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Appendix 1

Table A1. Summary of the scaling relationships between body mass and keel length in male and female lesser kestrel used for computing the scaled mass index (SMI). SMI for individual *i* was computed according to the formula $SMI_i = BM_i \times (L_0/L_i)^{b_{SMA}}$, where BM_i is the body mass of the individual *i*, L_0 is a reference values of the linear body measurement for the population, L_i is the linear body measurement (in our case keel length) for individual *i*, and b_{SMA} is the scaling exponent of the relationship between body mass and the linear measurement (Peig and Green 2009, 2010) [slope of the standardized major axis (SMA) regression between body mass and the linear measurement (both natural log-transformed) in the reference population]. As scaling exponents were significantly different between males and females (likelihood ratio test: $\chi^2 = 5.58$, df = 1, p = 0.018), SMI was computed separately for each sex. As the reference value L_0 for the population we used mean keel length of each sex. Because mean keel length of males and females was very similar [females: 31.9 mm (1.9 SD), males: 31.9 mm (1.6 SD); $t_{154} = 0.01$, p = 0.99], SMI values of both sexes were comparable. Scaling exponents and test statistics of SMA regressions were computed by the *smatr* R package (Warton et al. 2012).

Sex	n	b_{SMA} (95% CI)	Intercept (95% CI)	p^a	R^2
Females	82	1.037 (0.839; 1.281)	1.453 (0.687; 2.220)	0.011	0.08
Males	74	1.496 (1.202; 1.863)	-0.278 (-1.243; 0.867)	0.003	0.11

a: p-values of the null hypothesis that b_{SMA} was equal to zero

Table A2. Fit statistics (Akaike information criterion value, AIC, and R^2) of body condition (scaled mass index, SMI), oxidative (TAC, TOS) and moult status GLMs (full models) including either breeding stage or sampling date as predictors. These two variables were intrinsically correlated (r = 0.39) and could thus not be included together in the same model. To control for intra-seasonal variation in body condition, oxidative and moult status (birds were captured over 38 days, during both incubation and nestling-rearing phases; see e.g. Donázar et al. 1992 for body mass decline from incubation to nestling rearing), we therefore included in models either breeding stage or sampling date as a predictor, choosing the one which better fitted the data. The best-fitting model (lowest AIC value) is highlighted in boldface. List of abbreviations for predictors: FS = food supplementation, SE = sex, BS = breeding stage, TM = total moult investment, SA = sampling date, SMIc = scaled mass index, centred within sex categories (see Statistical analyses).

Model predictors	AIC	R^2
SMI (n = 144)		
FS + SE + BS + TM + (FS × SE) + (FS × BS) + (FS × TM)	**1146.5**	**0.44**
FS + SE + SA + TM + (FS × SE) + (FS × SA) + (FS × TM)	1149.5	0.43
TAC (n = 126)		
FS + SE + BS + SMIc + TM + (FS × SE) + (FS × BS) + (FS × SMIc) + (FS × TM)	1763.3	0.35
FS + SE + SA + SMIc + TM + (FS × SE) + (FS × SA) + (FS × SMIc) + (FS × TM)	**1755.3**	**0.39**
TOS (n = 71)		
FS + SE + BS + SMIc + TM + (FS × SE) + (FS × BS) + (FS × SMIc) + (FS × TM)	286.7	0.06
FS + SE + SA + SMIc + TM + (FS × SE) + (FS × SA) + (FS × SMIc) + (FS × TM)	**285.3**	**0.08**
Moult initiation (n = 144)		
FS + SE + BS + SMIc + (FS × SE) + (FS × BS) + (FS × SMIc)	160.6	0.24
FS + SE + SA + SMIc + (FS × SE) + (FS × SA) + (FS × SMIc)	**147.2**	**0.32**
Total moult investment (n = 144)		
FS + SE + BS + SMIc + (FS × SE) + (FS × BS) + (FS × SMIc)	1421.5	0.19
FS + SE + SA + SMIc + (FS × SE) + (FS × SA) + (FS × SMIc)	**1371.3**	**0.43**

