# Correlation and regression between age and body weight on semen quality of Limousin bulls in Artificial Insemination Center, Lembang, West Java

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## ABSTRACT

This research aimed to determine the correlation and to find the best regression model for predicting semen quality (semen volume, individual motility, and sperm concentration) based on age and body weight in Limousin bulls. This research was conducted in December 2019 in Artificial Insemination Center, Lembang, West Java. The method used was a survey with census data collection, namely all Limousin bulls with semen collected were used in this study. The data were analyzed for correlation and simple and multiple regression using R program. The results showed that the average of age, body weight, semen volume, individual motility and sperm concentration were 58.36 ± 40.19 months, 807.12 ± 91.59 kg, 5.86 ± 1.31 ml, 67.59 ± 4.11%, and 1006.23 ± 145.28 million/ml, respectively. Age with semen volume, body weight with semen volume, and combination of age and body weight with semen volume, had a medium positive correlation ($P<0.05$), with a correlation coefficient of 0.52, 0.58 and 0.58, respectively. The regression model with the highest coeficient of determination value ($R^2$) was between body weight and semen volume with regression equation of $\hat{Y}$ = -0.8129 + 0.008269X and of $R^2$ = 0.34. In conclusion, semen volume of Limousin bull could be estimated using their age and body weight, while individual motility and sperm concentration might not be able to be estimated using their age and body weight.

Keywords: Age, Body weight, Correlation, Individual motility, Semen volume, Sperm concentration

## Introduction

Indonesia population increases from year to year which is directly proportional to the increase in the need for animal protein which the community must fulfill to meet nutritional needs. Meat is a source of animal protein derived from livestock, and is an important commodity for Indonesian society. This commodity also has an important role in the economic sector because it can be developed by small and large-scale communities. The availability of national meat has not been able to meet all the needs of the Indonesian people. This occurs

because the increase in the population of cattle in Indonesia is still not optimal, the average growth of beef cattle from 2017 to 2018 is 3.7% (Ministry of Agriculture, 2018). In addition, the increase in cattle population is only concentrated in some provinces such as East Java, Lampung and West Nusa Tenggara.

Limousin cattle is beef cattle that has great potential to be developed and is in great demand by breeders because of its good meat producer. One of the ways to increase superior cattle population in Indonesia is by using reproductive technology for example artificial insemination (AI). AI is an applicable reproductive technology in increasing livestock populations and improving the genetic quality of the livestock so as to produce good quality offspring. Artificial insemination technology makes a superior male potential optimized and its semen can be distributed throughout the region in Indonesia.

Factors that influence the success rate of AI include the quality of inseminated semen. According to Susilawati *et al.* (1993), semen quality can be influenced by several factors, namely breed of cattle, age, body weight, feed, temperature, season and frequency of ejaculation or semen collection. Superior beef cattle are closely related to high body weight. Likewise, body weight is closely related to the age of the cattle. Thus, it is very important to know the relationship between body weight and age of cattle on semen quality. That is why superior bull with good semen quality is important in AI.

Selection of male Limousin cattle to become superior bulls and produce good quality of semen needs to be initiated from selection based on age and body weight. Research on relationship between age and body weight on semen quality was limited. Previous study indicated that semen volume is affected by age (Dewi *et al.*, 2012 in male Jawa cattle; Aminasari (2009) in Limousin cattle in Singosari Artificial Insemination Center). Other researcher reported that there was a relationship between body weight and semen volume in post pubertal Frisian Holstein cattle (Devkota *et al.,* 2008), in Bali cattle (Nugraha *et al.,* 2019; Indriastuti *et al.,* 2020) and in Simmental cattle (Adhyatma *et al.,* 2012). Furthermore, Prastowo

*et al.* (2018), Adhyatma *et al.* (2012), Juliani (2013) and Nugraha *et al.* (2019) reported that age and body weight did not significantly affect (P>0.05) on individual motility and sperm concentration in Bali catlle and Friesian Holstein cattle. Research on the relationship and estimation of semen quality of Limousin bulls based on age and body weight was limited in Artificial Insemination Center, Lembang, West Java. Therefore, the current research aimed to determine the correlation and regression between age and body weight on semen quality (semen volume, sperm concentration and individual motility) of Limousin bulls in the Artificial Insemination Center, Lembang, West Java.

