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The pattern of thoroughbred growth is affected by a foal's birthdate

Andrea Kocher, W. Burton Staniar*

The Pennsylvania State University, 324 Henning Building, University Park, PA 16802, USA

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ABSTRACT

Understanding equine growth patterns is important when balancing the economic and perceived athletic benefits of large size and rapid growth against the potential associated risk of skeletal abnormalities. Existing Thoroughbred growth data indicate that the long and short term patterns of growth are different based on when a foal is born, however this difference has not previously been quantified for body weight (BW) and withers height (WH). Therefore, the objectives of this study were to (1) accurately and precisely characterize the short term patterns of equine growth separated from the long term sigmoidal pattern and (2) investigate the influence of the day of year on which the foal was born (DOB), age, and day of year (DOY) on the short term pattern of growth. Data for this study consisted of 35,044 BW measurements and 25,987 WH measurements from 2184 horses. Data were collected from 1977 to 2007 on farms located in the United Kingdom, Ireland and the United States. The BW and WH data were examined as changes over age or the DOY on which the measurements were taken. The data were further categorized based on DOB. The Richards sigmoid growth model was fit to the data and percentiles for BW and WH over age described. The long term pattern of growth was similar to that in previous studies of Thoroughbreds. The DOB influenced the short term patterns of BW and WH growth over time, such that at specific ages or on particular DOY foals born in the first 60 days of the year will be growing differently than those born between DOY 91 to 150. The data further indicate that early growth is more closely associated with age, while later growth may be more affected by environment. This study adds to the rich database of Thoroughbred growth data already available and adds significant detail regarding WH development and specific characteristics of short term growth. The data and results presented here should be useful to those managing growing stock and interested in more precisely moderating the pattern of growth. The study also raises questions regarding how the patterns of growth can be controlled and whether certain patterns may be more beneficial or detrimental than others regarding the future health and performance of the horse.

1. Introduction

The pattern of early development is an important determinant in the future athletic potential of the horse. In all breeds of horse, there is a great deal of attention paid to the developmental period from birth to approximately two years of age (Dawson et al., 1945; Greene et al., 2005; Santos et al., 2006). By two years of age it is estimated that 90% of the mature body weight (BW) and 95% of the mature withers height (WH) may have been reached (Willoughby, 1975; Staniar et al., 2005). Due to the amount of development that occurs during this period, nutrition and management changes can have a significant positive

* Corresponding author. Tel.: +1 814 865 0698; fax: +1 814 863 6042.
E-mail addresses: wstaniar@psu.edu, wstaniar@gmail.com (W. Burton Staniar).

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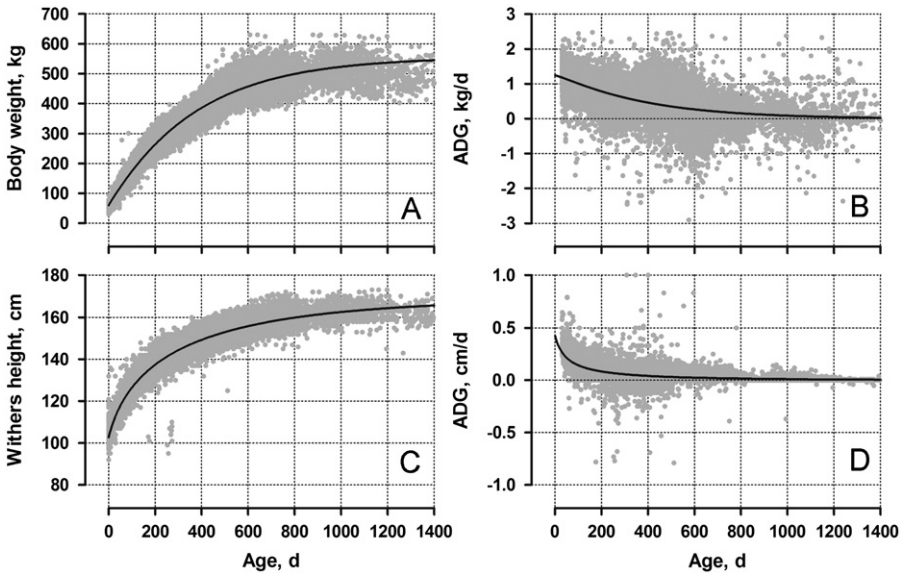

