

Department of Pet Breeding and Wildlife Management,
University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin
e-mail: malgorzata.goleman@up.lublin.pl

MAŁGORZATA GOLEMAN

Interactions between puppies' body measurements and kind of maintenance and puppy test results

Interakcje między wymiarami ciała szczeniąt a sposobem utrzymania
i wynikami testów dla szczeniąt

Summary. The aim of the study was to verify if the kind of maintenance had an impact on puppies' body measurement and if puppies body size had an impact on puppy test results. The material for the study were 259 German Shepherd puppies (124 males and 135 females) at the age of 6 to 9 weeks from 18 breedings registered in FCI. Puppies were divided into three groups according to the kind of maintenance. Biometrical measurements of the investigated puppies were also carried out. On the basis of the measurements, the index of massiveness and the index of compactness for each puppy were calculated. As a method, a modified puppy aptitude test was chosen. Puppies' body measurements were analyzed as the index of massiveness and compactness in relation to puppies' sex and kind of maintenance. Analysis of variance (ANOVA) was applied and essential differences between the means were verified by Duncan test. Correlations between index of the massiveness and compactness as well as domination tests and final PAT test results were calculated. The average value of the massiveness index of litters from the same mother was compared with the single-factor analysis of variance using the least squares method (LSM) of the SAS software. The average value of the index of massiveness was higher in females, but the average value of index of compactness was higher in males. The differences were not statistically important. Comparing puppies' kind maintenance, the highest value of both the index of massiveness and the index of compactness was observed in puppies born in the owner's house and moved to kennel at the age of 4–5 weeks, and the lowest ones in the maintenance group „house”. The differences were statistically important. No statistically important correlations were found between the index of massiveness and the index of compactness and domination test results and the final PAT test results. Comparing the puppies' body measurement of different litters originated from the same mother, statistically high important differences in the average value of massiveness index in progeny were observed in nearly 50% mothers, even within the full siblings.

Key words: German Shepherd Dog, puppies, index of massiveness, index of consistence, modified PAT test

INTRODUCTION

Dogs are kept by a man under various conditions. As companions, dogs most often live nearby a man in its apartment and sometimes they are kept in a garden with limited access to a house. The situation is distinct, when canines are maintained for breeding. If a breeder has only one or two reproduction females, the maintenance conditions are frequently unchanged, puppies are born and grow at home. However, in the case of larger number of dogs to keep, it is necessary to ensure at least temporary isolation of a female after its parturition for making it convenient to rear the litters. Such an opportunity cannot be always guaranteed at home or apartment. Breeding of dogs, namely large ones and with abundant hair cover, is most often carried out in coops. Both canine maintenance systems have their pros and cons, and both have different influences on their physical and mental development. Conditions at home give the puppies wider opportunities to be a part of a family than those found in the coop, which of course positively affects the litter mental development. On the other hand, puppies kept in a coop have more exercises and their physical development is versatile.

The research aimed at evaluating the influence of puppies maintenance on their size as well as puppies dimensions on aptitude test results.

MATERIAL AND METHODS

Studied material consisted of German Shepherd dogs, including 259 puppies (124 males and 135 females) born in 46 litters at 18 breeding centers that are registered by FCI (Federation Cynologique Internationale – International Cynology Federation) in Poland, Germany, Czech, and Slovakia.

The zoometric measurements of puppies were made to verify whether their size and body weight is associated with dominating behavior of a given puppy within a litter. Following items were determined:

1. Body weight.
2. Height at croup – distance between grounds and croup in the line of the front leg – measured using zoometric band.
3. Chest circumference – along the croup, shoulders, elbows, and upper edge of sternum – measured using zoometric band.
4. Chest depth – distance between the croup and upper edge of sternum – measured using zoometric compasses.
5. Slope body length – distance from shoulder cap to sciatic cap – measured using zoometric band.

The modified Puppy Aptitude Test (PAT) was chosen to test litters [Goleman 2008]. The test consists of sociability tests, domination tests, and tests that verify the congenital predispositions for fetching and cooperating with man. The tested behavior was scored from 1 through 6, where 6 stood for dog's behavior the most desirable at its further training, while 1 – the least desirable one. Achieved sum of scores allowed for assigning the note describing the puppy's behavior from bad through very well: 1–21 points – bad, 22–30 points – sufficient, 31–39 points – well, 40–48 points – very well.

