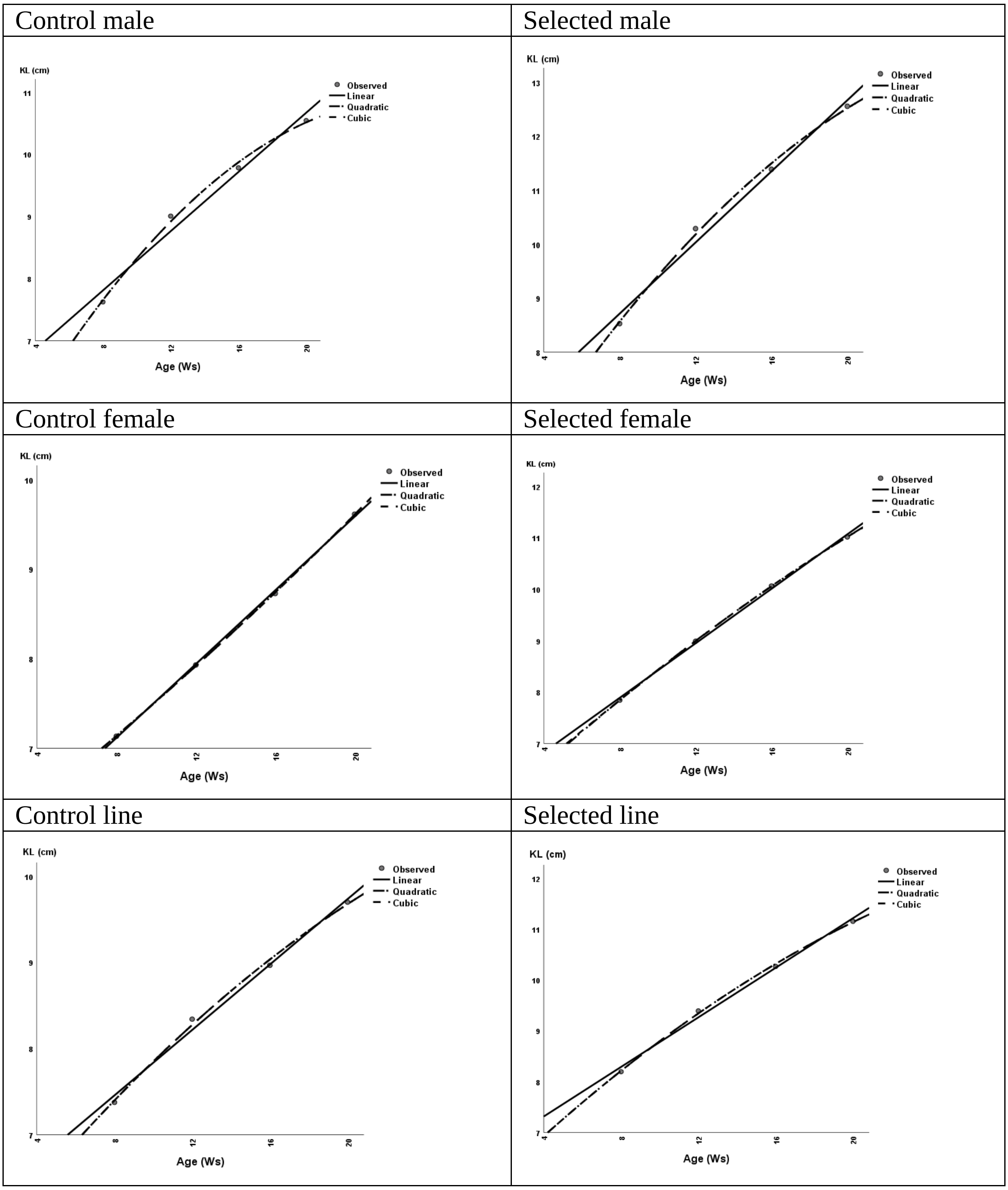


Figure (3): Curves of keel length for selected and control lines in each sex for different regression models.

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الملخص العربي

التنبؤ ببعض مقاييس النمو باستخدام نماذج الانحدار في خطين من دجاج الدندراوي

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أداء النمو عادة ما يكون مؤشراً عادل لمعدل سرعة النمو في الدجاج. لهذا، أُجريت الدراسة الحالية في مزرعة الدواجن البحثية بجامعة أسيوط على إجمالي ١٢٧٢ كتكوت منسب للدجاج الدندراوى من الجيل السادس المنتخب لوزن الجسم العالي عند عمر ٨ أسابيع لوصف والتنبؤ ببعض مقاييس النمو (وزن الجسم، طول الساق وطول القص) في مختلف الأعمار للطيور بواسطة تقدير نموذج الانحدار الخطى، التربيعي والتكعيبي للذكور والاناث في خطى الدجاج الدندراوى. تم تسجيل وزن الجسم في عمر (يوم، ٤، ٨، ١٢، ١٦ و٢٠ أسبوع) وطول الساق في عمر (٤،٨،١٢، ١٦ و٢٠ أسبوع) وطول القص في عمر (٨، ١٢، ١٦ و٢٠ أسبوع).
بينت النتائج أن الانتخاب لوزن الجسم العالي عند عمر ٨ أسابيع في دجاج الدندراوي أدى إلى تحسين ملحوظ وزيادة في مقاييس النمو في الخط المنتخب مقارنة بخط المقارنة، حيث بلغ وزن الجسم عند عمر ٨ أسابيع في الخط المنتخب ٩٥٥,٤ جرام، بينما كان ٦٩١,٧٠ جرام في خط الكنترول. كذلك تفوقت الذكور علي الاناث في جميع مقاييس النمو في جميع الاعمار في هذه الدراسة. أيضا، أظهرت النتائج أن هناك علاقة معنوية جداً بين وزن الجسم وعمر الطائر، وكذلك بين كلا من طول الساق أو طول القص وعمر الطائر وكانت نماذج الانحدار الثلاثة التي تمت دراستها متشابهة جداً تقريباً وكانت لها تقديرات عالية لمعامل التقدير (قريبة من الواحد).
يمكن أن نستنتج أن برنامج الانتخاب يعتبر أداة مهمة جداً لتحقيق مزيد من التحسين في مقاييس النمو في الدجاج الدندراوي وأن العلاقة بين وزن الجسم وعمر الطائر في الذكور والاناث لكلا الخطين تم وصفها بشكل أفضل باستخدام النموذج التكعيبي حيث كان له أعلى تقديرات لمعامل التقدير (٠.٩٥٨ للخط المنتخب و ٠.٩٥١ لخط الكنترول).
الكلمات الدالة: أداء النمو، التنبؤ، الانحدار، الانتخاب، دجاج الدندراوي.