## Materials and Methods

This research was conducted in December 2019 at the Artificial Insemination Center (AIC) Lembang, West Java. The research materials used were primary and secondary data of 47 Limousin bulls at the AIC. The tools used in this study included writing instruments, artificial vagina, microscope and SDM5 photometer.

Survey method was used in this research with data collection using census method, namely all Limousin bulls semen that collected in AIC Lembang were used. The data used consisted of primary data and secondary data. Primary data were obtained by collecting semen and analyzing the quality of semen from Limousin bulls directly in AIC. Secondary data were data obtained from data recording of Limousin bulls in AIC from 2017-2018. The variables observed in this study were age (months), body weight (kg), semen volume (ml), individual motility (%), and sperm concentration (million/ml) of Limousin bulls. The data obtained were analyzed for simple and multiple correlation and regression with the help of the R program (Dakhlan, 2019; R Core Team, 2020), where age and body weight as independent variables while semen volume, individual motility, and sperm concentration as dependent variables.

Pearson's correlation was used to evaluate the relationship between dependent and independent variables using the R program.

## Results and Discussion

### Age, body Weight and semen quality of Limousin bull

The average of age, body weight, and quality of semen obtained including semen volume, individual motility, and sperm concentration are presented in Table 1. The average age of Limousin bulls in AIC Lembang was 58.36 ± 40.19 months or about 6 years with median value of 37.15 months, the smallest data (minimum) was 30.56 months and the largest data (maximum) was 161.12 months. The ages of bulls in AIC Lembang ranged from 2.5 to 13 years. Out of the 47 Limousin bulls in AIC Lembang, there were 20 bulls were born in 2016 or around 3 years old. The average of body weight of Limousin bulls at AIC Lembang was heavy enough ( 807.12 ± 91.59 kg), while semen volume was high enough (5.86±1.31 ml), individual motility was enough (67.59%) and sperm concentration was 1006.23 million/ml.

Table 1. Descriptive statistics of age, body weight, semen volume, individual motility and sperm concentration of Limousin bulls in AIC Lembang

| Variable | Mean | Standard deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|
| Age (month) | 58.36 | 40.19 | 37.15 | 30.56 | 161.12 |
| Body weight (Kg) | 807.12 | 91.59 | 761.81 | 701.00 | 1027.37 |
| Semen volume (ml) | 5.86 | 1.31 | 5.87 | 4.19 | 10.44 |
| Individual motility (%) | 67.59 | 4.11 | 68.75 | 54.38 | 71.56 |
| Sperm concentration (million/ml) | 1006.23 | 145.28 | 1028.50 | 678.81 | 1286.25 |

Semen volume in this research are in accordance with the report of Toelihere (1993), that the volume of bull semen ranged from 5-8 ml. The results of this study were lower than those reported by Muada *et al.* (2017) that the volume of Limousin cattle was 7.2 ml. The

volume of semen produced by the bulls can vary depending on the age of bull, breed of animal, size and weight of animal, and frequency of semen collection (Partodihardjo, 1980).

The results of individual motility of this study were categorized as good because the mean value of individual motility was more than 40%. This is in accordance with Toelihere's (1993) opinion that the motility of bovine spermatozoa below 40% indicates poor semen values and is often associated with infertility. Most fertile bulls have 50-80% motile and progressive active spermatozoa. The results of this study were higher than those reported by Muada *et al.* (2017) that the average individual motility of Limousin bulls in AIC Lembang was 59.29 ± 13.87%. Rahmawati *et al.* (2015) reported that the average individual motility of Limousin cattle was 63.81 ± 6.18%. The results of this study were also higher when compared to the result reported by Sugiarto *et al.* (2014) that the individual motility of Limousin cattle was 58 ± 2.74%.