Fig. 1. The individual body weight and withers height data points (Panels A and C) with associated average daily gains (Panels B and D) on an age basis. The dark lines represent the Richards prediction curves.

or negative impact on the pattern of growth and potentially the future health and performance of the horse.

Some have suggested that genetic selection and management protocols utilized in raising young horses are sometimes aimed at supporting precocious growth due to the association of size with athletic prowess (Kronfeld, 2003; Pagan, 2009). Some research in horses, strengthened by work in other mammalian species supports an association between rapid growth and skeletal abnormalities (Hill, 1990; Pagan and Jackson, 1996; van Weeren et al., 1999). Selection for growth is likely to contribute to the heritability of skeletal abnormalities such as osteochondrosis. Developmental orthopedic disease (DOD) is a major contributor to loss of athletic performance in the equine industry (Jeffcott, 1996; Rossdale, 1999). Heritability of osteochondrosis has been estimated from 23% to 52% in Scandanavian trotters (Grondahl and Dolvik, 1993; Philipsson et al., 1993). Yet, no mode of inheritance has been identified; leaving the current focus on manageable environmental factors, such as nutrition and controlled exercise, which may be necessary in combination with genetic predisposition to optimize skeletal health (Torre, 1999).

Mammalian growth is often described using a flexible sigmoid curve (Fitzhugh, 1976). This mathematical representation of growth fits the long term pattern, but does not characterize short term deviations. Further, the accuracy of parameter estimates of the long term curve can be negatively impacted by short term deviations (Staniar et al., 2004b). For those managing horses, the short term deviations in growth may be of greater interest as they often represent places in time when management changes have the greatest potential to impact growth. While there are a number of examples of studies of equine growth that characterize average daily gain (ADG), we could find no examples that attempt to remove the long term pattern of growth for a more direct analysis of short term patterns (Jelan et al., 1996; Morel et al., 2007; Onoda et al., 2011).

Thoroughbred foals in the northern hemisphere are generally born between January 1st and sometime near the beginning of June. There are a few studies that have separated foals based on the time of year when they were born and commented on differences in the patterns of growth (Goater et al., 1983; Pagan et al., 1996). However, a more detailed characterization would facilitate precise changes to feeding and management, as well as enable other researchers to better design trials aimed at controlling growth. The hypothesis of this study is that the day of year on which the foal was born (DOB) influences the short term patterns of growth in Thoroughbreds. The objectives of this study were to (1) accurately and precisely characterize the short term patterns of equine growth separated from the long term sigmoidal pattern and (2) investigate the influence of DOB, age, and day of year (DOY) on the short term pattern of growth.

2. Materials and methods

The growth measurements of 2184 Thoroughbred horses were used for analysis. Data were initially filtered to remove 208 BWs and 17 WHs representing animals greater than 10 years of age. Collectively there were 35,044 BW and 25,987 WH measurements, of which 99% of both were represented by measurements taken up to 4 years of age (Fig. 1). Percentiles for both BW and WH through two years of age were calculated and presented in Fig. 2. The data were collected from 1977 to 2007 from 34 locations in the United Kingdom, Ireland and the United States (Kentucky and Virginia). The majority (97%) of the data came from 7 of these locations that represent the stud farms where foals are raised. There was no additional management information included in the dataset used for this study. Foals over the collection periods were measured at arbitrary times during growth based on individual farm management protocols. Therefore, the age and DOY on which measurements were taken differed