Tests and measurements were carried out with 6–9-weeks-old puppies so that their body weight was very distinct one to another, because that period dogs grow very intensively with body weight gain reaching up to even 130 g daily [Zentek *et al.* 1995]. Therefore, body weight determination could not be a basis for puppies size comparisons. The measurements allowed for calculating the massiveness index (IM) and compactness index (IZ) for every single puppy tested [Kobryńczuk 1999].

$$\text{Massiveness Index (IM)} = \frac{\text{chest circumference} \cdot 100}{\text{height at croup}}$$

$$\text{Compactness Index (IZ)} = \frac{\text{chest circumference} \cdot 100}{\text{slope body length}}$$

Litters were divided into three groups in reference to their rearing system: I – at breeder's home (house) – 31 puppies (including 16 males and 15 females); II – in kennel outdoor (kennel) – 165 puppies (including 78 males and 87 females); III – puppies born at breeder's home, that were transferred to the kennel at 4–5th week of life (house/kennel) – 63 puppies (including 30 males and 33 females).

Body dimensions expressed as massiveness index and compactness index depending on sex and puppy rearing system were subject to considerations. Numerical data were processed applying variance analysis and difference significance between mean values was verified by means of Duncan test.

Correlations between massiveness index and compactness index vs. dominating tests results (PAT 3, PAT 4, PAT 5) were calculated with a help of Statistica software package.

Correlations between final results from PAT test and massiveness test scores were calculated in similar way to check if a puppy size affects the test results.

Mean values of massiveness test for litters from the same female were compared to find out whether these parameters are repeated at sibs and semi-sibs. Calculations were made on a base of single-factorial variance analysis by means of least squared means (LSM) with a help of SAS software and taking into account the litter's origin.

RESULTS

Analysis of body dimensions expressed with massiveness index and compactness index (Tab. 1 and 2) revealed that mean IM value was higher at females than at males (Tab. 1), while mean IZ level was higher for males (Tab. 2), yet differences were not statistically significant in both cases.

Considering the mean value of massiveness index for maintenance and sex groups, its highest level was observed for puppies born at house and of 4–5-weeks-old while transferred to the kennel („house/kennel” group) (Tab. 3), whereas the lowest – for „house” group. The greatest oscillations of the index value were recorded in „kennel” group, which amounted to: 121.21–155.17 for males and 120.00–156.67 for females, which can be explained by quite large difference of body dimensions for summer and winter litters.

Table 1. Average value of index of massiveness (IM) in sex groups

Tabela 1. Średnia wartość indeksu masywności (IM) dla płci

Sex – Płeć	n	\bar{X}	SD	Min-max (cm)
Male – Pies	124	135.72	7.70	120.69–157.69
Female – Suka	135	136.03	7.32	118.75–156.67

Table 2. Average value of index compactness (IZ) in sex groups

Tabela 2. Średnia wartość indeksu zwięzłości dla płci

Sex – Płeć	n	\bar{X}	SD	Min-max (cm)
Male – Pies	124	127.70	10.63	102.86–160.00
Female – Suka	135	126.59	10.35	83.33–150.00

Table 3. Average value of index massiveness (IM) in maintenance and sex groups

Tabela 3. Średnia wartość indeksu masywności dla poszczególnych grup utrzymania i płci

Maintenance Utrzymanie	n	\bar{X}	SD	Płeć Sex	n	\bar{X}	SD	Min-max (cm)
House – Dom	31	130.12 ^A	6.32	M	16	130.54 ^A	6.30	120.69–142.31
				F	15	129.67 ^C	6.54	118.75–137.50
Kennel – Kojec	165	136.12 ^B	7.51	M	78	135.51 ^B	7.35	121.21–155.17
				F	87	136.66 ^D	7.65	120.00–156.67
House/Kennel Dom/Kojec	63	138.11 ^B	6.56	M	30	139.05 ^B	6.79	129.03–157.69
				F	33	137.25 ^D	5.17	129.03–148.08

To mark the differences in all tables, the following rule has been applied:

designation in lower case concerns significance at $p \leq 0.05$ and means important differences,

designation in capitals concerns significance at $p \leq 0.01$ and means highly important differences.

Differing data was put together according to a–b, c–d scheme.

