PREDICTING
ADULT WITHER HEIGHTS

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Jean Dills' (Picadilly) predictions of development patterns in Beagles *(SBQ 1995, 2001, 2007, 2013 and at www.showbeaglequarterlymagazine.com)* have been and remain quite useful to breeders in evaluating and selecting their future show dogs. One of her conclusions was that doubling wither measurements at 6 1/2 weeks predicts a dog's eventual adult height. The late Tony and Judy Musladin (The Whims) were able to accurately estimate a puppy's eventual height via weight measurements each week from birth to a few months. Vicki and I (BeaglesBay) found the above methods to have validity but we wanted to try to improve upon their accuracy with the use of some very basic statistical methods by observing two dozen or so of our Beagles from birth to adulthood.

Our data showed that, while measurements around six or seven weeks had some predictive validity, the older the puppy is when the measurements are taken, the more accurate the predictions will be. We also found that, while it is easier to weigh puppies than it is to measure their wither heights, height measurements are move powerful predictors than weight measurements. Weight is affected by length of back and leg, degree of bone, spring of rib, skull size and so on. In our dogs, the weight-based equations over estimate the heights for substantial pups. Some of our data for predicting height begins at two months and some at five weeks since we did not start taking wither measurements at five weeks from the very beginning.

Two methods of prediction are presented – regression equations and cutoff scores. Listed next are some regression equations that we have been using. From birth to eight weeks the formulas are based on weight. From two to eleven months they are based on height. We did examine dam's height, sire's height and a host of other variables, but the only factor that aided in wither predictions was gender. Thus, the sex of the dog is included in the regression equations. (See Table 1.)

These regression tables are meant to predict exact height, not just whether the dog will be over 13 or 15 inches. For those of you not familiar with regression equations, they are easy to use once you try a couple. Let's take the first equation, "Adult height = 11.28 - (0.81 x Gender) + (4.57 x weight at birth)," and use the information from our bitch, Sara. Sara's birth weight was 0.547 pounds (or 8.75 ounces divided by 16 ounces). So, we take the constant, 11.28 and subtract the

indicated 0.81 because she is a girl. Boys do not get this subtraction. The result is 10.47. Now we multiply her birth weight, 0.547 by the indicated 4.57 which equals 2.5. Finally, we add 2.5 to our first result of 10. 47 which equals 12.97 inches; her predicted adult height. From her birth weight, Sara was predicted to be under 13 inches using this weight-based equation. However, by two months, using her wither height instead of her weight, she was predicted to be 12.5 inches. Today, she is 12.25 inches.

As Table 2 and Table 3 show, we also use cutoff scores to predict whether a dog will be under or over 13 inches. We did not have any dogs go over 15 inches, and therefore do not have meaningful cutoff scores for 15 inches. We find Table 3 most useful since we can check a dog's progression any day of any week or month. *(Table 3 is not shown here.)*

You should know that, while the regression equations and cutoff scores improve our ability to predict, they are by no means perfect. We use them for more information as we evaluate a dog. If we have one that is slightly over at three months but a very nice dog, we may give the dog more time. But, by five months, if he is still over (13 inches) we may be willing to conclude that he is very likely a fifteen and make our decisions accordingly.

With respect to predicting eventual adult size by weight or height measurements of puppies, there is no doubt the data have validity. The question is: Are the data useful or helpful? If a puppy's height at seven weeks is moderately correlated with its eventual adult height (e.g. r=0.55), the amount of variance

PREDICTING HEIGHT

explained by that association is about 30% (.55x.55). This means 70% of the variance is accounted for by other factors such as nutrition, health and other unmeasured variables (e.g., genes). In other word, these cutoff scores give us more information than if we did not have them but they are imperfect and do not predict all cases. As the puppy gets to be four months and certainly six months old the predictions are far more reliable but still do not account for 100% of the variance. Thus, there will still be exceptions to the predictions. It is not surprising to hear from those who expect or need a high degree of precision that "the predictions do not work" because they do not hold true in all cases. While not surprising, this conclusion is not accurate. This is like saying that predicting one will get 25% red and whites in a litter from a non-homozygous tri sire and a non-homozygous tri dam does not work because the actual litter yielded six tris which statistically will happen 3% of the time in a litter of six."

EDITOR'S NOTE:

David and Vicki Phillips, formerly BeaglesBay Kennels, have retired from breeding in the years since the first publication of the preceding article, but it has remained useful for many of us. For me, most times his predictions have been pretty close, particularly in terms of "is it a 13 or a 15?" Since the Phillips' concentrated largely on breeding 13 inch Beagles, it has been most accurate for the little ones in my own kennel. David provided much more information than there was room to publish, specifically, Table 3, which offers cut-off heights to remain 13 inches at adulthood for just about every day of a puppy's early life.