Table A3. Summary of body condition, oxidative and moult status GLMs accounting or not for the duration of food supplementation (time to sampling). Because birds were captured at different times after start of food supplementation [mean value = 27 days (SD 7)], we checked whether the duration of food supplementation, rather than food supplementation per se, affected adult traits, by re-running final models while expressing food supplementation as the interaction between food supplementation and the number of days elapsed between sampling date and laying date (time to sampling hereafter; corresponding, for food-supplemented individuals, to the duration of food supplementation). The food supplementation × time to sampling interaction hence tests for any differential effect of food supplementation on measured adult traits according to the duration of food supplementation. In these models, breeding stage and sampling date were replaced by time to sampling, because the former two variables were intrinsically correlated with the latter (r = 0.70 and 0.44, respectively). Since these models provided a similar or worse fit than those including food supplementation only, and the results concerning food supplementation effects were qualitatively unaltered, for simplicity we report in the main text the results of models not accounting for time to sampling effects (Table 1). List of abbreviations for predictors: FS = food supplementation, SE = sex, BS = breeding stage, TM = total moult investment, SA = sampling date, SMIc = scaled mass index, centred within sex categories (see Statistical analyses), TS = time to sampling. Estimates for the food supplementation effect are reported (upper model: FS effect; lower model: FS × TS effect).

Model predictors	Estimate (SE)	t/Z	p	AIC	R^2
SMI (n = 144)					
FS + SE + BS + TM	2.86 (2.16)	1.32	0.19	1146.5	0.44
FS + SE + TS + TM + (FS × TS)	-0.25 (0.29)	0.87	0.39	1141.4	0.45
TAC (n = 126)					
FS + SE + SA + SMIc + TM	-65.62 (45.74)	1.43	0.15	1750.8	0.38
FS + SE + TS + SMIc + TM + (FS × TS)	-6.43 (6.34)	1.01	0.31	1767.6	0.30
TOS (n = 71)					
FS + SE + SA + SMIc + TM	0.41 (0.42)	0.99	0.33	280.1	0.04
FS + SE + TS + SMIc + TM + (FS × TS)	0.06 (0.06)	1.00	0.32	279.7	0.07
Moult initiation (n = 144)					
FS + SE + SA + SMIc	0.64 (0.44)	1.46	0.15	145.5	0.30
FS + SE + TS + SMIc + (FS × TS)	-0.003 (0.056)	0.05	0.96	163.7	0.20
Total moult investment (n = 144)					
FS + SE + SA + SMIc + (FS × SA)	2.46 (0.65)[a]	3.76	< 0.001	1367.8	0.43
FS + SE + TS + SMIc + (FS × TS)	1.54 (0.74)	2.07	0.028	1418.4	0.19

a: estimate refers to the FS × SA interaction (Table 2).

Table A4. Fit statistics for LMMs of egg mass (with clutch identity as a random intercept effect) with different codings of laying order. Abbreviations: LOc = laying order (continuous variable); LOf = laying order (5-level factor); RLO = relative laying order. Models were fitted on the subset of eggs whose laying order was certain (n = 217 eggs and 65 clutches) and are sorted according to AIC value [lowest through highest; AIC values computed according to maximum likelihood estimation (Zuur et al. 2009)]. The best-fitting model is highlighted in boldface.

Model predictors	AIC	R^2
RLO + RLO^2	**589.4**	**0.11**
LOc + LOc^2	600.1	0.10
LOf	601.3	0.11
RLO	603.3	0.08
LOc	603.8	0.09

Table A5. Summary of sex differences in nestling body mass, morphology and mortality (LMM or GLMM, Table 1). Even though tarsus and forearm length were slightly significantly larger in males than in females (see Table footnotes), body mass and mortality were not significantly different between the sexes, and there were no significant food supplementation × sex effects. Estimates for main effects of food supplementation and sex were from models with the same structure as the corresponding models reported in Table 5, whereas the food supplementation × sex effect was from the corresponding full model. Degrees of freedom for F-tests were estimated according to the Kenward–Roger's approximation.

Predictors	Estimate (SE)	F/Z	df	p	Effect size r
Body mass (n= 253 nestlings, n = 80 broods) (R^2 = 0.88)					
Food supplementation[a]	1.84 (1.22)	2.30	1, 74	0.14	0.12
Sex	0.37 (0.84)	0.20	1, 220	0.66	0.02
Food supplementation × sex[b]	-1.12 (1.71)	0.40	1, 215	0.52	0.04
Tarsus length (n = 243 nestlings, n = 77 broods) (R^2 = 0.68)					
Food supplementation	0.57 (0.37)	2.35	1, 71	0.13	0.14
Sex[c]	0.50 (0.24)	4.10	1, 209	0.044	0.12
Food supplementation × sex[b]	-0.82 (0.48)	2.92	1, 209	0.09	0.10
Forearm length (n = 244 nestlings, n = 77 broods) (R^2 = 0.71)					
Food supplementation[a]	0.62 (0.54)	1.33	1, 69	0.25	0.09
Sex[d]	0.94 (0.42)	4.84	1, 224	0.029	0.14
Food supplementation × sex[b]	-0.87 (0.86)	1.02	1, 220	0.31	0.06
Feather length (n = 181 nestlings, n = 67 broods) (R^2 = 0.60)					
Food supplementation	1.99 (1.07)	3.42	1, 58	0.07	0.18
Sex	-0.32 (0.81)	0.15	1, 161	0.70	0.03
Food supplementation × sex[b]	-1.76 (1.64)	1.13	1, 160	0.29	0.08
Mortality (n = 250 nestlings, n = 80 broods) (R^2 = 0.15)					
Food supplementation	-0.01 (0.52)	0.02	-	0.98	< 0.01
Sex	-0.31 (0.46)	0.68	-	0.49	0.04
Food supplementation × sex[b]	-0.01 (0.95)	0.01	-	0.99	0.01

