Effects of Change of Body Weight on Racing Time in Thoroughbred Racehorses

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더러브렛 경주마의 체중변화가 주파기록에 미치는 효과

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요 약

본 연구는 한국마사회로부터 수집한 8,197두의 경주기록 총 155,656개를 이용하여 더러브렛 경주마의 체중변화가 주파기록에 미치는 효과를 구명하기 위하여 수행되었다. 국내 더러브렛 경주마의 평균 체중은 449 kg 이었으며, 거세말, 수말과 암말의 평균 체중은 각각 460 kg, 454 kg과 441 kg으로 수말의 체중이 가장 높게 나타났다. 암말의 경우 체중의 감소는 3월, 4월과 5월사이에 가장 크게 나타나며, 수말과 거세마의 경우 5월, 6월과 7월에 체중의 감소가 가장 크게 나타났다. 전반적으로 경주마의 체중은 봄과 여름에 감소하며, 가을과 겨울에 증가하는 현상을 나타내었다. 주파기록에 대한 유전력과 반복력은 각각 0.237과 0.525였으며, 체중에 대한 유전력은 0.612로 추정되었다. 직전 경주 대비 체중의 변화가 ±10 kg 이상일 때 주파기록은 현저히 증가하였으며, 직전 경주 대비 체중의 변화가 ±20 kg인 경우는 ±5 kg인 경우와 비교했을 때 주파기록의 차이가 0.3초 정도 증가하였다. 체중의 변화가 체중에 비례하여 ±0.5% 정도 변화하였을 때 주파기록이 가장 우수하였으며, 체중의 변화가 체중 대비 ±2.5% 이상이 되면 경주능력은 현저히 감소하였다.

(**Key words :** Thoroughbred, Heritability, Repeatability, Change of body weight)

Ⅰ. INTRODUCTION

Since 1920, there has been a remarkable increase in the number of the Thoroughbred racehorses in Korea over the last 85 years. However, because of poor performance of racehorses produced in Korea. Compared with foreign countries, approximately 30% of racehorses in Korea have been imported from abroad. There is a great need to establish a breeding scheme for improving racehorses in Korea, and a great potential to produce the racehorses comparable to the foreign horses. The interest in establishing the better breeding program for racehorses in Korea is greater than that of the past, since the beginning of the global free trade era. Though the racehorses are expected to maintain optimal weight for outstanding performance in races, body weights of racehorses change time after time. Excessive decrease or increase in weight

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due to improper management, natural conditions, strangles, inappetence or lack of exercise may significantly affect racing ability. And also, performance of racehorses is affected by seasonal conditions and maintenance of consistent racehorse weight is very important in the adjustment for optimal conditions. Since the effects of change of body weight on racing time have been hardly studied, our study intended to clarify the effects of racehorse weight changes on racing records.

Ⅱ. MATERIALS AND METHODS

1. DATA

This data used in our study are 155,656 racing records collected from 8,197 racehorses that raced in Gwacheon Horse Racing Park from January, 1994 to December, 2006 provided by Korea Racing Association. The weights of racehorses and the changes of weights were measured before each racing. Racehorse weight change is defined as the comparison between the weight on the date of the racing and the weight right before the race. The distribution and characteristics of the data are shown in Table 1.

2. STATISTICAL METHODS

The variance components for racing time, weight and weight change were estimated using restricted maximum likelihood function (DF-REML; Meyer, 1989), and the 2 single traits analytical models were used for this analysis are as follows.

(1) Racing time (Model I)

$y_{ijklmn} = \mu + d_i + s_j + m_k + c_l + a_m + p_m + e_{ijklmn}$,

where, y_{ijklmn} = racing time, μ = overall mean, d_i = fixed effect of the i^{th} racing distance (i = 1, 2, ⋯, 7), s_j = fixed effect of the j^{th} sex (j = 1, 2, 3), m_k = fixed effect of the k^{th} age (k = 1, 2, ⋯, 6), c_l = fixed effect of the l^{th} contemporary group (l = 1, 2, ⋯, 14,119), a_m = random additive genetic effect of the m^{th} animal (m = 1, 2, ⋯, 15,770), p_m = random permanent environmental effect of the m^{th} animal (m = 1, 2, ⋯, 8,197), and e_{ijklmn} = random residual effect.