Dla zaznaczenia różnic w tabelach przyjęto następującą zasadę:

oznaczenie małymi literami – dotyczy istotności dla $p \leq 0,05$ i oznacza różnice istotne,

oznaczenie dużymi literami – dotyczy istotności dla $p \leq 0,01$ i oznacza różnice wysoko istotne.

Dane różniące się między sobą zostały sparowane wg schematu: a–b.

Table 4. Average value of index of compactness (IZ) in maintenance and sex groups

Tabela 4. Średnia wartość indeksu zwięzłości dla poszczególnych grup utrzymania i płci

Maintenance Utrzymanie	n	\bar{X}	SD	Płeć Sex	n	\bar{X}	SD	Min-max (cm)
House – Dom	31	113.30 ^A	5.61	M	16	112.73 ^A	6.14	102.86–121.88
				F	15	113.91 ^C	5.12	106.25–125.71
Kennel – Kojec	165	128.05 ^B	9.17	M	78	129.23 ^B	8.86	107.69–160.00
				F	87	126.99 ^D	9.33	83.33–146.15
House/Kennel Dom/Kojec	63	131.48 ^B	10.15	M	30	131.68 ^B	10.23	114.29–156.52
				F	33	131.29 ^D	10.24	110.53–150.00

Table 5. Relation between body measurement and the results of domination PAT substest
Tabela 5. Zależność pomiędzy wymiarami ciała i podtestami na dominację PAT

Feature Cechy	IM and IZ	IM and PAT 3	IM and PAT 4	IM and PAT 5	PAT 3 and PAT 4	PAT 3 and PAT 5	PAT 4 and PAT 5
Coefficient of correlation Współczynnik korelacji	0.42*	-0.04	-0.10	0.09	0.17*	0.23*	0.22*

*importance for $p \leq 0.05$ – istotność dla $p \leq 0,05$

Table 6. Average value of index of massiveness (IM) for litters originated from the same mother
Tabela 6. Średnia wartość indeksu masywności miotów pochodzących od tej samej matki

Mother Matka	Number of litter Nr miotu	Amount of puppies in the litter Liczba szczeniąt w miocie	LSM IM	Kind of maintenance System odchowu miotu
1	6	9	136,00 ^A	dom – house
1	7	5	125,54 ^B	dom – house
1	9	6	123,26 ^B	dom – house
6	23	8	136,51	kojec – kennel
6	40	6	138,63	kojec – kennel
8	14	9	137,30	kojec – kennel
8	17	8	136,58	kojec – kennel
9	24	3	133,93 ^A	kojec – kennel
9	27	5	145,52 ^B	kojec – kennel
10	10	11	135,62 ^b	dom/kojec – house/kennel
10	12	10	143,79 ^a	dom/kojec – house/kennel
10	16	10	136,40 ^b	kojec – kennel
11	35	8	133,05	kojec – kennel
11	46	3	129,79	kojec – kennel
15	30	6	135,00	dom/kojec – house/kennel
15	32	4	137,84	dom/kojec – house/kennel
24	21	4	147,98	kojec – kennel
24	44	6	149,04	kojec – kennel
25	25	3	129,76 ^B	kojec – kennel
25	26	3	151,37 ^A	kojec – kennel
25	28	4	134,11 ^B	kojec – kennel
25	36	4	137,51 ^B	kojec – kennel
27	33	4	126,18	kojec – kennel
27	34	2	131,80	kojec – kennel
29	1	7	134,63 ^B	dom/kojec – house/kennel
29	2	10	134,94 ^B	dom/kojec – house/kennel
29	3	2	145,00 ^A	dom/kojec – house/kennel
29	4	1	140,00	dom/kojec – house/kennel

Highly significant statistical differences between house-kept vs. „kennel” and „house/kennel” puppies were found. Similarly highly significant dependence occurred for females.

Values of compactness index for particular maintenance and sex groups are illustrated in Table 4. Its highest values were observed in „house/kennel”, while the lowest in „house” group, and the differences were statistically highly significant. The highest mean value of IZ was recorded for males in „house/kennel” (131.68), while the lowest at „house” puppy group (112.73). Statistically highly significant differences were found between males of „house” vs. „house/kennel” groups as well as between females of „house” vs. „house/kennel” and „kennel” females groups. The largest variability of compactness index value was recorded for „house/kennel” maintenance group.