a: estimate from mean-centered covariate
b: estimate from the full model, or from a model without other non-significant interactions
c: estimated mean values: males = 20.7 (0.22 SE) mm, females = 20.2 (0.22 SE) mm
d: estimated mean values: males = 28.3 (0.34 SE) mm, females = 27.3 (0.34 SE) mm

Table A6. Fit statistics for LMMs of egg mass including different interaction terms, with clutch identity as a random intercept effect. The non-significant food supplementation × (relative laying order^2) interaction (FS × RLO^2, p = 0.14) was removed first. In exploratory analyses, we observed that including in the egg mass model both the food supplementation × laying date (FS × LD) and the food supplementation × female SMI (FS × SMI) interactions at the same time negatively affected model performance because it increased correlations among fixed effects. We therefore fitted two separate models and reported in Table 3 the results of model M6 (final model after removing non-significant interactions), which included the test of differential body condition effects on egg mass according to food supplementation (one of the main hypotheses being tested in the study). AIC values were computed according to Maximum Likelihood estimation (Zuur et al. 2009). List of abbreviations for predictors: FS = food supplementation, RLO = relative laying order, LD = laying date, CS = clutch size, SMI = female scaled mass index.

Model predictors	AIC	R^2
M1: Full model (including all 2-way interactions) FS + RLO + RLO^2 + LD + CS + SMI + (FS × RLO) + (FS × RLO^2) + (FS × LD) + (FS × CS) + (FS × SMI)	860.0	0.33
M2: Excluding FS × RLO^2 FS + RLO + RLO^2 + LD + CS + SMI + (FS × RLO) + (FS × LD) + (FS × CS) + (FS × SMI)	860.2	0.33
M3: Excluding FS × RLO^2 and (FS × SMI), including (FS × LD) FS + RLO + RLO^2 + LD + CS + SMI + (FS × RLO) + (FS × LD) + (FS × CS)	861.4	0.30
M4: Excluding FS × RLO^2 and (FS × LD), including (FS × SMI) FS + RLO + RLO^2 + LD + CS + SMI + (FS × RLO) + (FS × CS) + (FS × SMI)	861.3	0.30
M5: Final model (M3 excluding non significant interactions) (Table A7) FS + RLO + RLO^2 + LD + CS + SMI + (FS × RLO) + (FS × LD)	860.6	0.30
M6: Final model (M4 excluding non significant interactions) (Table 3) FS + RLO + RLO^2 + LD + CS + SMI + (FS × RLO) + (FS × SMI)	860.6	0.30

Table A7. Linear mixed model of the effects of food supplementation on egg mass (model M5 from Table A6). Degrees of freedom for F-tests were estimated according to the Kenward–Roger's approximation. See Fig. A1 for graphical representation of the food supplementation × laying date interaction.

Predictors	Estimate (SE)	F	df	p	Effect size r
Egg mass (n = 349 eggs, n = 82 clutches) (R^2 = 0.30)					
Food supplementation[a]	0.17 (0.25)	0.48	76	0.49	0.07
Relative laying order[a]	0.71 (0.31)	5.17	265	0.024	0.10
(Relative laying order^2)[a]	-0.28 (0.08)	13.23	265	< 0.001	0.22
Laying date	-0.02 (0.02)	0.97	77	0.33	0.10
Clutch size	-0.48 (0.18)	6.96	77	0.01	0.24
Female SMI[a]	0.02 (0.01)	2.23	76	0.36	0.15
Food supplementation × relative laying order	0.33 (0.09)	13.13	264	< 0.001	0.09
Food supplementation × laying date	-0.07 (0.03)	5.36	76	0.023	0.22

a: estimate for mean-centered covariate

Table A8. Fit statistics of GLMMs of hatching success including the squared term of clutch size (which significantly predicted hatching success in a previous study; Serrano et al. 2005). The squared term of clutch size was not significant ($p = 0.24$) in the model with main effects and did not significantly improve model fit according to AIC values. Clutch identity was included as a random intercept effect. See final model in Table 3 for the (non-significant) effect of female SMI on hatching success.