The results of sperm concentration of this study are classified as good according to Campbell *et al.* (2003) stated that the spermatozoa concentration in adult bulls ranged from 800-1200 million/ml of semen. A bull is considered satisfactory if he has a spermatozoa concentration more than 500 million/ml with a bovine sperm motility value between 70-80% (Hafez, 1987). The results of this study were lower than those reported by Nugraha *et al.* (2012) stated that the sperm concentration of Limousin cattle in AIC Lembang was 1721.20 ± 332.60 million/ml. The result of his study was also lower than the study reported by Rahmawati *et al.* (2015) that the sperm concentration of Limousin cattle in AIC Lembang was 1,132.60 ± 177.46 million/ml.

**Correlation between age and body weight on semen quality of Limousin bull**

Correlation between age, body weight and combination of age and body weight on semen quality of Limousin bull are presented in Table 2. Table 2 shows that there were significant correlations between age and semen volume, body weight and semen volume, and combination of age and body weight on semen volume; 0.52, 0.58, and 0.58, respectively.

However, there was no significant (P>0.05) correlation between age, body weight and combination of age and body weight on semen quality (individual motility and sperm concentration).

Table 2. Correlation between age and body weight on semen quality of Limousin bull

| Correlation between variables | Correlation coefficient (r) | P-value |
|---|---|---|
| Semen volume ~ age | 0.51980 | 0.00324* |
| Individual motility ~ age | 0.08132 | 0.123600 |
| Sperm concentration ~ age | -0.10797 | 0.570100 |
| Semen volume ~ body weight | 0.57960 | 0.00079* |
| Individual motility ~ body weight | -0.23620 | 0.280900 |
| Sperm concentration ~ body weight | -0.12076 | 0.525000 |
| Semen volume ~ age + body weight | 0.57959 | 0.00079* |
| Individual motility ~ age + body weight | -0.25997 | 0.165300 |
| Sperm concentration ~ age + body weight | -0.12060 | 0.525300 |

Note: * = Significant level at 5% (P<0.05)

The results of this study are consistent with the research reported by Melita *et al.* (2014) in male Aceh cattle that age has a significant effect on semen volume and sperm concentration. The results of this study are also in line with the result reported by Dewi *et al.* (2012) in male Jawa cattle and by Aminasari (2009) in Limousin cattle, that age played an important role in the semen volume that is ejaculated. Adult cattle produced a higher semen volume than young cattle. The low volume of semen in young cattle is due to the fact that these animals are still experiencing development in their reproductive organs. When the livestock reach maturity, the quality of the semen produced will be better because the primary and secondary reproductive organs have been optimal. However, this result of this study differed from the study of Prasetyo *et al.* (2020) who compared 3 Ongole cattle aged 1.5 years and 3 Ongole cattle aged 3 years that different age did not affect on semen volume (4.55 ± 1.00 at 1.5 years and 5.41 ± 0.96 at 3 years).

Susilawati *et al.* (1993) stated that the quality and quantity of semen is influenced by body weight. The results of this study are in line with the research of Devkota *et al.* (2008) which reported that there was a relationship between body weight and volume (r = 0.282) in

post pubertal Frisian Holstein cattle. This result is supported by the result reported by Nugraha *et al.* (2019) that Bali cattle body weight has a significant effect (P <0.05) on semen volume. Adhyatma *et al.* (2012) reported that there was a significant effect (P <0.01) of body weight on semen volume of Simmental cattle.

The results shown in Table 2 indicated that if there is an increase in age and body weight of Limousin cattle, it will not be followed by an increase in the individual motility of spermatozoa. This study is in accordance with the study reported by Prastowo *et al.* (2018) that age did not significantly affect (P> 0.05) on individual motility in Bali cattle at 4 and 7 year age groups. The results of this study are also in accordance with the result reported by Adhyatma *et al.* (2012) that male body weight did not affect on individual motility of spermatozoa (P> 0.05).