I also took some license with the Regression Equations, changing the terminology slightly to make it what I hope is clear to the mathmatically challenged Beagler such as I! I do not think the end result will be affected, and I hope that David will forgive my fiddling around with his hard-gathered data.

Table 1. Regression Equations

Weight Based Prediction Equations:

W-0. Weight at Birth — Predicted Adult Height $= 11.28 - (.81 \times \text{gender}) + (4.57 \times \text{wgt.})$

W-1. Weight at 1 wk — Predicted Adult Height $= 11.85 - (1.17 \times \text{gender}) + (2.12 \times \text{wgt.})$

W-2. Weight at 2 wks — Predicted Adult Height $= 11.32 - (1.07 \times \text{gender}) + (1.64 \times \text{wgt.})$

W-3. Weight at 3 wks — Predicted Adult Height $= 11.27 - (1.09 \times \text{gender}) + (1.19 \times \text{wgt.})$

W-4. Weight at 4 wks — Predicted Adult Height $= 10.73 - (1.10 \times \text{gender}) + (1.12 \times \text{wgt.})$

W-5. Weight at 5 wks — Predicted Adult Height $= 11.96 - (.88 \times \text{gender}) + (0.83 \times \text{wgt.})$

W-6. Weight at 6 wks — Predicted Adult Height $= 9.96 - (.67 \times \text{gender}) + (0.90 \times \text{wgt.})$

W-7. Weight at 7 wks — Predicted Adult Height $= 12.36 - (.29 \times \text{gender}) + (0.16 \times \text{wgt.})$

W-8. Weight at 8 wks — Predicted Adult Height $= 10.80 - (.42 \times \text{gender}) + (0.48 \times \text{wgt.})$

Height Based Prediction Equations:

H-2. Height at 2 mos. — Predicted Adult Height $= 4.14 - (0.40 \times \text{gender}) + (1.12 \times \text{hgt.})$

H-3. Height at 3 mos. — Predicted Adult Height $= 6.23 - (0.22 \times \text{gender}) + (0.73 \times \text{hgt.})$

H-4. Height at 4 mos. — Predicted Adult Height $= 2.17 - (0.24 \times \text{gender}) + (1.03 \times \text{hgt.})$

H-5. Height at 5 mos. — Predicted Adult Height $= 3.22 - (0.12 \times \text{gender}) + (0.85 \times \text{hgt.})$

H-6. Height at 6 mos. — Predicted Adult Height $= 2.16 - (0.25 \times \text{gender}) + (0.91 \times \text{hgt.})$

H-7. Height at 7 mos. — Predicted Adult Height $= 1.63 - (0.03 \times \text{gender}) + (0.90 \times \text{hgt.})$

H-8. Height at 8 mos. — Predicted Adult Height $= 0.83 - (0.06 \times \text{gender}) + (0.96 \times \text{hgt.})$

H-9. Height at 9 mos. — Predicted Adult Height $= 1.66 - (0.11 \times \text{gender}) + (0.89 \times \text{hgt.})$

H-10. Height at 10 mos. — Predicted Adult Height $= 1.78 - (0.03 \times \text{gender}) + (0.87 \times \text{hgt.})$

H-11. Height at 11 mos. — Predicted Adult Height $= 1.44 - (0.13 \times \text{gender}) + (0.90 \times \text{hgt.})$

DEFINITIONS: Gender (1 = female, 0 = male.) **Weight** is measured in pounds expressed in decimal figures rounded to the nearest 1000th. (e.g. 1 lb. 3 oz. = 1.188 lbs.) We measure quarter ounces for the first week; thereafter we tally to the closest full ounce. **Height** is measured in inches expressed in decimal figures rounded to the nearest 1000th. (e.g. 6 3/8 inches = 6.375.) We measure to the nearest eighth of an inch.

Table 2. Wither 13-inch Cutoff Heights
Weekly and Monthly Heights in Inches

Age	Max. Hgt. Males	Max. Hgt. Females
Five Weeks	5.875	6.250
Six Weeks	6.625	6.875
Seven Weeks	7.125	7.375
Eight Weeks	7.625	7.750
Two Months	7.875	8.250
Three Months	9.500	9.125
Four Months	10.50	10.625
Five Months	11.625	11.50
Six Months	12.125	12.00
Seven Months	12.50	12.50
Eight Months	12.625	12.50
Nine Months	12.75	12.875
Ten Months	12.75	13.00
Eleven Months	12.75	13.00
Twelve Months	12.875	13.00

Readers should also note that Alice Cancikova of the Czech Republic is currently writing a thesis based on a similar set of criteria and has gathered data from a large variety of breeders' stock worldwide. We hope to publish that thesis which will reveal, we hope, trends, percentages, and overall results from a larger gene pool than just one kennel of largely related animals, perhaps adding to the toolbox that much desired key to predicting adult height in Beagles.