(2) Body weight (Model II)

$y_{ijklm} = \mu + s_i + h_j + m_k + a_l + p_l + e_{ijklm}$,

where, y_{ijklmn} = body weight and change of body weight, μ = overall mean, s_i = fixed effect of the i^{th} sex (i = 1, 2, 3), h_j = fixed effect of the j^{th} age (j = 1, 2, ⋯, 6), m_k= fixed effect of the k^{th} racing month (k = 1, 2, ⋯, 12), a_l = additive genetic effect of the l^{th} animal (l = 1, 2, ⋯, 15,770), p_l = permanent environmental effect of the l^{th} animal (l = 1, 2, ⋯, 8,189), and e_{ijklm} = random residual effect.

Ⅲ. RESULTS AND DISCUSSION

1. Data description

The racing records of 1,000 m to 1,400 m, the short-medium distance, took up 65.8%, and the racing records of 1,900 m and 2,000 m mostly run by class 1 were 12.8% of the entire records. The reason the number of records decreased with increase in racing distance was because number of races was fewer than short-medium distance due to decrease in the number of racehorses toward long distance according to winner group system (Park and Lee, 1999).

2. Body weight and change of body weight

As shown in Table 1, gradual increase in average weight with increase in racing distance is due to the fact the that racehorses grew older as distance gets longer due to racehorse winning. The average weight of domestic racehorses was 448.61 kg. Weight changes showed normal distribution

Table 1. Distributional properties for analysis data by racing distance

Racing distance	No. of records	No. of racehorses	Racing time, s[2]	BW[3], Kg	CBW[4], Kg
			Mean ± SD	Mean ± SD	Mean ± SD
1,000 m	29,658	6,919	65.01 ± 1.54	443.28 ± 29.41	−0.40 ± 7.64
1,200 m	37,951	7,001	78.84 ± 1.73	445.85 ± 29.22	−0.02 ± 7.06
1,400 m	34,810	6,071	91.95 ± 1.96	447.81 ± 28.23	0.23 ± 6.64
1,700 m	15,871	4,281	115.95 ± 2.16	450.12 ± 27.68	−0.02 ± 6.38
1,800 m	17,497	3,551	122.64 ± 2.30	453.37 ± 27.36	0.14 ± 6.34
1,900 m	10,008	2,289	129.45 ± 2.33	455.66 ± 26.77	0.02 ± 6.50
2,000 m	9,861	1,709	135.94 ± 2.46	460.02 ± 27.18	0.17 ± 6.31
Overall	155,656	8,197[1]	−	448.61 ± 28.77	−0.01 ± 6.86

[1] Total number of racehorses used across all distance, not the column sum
[2] s = second, [3] BW = body weight, [4] CBW = change of body weight, [5] SD = standard deviation

with mean of 0 kg, where the average was near '0' was because of the increase and decrease between + and - by the seasons, and weight changes were around in between +20 and −20kg. For analysis of variance, weight and weight changes, weight changes were affected mostly by the month of the racing while weights by sex of racehorse.

The average weights of, stallion, gelding, and mare were 460.25 kg, 454.42 kg, and 440.70 kg, respectively. Recently, horse owners and trainers prefer large framed racehorses. Moreover, they believe that dependable weight can help efficient exercise of racing ability. The reason that 2 year-old horses weigh heavier than 3 or 4 year-old horses is because 2 year-old racehorses are unexperienced in race, lose flab during training process after joining the racing field. However, they were shown to gain weight again gradually after 4 year of age (Fig. 1).