Dependencies between body dimensions and domination tests results (PAT 3, PAT 4, and PAT 5) were also subject to statistical processing (Tab. 5).

Significant dependence (at $p \leq 0.05$) was found between massiveness index vs. compactness index, while no significant correlations were observed between massiveness and compactness indices vs. domination tests results (PAT 3, PAT 4, and PAT 5). Instead, statistically significant dependence was found among domination tests results.

Final scores from PAT tests were also correlated with massiveness index using Spearman rank correlation; however, no dependence between massiveness index value and PAT test result was found.

Body dimensions of puppies from different litters of the same mother expressed as the massiveness index, were subject to statistical processing of single-factor variance analysis by means of least squared means method (Tab. 6).

Highly significant differences of massiveness index for litters of 5 females (of 11 analyzed ones) were recorded. Statistically significant differences were also found between litters originated from the same male (litters No 6 and No 9 – full siblings) and reared at the same breeder under similar conditions.

DISCUSSION

Because puppies were tested between their 6th and 9th week of life, the body weight could not be the factor for their size comparisons, thus massiveness and compactness indices were calculated to make puppies' size and proportions comparable.

The highest values of both indices were revealed by puppies born at breeder's home and their subsequent transfer to the kennel at 4–5th week of life. It could be observed that house bred puppies were taller, yet finer, which can be explained by limited space they could find at breeder's house and insufficient exercises to gain muscle weight similar to those puppies reared in the garden, for instance.

Puppies bred at house and house/kennel system reached the best scores during tests [Goleman 2008]. No dependence between massiveness index value vs. PAT test results was found, which means that puppies' massiveness had no effects on scores they achieved at the tests. In order to verify the hypothesis of the influence of a puppy's massiveness on its domination behavior, the domination sub-tests of PAT test were also subject to statistical analysis, which revealed that the increase of IM value had no statistical influence on domination behavior. Instead, the domination behavior in PAT 4 (so-

cial domination) and PAT 5 (domination by lifting up) significantly increased along with the increase of domination behavior during PAT 3 test (domination – limited exercise).

Wilsson and Sundgren [1998b] during their studies upon body weight, litter size, and mother's reproduction experiences effects on puppies' behavior, observed that body weight was the mostly affecting variable; larger puppies were more explorative and active in manipulating with objects. The body weight effect was much stronger at females than at males, hence it was concluded that it can be negligible at males. During tests at the age of 8 weeks, larger puppies were more active and had better cognitive skills, and achieved higher scores for protective instinct and hardness when grown up [Wilsson and Sundgren 1997, 1998a, 1998b].

The problem of puppy rearing under kennel conditions in some breedings consists in insufficient socialization, because bitch-mother along with its litter is kept out of the breeder's home in separate room. Besides, dog breeding is most often situated in suburbia, hence puppy socialization requires from the breeder more involvement and time. Experiments conducted upon the isolation of puppies' from their surrounding during socialization period (4–7th week of life) revealed that such animals were emotionally instable when grown up, could not get into appropriate relations both with other dogs and humans, and all social contacts made them frightened [Melzack and Scott 1957]. Isolated puppies also learned new things slower and slower accepted new events [Fuller 1964]. Puppies bred at breeder's home – even with no breeder's involvement – were stimulated in various ways (moving people, turned on TV, playing radio, etc.) just from their birth. Learning and experience is based on cognition of new phenomena at animals. Any novelty releases both fear and interest (attractiveness) reactions [Grandin and Dresing 1998]. Also studies upon dogs maintained in kennels revealed that dog, besides contact with a man, needs its environment to be improved by toys, for instance [Wells 2004]. The „house/kennel” system ensured such rearing conditions. Problem of early socialization can be solved by breeder's family contacts with puppies and arranged kennel space.