Model predictors	AIC	R^2
Full model FS + RLO + LD + CS + CS^2 + (FS × RLO) + (FS × LD) + (FS × CS) + (FS × CS^2)	315.2	0.07
Excluding FS × CS^2 FS + RLO + LD + CS + CS^2 + (FS × RLO) + (FS × LD) + (FS × CS)	313.3	0.07
Excluding non-significant interactions FS + RLO + LD + CS + CS^2	314.5	0.04
Final model excluding CS^2 (Table 3) FS + RLO + LD + CS	313.9	0.03

Table A9. Binomial GLMs (restricted to control clutches/broods) testing the effect of female/male SMI on the probability of nest desertion.

Predictors	Estimate (SE)	Z	p	Effect size r
Model including female SMI (n = 38 clutches) ($R^2 = 0.32$)				
Laying date	0.16 (0.09)	1.86	0.06	0.41
Clutch size	1.27 (0.98)	1.30	0.20	0.29
Female SMI	-0.16 (0.07)	2.28	0.023	0.53
Model including male SMI (n = 31 clutches) ($R^2 = 0.21$)				
Laying date	-0.12 (0.10)	1.23	0.22	0.33
Clutch size	1.73 (1.10)	1.57	0.12	0.43
Male SMI	0.03 (0.06)	0.44	0.66	0.11

Table A10. Binomial models of sex allocation: a) testing whether PSR was predicted by the squared term of female SMI (Aparicio and Cordero 2001); b) assessing whether the analysis of factors affecting the probability of a nestling being male (Table 4) was affected by excluding those broods with one sexed nestling only (final model); c) testing whether the probability of a nestling being male varied along the laying sequence, fitted on data from those nestlings with known egg of origin; the model-predicted proportion of males in the first-laid egg was 0.18, whereas it was 0.80 in the fifth-laid egg. Brood identity was included as a random intercept effect in GLMMs.

Predictors	Estimate (SE)	Z	p	Effect size r
a) Binomial GLM of PSR (n = 25 broods) (R^2 = 0.10)				
Food supplementation	-0.29 (0.45)	0.65	0.51	0.12
Laying date	-0.02 (0.03)	0.52	0.60	0.10
Clutch size	-0.31 (0.30)	1.00	0.31	0.20
Female SMI	0.01 (0.02)	0.02	0.99	< 0.01
Female SMI^2	0.01 (0.01)	0.20	0.84	0.04
b) Binomial GLMM of the probability of being male (n = 248 nestlings, n = 75 broods) (R^2 = 0.05)[a]				
Food supplementation	-0.37 (0.27)	1.35	0.18	0.09
Rank	0.36 (0.12)	3.08	0.002	0.20
Laying date	0.01 (0.02)	0.05	0.96	< 0.01
c) Binomial GLMM of the probability of being male (n = 51 nestlings, n = 41 broods) (R^2 = 0.14)[b]				
Laying order	0.65 (0.32)	1.99	0.047	0.37

a: dispersion parameter = 1.15
b: dispersion parameter = 1.05

Table A11. LMM of egg mass fitted on the subset of eggs which could be associated to sexed nestling (n = 51 eggs from 41 clutches), with clutch identity as a random intercept effect. The squared term of relative laying order was not included in the model as it did not significantly improve model fit in this subset. Degrees of freedom were estimated according to the Kenward-Roger's approximation. R^2 of the final model (excluding the two non-significant interactions) = 0.25.

Predictors	Estimate (SE)	F	df	p	Effect size r
Food supplementation	0.71 (0.41)	2.97	1, 37	0.09	0.26
Relative laying order	-0.64 (0.19)	9.03	1, 21	0.007	0.34
Sex	-0.64 (0.36)	2.78	1, 41	0.10	0.22
Food supplementation × relative laying order[a]	0.07 (0.47)	0.02	1, 20	0.88	0.02
Food supplementation × sex[a]	0.44 (0.85)	0.24	1, 37	0.63	0.07

a: excluded term

Table A12. Binomial GLMM of nestling mortality (final model) excluding deserted broods (sample size: n = 266 nestlings from 78 broods) (with brood identity as a random intercept effect). R^2 of the final model = 0.18.