As shown in Fig. 2, body weights were significantly affected by the month of the racing, mares were shown to lose weight mostly in between March and May of the breeding season, while stallion and gelding lost weights in between April and July. In general, racehorses showed the tendency to lose weight in spring and summer and gained weight again in fall.

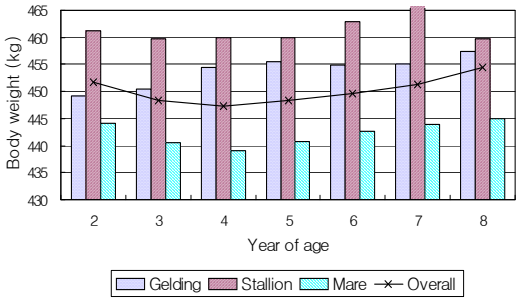

Fig. 1. Means of body weight by age and sex.

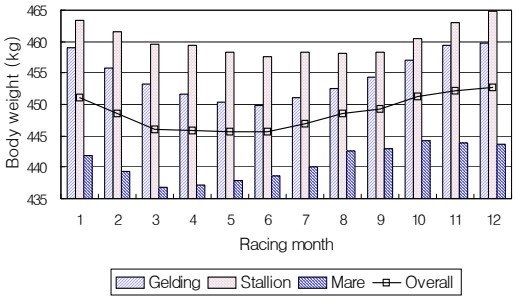

Fig. 2. Relationship between racing month and body weight by sex.

Estimation of the regression coefficients of racing time on weight changes for several distances is provided in Table 2.

3. Heritability and repeatability

Estimation of the variance components for racing records, weights and weight changes, and genetic parameters are provided in Table 3. The estimated heritability and repeatability for racing time were 0.237 and 0.525, respectively, which are quite similar to the results reported in the other studies (Hintz, 1980; Tolley, et al, 1983; Ojala et al, 1987; Buttram et al, 1988; lee and Park, 1996, Park and Lee, 1999), and the estimated heritability and repeatability for body weight were slightly different in genders (Table 4). The estimated heritability and repeatability for body weight from the overall data, shown in Table 3, were 0.612 and 0.914, which were somewhat higher than those from the report of Lee and Park (1996). The reason for such results is possible because the body weight was measured right after joining as racehorse and the data used in this study were the repeated measurement at every racing. However, the heritability for weight change was 0 and such results are concluded to show increase or decrease by environmental factors while genetic factors are not in effect at all.

Table 2. Regression coefficients of change of body weight for racing time by racing distance

Distance	Intercept	Linear	Quadratic	r^2
1,000 m	64.92	−0.0062** ± 0.0016	0.0005** ± 0.0002	0.40
1,200 m	78.78	−0.0109** ± 0.0014	0.0008** ± 0.0001	0.72
1,400 m	91.91	−0.0155** ± 0.0021	0.0007** ± 0.0002	0.65
1,700 m	115.90	−0.0123** ± 0.0026	0.0006* ± 0.0002	0.42
1,800 m	122.59	−0.0130** ± 0.0036	0.0007* ± 0.0003	0.32
1,900 m	129.35	−0.0160** ± 0.0043	0.0014** ± 0.0004	0.41
2,000 m	135.86	−0.0107** ± 0.0026	0.0015** ± 0.0002	0.57

* $P < 0.05$, ** $P < 0.01$

Table 3. Estimates of variance components and genetic parameters for racing time and body weight

Traits	σ^2_a	σ^2_{pe}	σ^2_e	h^2	r
Racing time	0.7788	0.9458	1.5555	0.237± 0.019	0.525
Body Weight	516.1698	254.9858	71.8448	0.612± 0.034	0.914

Table 4. Estimates of variance components and genetic parameters for body weight by gender

Gender	σ^2_a	σ^2_{pe}	σ^2_e	h^2	r
Gelding	405.2471	388.8469	64.2802	0.472± 0.124	0.925
Stallion	479.5555	286.1250	64.5978	0.578± 0.083	0.923
Mare	443.0731	283.1045	72.1661	0.555± 0.051	0.910