When puppies were reared in kennels, decrease in body weight of autumn-winter and winter-spring litters was observed. It seems that lower air temperatures made living conditions worse, which was confirmed by lower body weights; however, Wilsson and Sundgren [1997, 1998b] in studies carried out in Swedish Dog Training Centre (SDTC) and related to inheritance of behavioral traits at newly born puppies, reported the change of their behavior when bedding in the parturition boxes was replaced (from thick cardboard into soft isolating blanket). According to the opinion of SDTC staff, the maintenance puppy rearing conditions improved. Puppies that were remained on soft blanket, slept for a longer time, were less active, and less barked. Nevertheless, such behavior change was assumed as negative, because of the lack of early puppy maintenance, i.e. early stimulation by means of exposure to stress-invoking factors, which in turn exerted a sensitivity towards physical and mental stresses of adult dogs [Wilsson and Sundgren 1998b]. Such short-term impulse causes earlier stimulation of nerve system and in consequence better achievements and faster development of an animal. The technique is applied in numerous services in USA as „Bio-Sensor” program [Battaglia 2007]. Welker [1959] reported that newly born puppies reared under cooler conditions (+15°C) were more active, showed greater vocalization, and greater touching sensitivity as compared to those kept in warmer surroundings. Higher air temperatures may cause the mother's

discomfort, which makes that it spends less time with its puppies and results in their behavior and body dimensions [Wilsson and Sundgren 1998b]. Whether puppies reared in kennel have assured with a contact to people, breeder's family, and new stimuli, is dependent only on the breeder.

CONCLUSIONS

1. Mean value of massiveness index was higher at females, while average value of compactness index was higher at males, although the differences were not statistically significant.

2. The highest level of massiveness index was recorded for puppies born and reared in „house/kennel” system, whereas the lowest – in „house” maintenance system; the differences were highly significant. Results related to compactness index were similar.

3. No significant correlation between massiveness and compactness indices vs. domination tests results (PAT 3, PAT 4, and PAT 5), was observed.

4. No significant correlations between massiveness and compactness indices vs. final results from PAT tests, were found.

5. Comparison of body dimensions of puppies from different litters and the same mother expressed as the massiveness index revealed statistically highly significant differences of average massiveness index value for progeny at almost half of mothers, even within full siblings group.

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Streszczenie. Celem pracy była ocena wpływu sposobu utrzymania szczeniąt na ich wielkość i wielkości szczeniąt na wyniki testów uzdolnień. Materiał do badań stanowiło 259 szczeniąt rasy owczarek niemiecki (124 pieski i 135 suczek) w wieku od 6 do 9 tygodnia życia, pochodzących z 18 hodowli zarejestrowanych w FCI. Szczenięta podzielone zostały na trzy grupy ze względu na system utrzymania. Przeprowadzono pomiary zoometryczne i na ich podstawie wyliczono indeks masywności i indeks zwięzłości. Jako metodę testowania szczeniąt wybrano zmodyfikowany test PAT (Puppy Aptitude Test). Analizie poddano wymiary ciała szczeniąt wyrażone indeksem masywności i indeksem zwięzłości w zależności od płci oraz sposobu utrzymania szczeniąt. Użyto analizy wariancji, a istotność różnic weryfikowano testem Duncana. Obliczono korelacje między indeksem masywności i zwięzłości a testami dominacyjnymi i końcowymi wynikami testu PAT. Porównano też średnie wartości indeksu masywności miotów pochodzących od tej samej matki za pomocą jednoczynnikowej analizy wariancji metodą najmniejszych kwadratów (LSM) programu statystycznego SAS. Średnia wartość indeksu masywności była większa u suczek, natomiast średnia wartość indeksu zwięzłości była większa u piesków, nie były to jednak różnice statystycznie istotne. Porównując sposoby utrzymania szczeniąt, największą wartość zarówno indeksu masywności, jak i zwięzłości stwierdzono u szczeniąt urodzonych w domu hodowcy i w wieku 4–5 tygodni przeniesionych do kojca, a najmniejszą – w grupie utrzymania „dom” i były to różnice statystycznie wysoko istotne. Nie znaleziono istotnych korelacji pomiędzy indeksem masywności i zwięzłości a wynikami testów dominacyjnych oraz końcowymi wynikami testów PAT. Porównując wymiary ciała szczeniąt z różnych miotów od tej samej matki wyrażone indeksem masywności, stwierdzono statystycznie wysoko istotne różnice w średniej wartości indeksu masywności potomstwa u prawie połowy matek, nawet w obrębie pełnego rodzeństwa.

Słowa kluczowe: owczarek niemiecki, szczenięta, indeks masywności, indeks zwięzłości, zmodyfikowany test PAT