Predictors	Estimate (SE)	Z	p	Effect size r
Food supplementation	0.10 (0.44)	0.22	0.83	0.02
Rank	1.38 (0.25)	5.61	< 0.001	0.41
Laying date	-0.01 (0.03)	0.12	0.90	0.01
Brood size	-0.44 (0.26)	1.69	0.09	0.13
Ectoparasite load	-0.15 (0.36)	0.41	0.68	0.05

a: dispersion parameter = 0.85

Table A13. LMM of nestling ectoparasite load (final model), with brood and nestling identity as random intercept effects. Monitoring session was included in the model as a 3-level factor (see Podofillini et al. 2018, which see also for discussion of significant rank and laying date effects on ectoparasite load). Degrees of freedom were estimated according to the Kenward–Roger's approximation. R^2 of the final model = 0.12.

Predictors	Estimate (SE)	F	df	p	Effect size r
Food supplementation	0.01 (0.06)	0.01	1, 80	0.92	0.01
Session	-	1.62	3, 723	0.18	< 0.05
Rank	-0.05 (0.01)	12.42	1, 219	< 0.001	0.12
Laying date	-0.02 (0.004)	24.13	1, 90	< 0.001	0.32
Brood size	0.01 (0.02)	0.01	1, 384	0.96	0.01

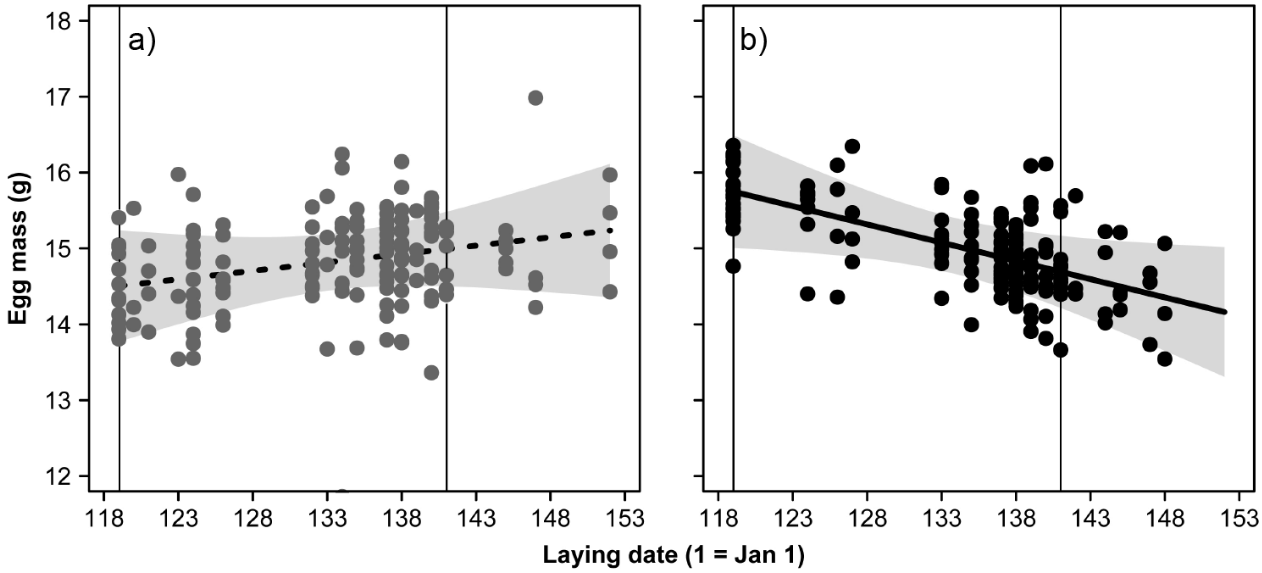

Figure A1. Egg mass did not significantly vary with laying date among control females [0.02 (0.02 SE)] (a), while it significantly decreased among food-supplemented females [estimate: -0.05 (0.02 SE)] (b). Partial plots accounting for other model effects are shown. The fitted lines (with 95% confidence bands) are derived from the corresponding model reported in Table A7. Full line: significant slope; dotted line: non-significant slope. Estimated marginal means (derived from the Table A7 LMM) computed at the 10th and 90th percentiles of the distribution of laying date (day 119 and 141, respectively; shown as thin vertical lines within each panel) revealed that egg mass of food-supplemented females was significantly larger than control ones early in the season [controls: 14.23 g (0.37 SE); food-supplemented: 15.48 g (0.38 SE), $t_{77} = 2.39$, $p = 0.019$], whereas no significant difference in egg mass between groups emerged among late-laid clutches [$t_{76} = 0.92$, $p = 0.36$].

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