4. Effect of change of body weight

It was indicated that when weight change is over ± 10 kg, racing record significantly increased (Fig. 3), and it was shown that with reference to ± 5 kg, if weight increases or decreases by ± 20 kg, racing record increased about over 0.3 seconds. It was particularly notable that in case weight change was 0 kg, indicating weight change was the same as that immediately before racing, racing record increased in comparison with when weight increased or decreased more or less ± 5 kg, and such results indicated that certain degree of weight change in each racing was more beneficial for the management of conditions.

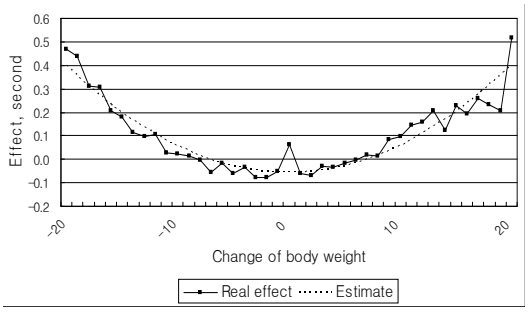

Fig. 3. Effect of change of body weight (kg) for racing time.

However, when racehorse with body weight of 400 kg lost 10 kg and where racehorse with body weight of 500 kg lost 10kg, the following result was not sufficient for explanation, so the effects for racing records were estimated by converting the weight change for each racehorse weight to percentage (Fig. 4).

When weight change was ± 0.5% of the body weight, racing record was the best, and when weight change was over ± 2.5%, racing record notably increased.

It is clear that maintenance of optimal condition is required for a racehorse to accomplish a good performance in racing. Genetic factors are significant in determining racehorse weight.

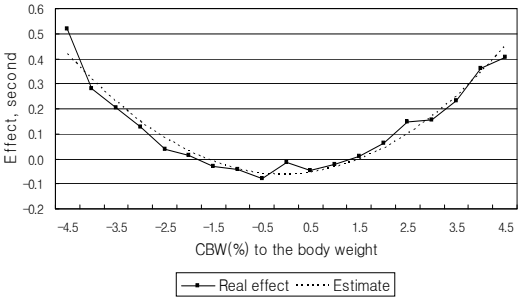

Fig. 4. Effects of percentage of change of body weight (CBW) to the weight for racing time.

However weight change is mostly due to environmental factors rather than genetic factors. Therefore, always to maintain the weight of racehorse properly, management of optimal condition with certain degree of weight change through exercises and specific management suitable for seasonal change are desirable.

Ⅳ. ACKNOWLEDGEMENT

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Ⅴ. ABSTRACT

The objective of this study was to estimate the effects of change in body weight on racing time in Thoroughbred racehorses, using total 8,197 horses and 155,656 racing records collected from Korea Racing Association (KRA). The average body weight of the racehorses was 449 kg, and the average body weights of stallion, gelding and mare were 460 kg, 454 kg and 441 kg, respectively. Body weight of stallion was the greatest. The considerable loss of body weight was observed in March, April and May for mare, and in May, Jun and July for stallion and gelding. Overall, the body weight of the racehorses decreased in spring and summer, and increased in autumn and

winter. The estimated heritability and repeatability for racing time were 0.237 and 0.525, respectively. The heritability for body weight estimated from total records was 0.612. The estimated heritabilities for body weight were 0.472, 0.578 and 0.555 for gelding, stallion and mare, respectively. As the change of body weight was greater than ± 10 kg, the racing time increased significantly. When the body weight changed more than ± 20 kg in comparison to the changes of body weight of ± 5 kg, the racing time increased by 0.3 second. When the change of body weight was ± 0.5% of body weight, the racing time was the best (fastest). When the change of body weight was more than ± 2.5%, racing performance decreased considerably.

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