The results of this study (Table 2) indicated that if the age of Limousin bulls increase, it is not followed by an increase in sperm concentration. The results of this study are in accordance with the result reported by Prastowo *et al.* (2018) that correlation between age and sperm concentration in Bali cattle aged 4 and 7 years was not significant (P>0.05). Juliani (2013) reported that there was no significant correlation (P> 0.05) of age with the sperm concentration of FH bulls in AIC Lembang with a correlation coefficient of 0.094. Nonsignificant correlation between age and sperm concentration in this study presumably because the Limousin bulls in AIC Lembang have entered the adult body phase or were not in the growth phase so that the increase in the number of seminiferous tubules tended not to increase. Wahyuningsih (2013) explained that young cattle of around 1.5 years which is undergoing a growth phase (puberty) produces low sperm quality because it is still developing in their reproductive organs.

The results of this study indicated that if there was an increase in body weight, it was not followed by an increase in the sperm concentration of Limousin bull in AIC Lembang. The results of this study are in accordance with the result reported by Nugraha *et al.* (2019) that body weight was not significant (P>0.05) in relation to the spermatozoa concentration of Bali

cattle with a correlation coefficient of 0.046. This result is also in accordance with what Juliani (2013) explained that there is no significant correlation (P>0.05) between body weight and sperm concentration of FH cattle in AIC Lembang with a correlation coefficient of 0.039. The absence of a correlation between body weight and sperm concentration of Limousin cattle in AIC Lembang is thought to be due to factors of livestock health, environment, feed and frequency of semen collection.

**Regression equations between age and body weight on semen quality of Limousin bulls**

The regression equations between variables in this study are presented in Table 3. The results of this study indicated that the regression between semen volume and body weight has the highest accuracy, although the coefficient of determination was still in the low category (0.34). This indicated that the estimation of semen volume can be carried out using body weight using regression equation of $\hat{Y}$ = -0.8129 + 0.008269 X. This is supported by the correlation between these two variables (0.58) which is significant (P<0.01). Combining age and body weight variables to estimate the volume of semen did not increase the accuracy of the estimation of semen volume ($R^2$ = 0.34). Estimation of semen volume using age produced a regression equation with lower accuracy ($R^2$ = 0.27) compared to using body weight.

The result of this study showed that estimation of semen quality (individual motility and sperm concentration) cannot use age, body weight or a combination of both because of low accuracy. This can be seen from the low value of determination coefficient (0.01-0.07). This can be seen also from the low and insignificant correlation value (-0.26-0.08).

Table 4. Regression equations of age and body weight with semen quality of Limousin bulls in AIC Lembang along with their determination coefficient ($R^2$)

| Variables | Regression equation | $R^2$ |
|---|---|---|
| Semen volume ~ age | $\hat{Y}$ = 4.877 + 0.016898 $X_1$ | 0.27019 |
| Individual motility ~ age | $\hat{Y}$ = 69.30841 – 0.02939 $X_1$ | 0.00661 |
| Sperm concentration ~ age | $\hat{Y}$ = 1029.006 – 0.3903 $X_1$ | 0.01166 |
| Semen volume ~ body weight | $\hat{Y}$ = -0.8129 + 0.008269 $X_2$ | 0.33594 |
| Individual motility ~ body weight | $\hat{Y}$ = 76.1419 – 0.010589 $X_2$ | 0.05579 |

| | | |
|---|---|---|
| Sperm concentration ~ body weight | $\hat{Y} = 1160.845 – 0.1916\ X_2$ | 0.01458 |
| Semen volume ~ age + body weight | $\hat{Y} = -0.081851 + 0.002984\ X_1 + 0.00715\ X_2$ | 0.33592 |
| Individual motility ~ age + body weight | $\hat{Y} = 68.2525 – 0.032319\ X_1 + 0.001522\ X_2$ | 0.06758 |
| Sperm concentration ~ age + body weight | $\hat{Y} = 1145.047 – 0.0647\ X_1 – 0.16731\ X_2$ | 0.01454 |

## Conclusion

In conclusion, there were significant correlations between age, body weight and combination of age and body weight on semen volume. This suggests that semen volume can be estimated by age and body weight of Limousin bull. The relationship between age, body weight and combination between age and body weight on individual motility and sperm concentration was not close enough so that the regression equation between the variables might not be used as accurate estimator. Suggestion for future study in relation to the result of this study that scrotal circumference should be included as predictor for semen quality, because scrotal circumference might relate directly to semen quality.

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