AN EXAMINATION OF THE CALCIUM AND PHOSPHORUS NUTRITION OF THOROUGHBRED RACEHORSES

I. W. Caple*, J. M. Bourke† and P. G. Ellis‡

SUMMARY: The calcium and phosphorus nutrition of thoroughbred racehorses was assessed by analysis of serum and urine samples collected from 90 horses in 1975 and 139 horses in 1980-81 at racetracks in Melbourne. Horses that were excreting greater than 15 μmole Ca/mosmole and which had a calcium to creatinine clearance ratio greater than 2.5% were considered to have adequate Ca intake. Horses that were excreting greater than 15 μmole P/mosmole and which had a phosphorus to creatinine clearance ratio greater than 4% were considered to have excessive phosphorus intake.

Sixty-percent of the horses sampled had adequate Ca intake, and 44% had excessive intakes of P. Twenty-five percent of the horses were excreting more P in urine than Ca. This would indicate these horses were subjected to nutritional secondary hyperparathyroidism, and horses entered in races by 53 of 99 trainers were in this category.

It may be concluded that a high proportion (40%) of thoroughbred racehorses receive inadequate calcium nutrition while they are fed high-grain diets during racing.

Introduction

The traditional diets of racehorses in Victoria are rich in phosphorus and low in calcium containing about 80% by weight of grain to 20% by weight of chaff, and extremes of 90% to 10% are not uncommon (Bourke 1968). Estimations by weight of chaff, and extremes of 90% to 10% are not uncommon (Bourke 1968). It has been recommended that racehorses in stables should receive supplemental Ca (Bourke 1968).

The absence of readily apparent osteodystrophic conditions might suggest that racehorses do receive adequate Ca supplementation, or that they can tolerate such imbalances. In Victoria, it is not known how much of the lameness seen in racehorses, and the spontaneous fractures occasionally seen in apparently sound horses, can be related to osteomalacia induced by faulty feeding (Bourke 1968). It is known that the feed for racehorses is imported, much of the lameness and fractures seen have been attributed to Ca deficiency (Mason 1980).

This study was undertaken to examine the Ca and P nutrition of thoroughbred racehorses in Victoria. Samples of urine were obtained from horses at racetracks, and their Ca and P nutrition was assessed from the amounts of the minerals being excreted (Caple et al 1982).

Materials and Methods

Urine and serum samples were collected from thoroughbred horses at the Flemington, Sandown, Caulfield and Moonee Valley Racetracks in Melbourne. In 1975, urine samples were collected from 90 horses entered in races by 49 trainers between July and November, and of the horses were sampled up to 4 times during this period. In a 6-week period between November 1980 and January 1981, serum and urine samples were collected from 139 horses entered in races by 99 trainers, and 24 of the horses were sampled up to 4 times. Horses were sampled during routine swabbing either before or after races. The horses included colts, fillies, mares and geldings aged between 3 and 9 years.

Analyses

Urine samples collected in 1975 were analysed for specific gravity, osmolality and Ca and P concentrations. Serum and urine collected in 1980 were also assayed for creatinine to enable the clearance ratios (%Cr) of Ca and P to be calculated (Traver et al 1976; Caple et al 1982).

Serum and urine samples were deproteinized by addition of trichloracetic acid. Calcium was measured by atomic absorption spectrophotometry in the presence of strontium chloride, and phosphorus colorimetrically (Jung and Parekh 1972). Creatinine in serum and urine samples was measured by the Jaffe alkaline picrate method. All assays were carried out in duplicate and a quality control serum* was included in each assay.

The creatinine clearance ratio (%Cr) of Ca and P was calculated using relationship:

\[
\text{urine Ca or P concentration} \times \frac{\text{serum creatinine concentration}}{\text{serum Ca or P concentration}} \times \frac{1}{100} \quad \text{(Traver et al 1976)}
\]

The excretion of Ca and P in urine was also calculated as the ratio of the mineral concentration to total urine solute concentration (Caple et al 1982). Urine solute concentration was determined from measurements of specific gravity deter-

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mined with a hand-held refractometer† and osmolality with an osmometer‡.

The criteria suggested by Caple et al 1982 were used to assess Ca and P nutrition. Horses which had a Ca-%Cr greater than 2.5% or ratio of Ca concentration to total urine solute concentration greater than 15 μmole/mosmole were considered to have adequate Ca intake. Horses which had a P-%Cr greater than 4% or ratio of P concentration to total urine solute concentration greater than 15 μmole/mosmole were considered to have excessive P intake. The nutrition was described as either: adequate in Ca, low in Ca, adequate in Ca and high in P, or low in Ca and high in P.

Results

The assessment of the Ca and P nutrition of the horses sampled is shown in Table 1. The results obtained from samples collected in 1975 and in 1980 were similar (Table 1). Sixty percent of the horses in both surveys were excreting amounts of Ca in their urine which suggested they were receiving adequate Ca intake. Of horses sampled in 1975, 31% were excreting excessive amounts of P, and in 1980-81, 44% were in this category. In 1975, 18% of the horses were excreting less Ca than P in urine, and in 1980 there were 24% in this category (Table 1). Only 2 of the 90 horses sampled in 1975 had undetectable levels of P in their urine (<0.15 mM) and all 139 horses sampled in 1980-81 were excreting P in their urine.

The creatinine clearance ratio of Ca (Ca-%Cr) in the horses sampled in 1980-81 ranged from 0.2% to 10%, and the P-%Cr ranged from 0.06 to 42% (Figure 1). There were significant relationships between values for the ratios of the urine mineral concentration to urine solute concentration and the %Cr (Figure 1).

Concentrations of Ca and P were measured in urine samples collected from a 3-year-old filly during micturition one hour before, and one hour after, racing (Table 2). There were no marked differences between the calculated excretion of Ca before (24.3 μmole/mosmole) and after racing (27.1 μmole/mosmole), or of P before (2.6 μmole/mosmole) and after racing (3.1 μmole/mosmole).

Twenty-four horses were sampled more than once during the 6-week period in 1980-81. In 17 of the horses, the excretion of Ca and P (expressed as μmole/mosmole or %Cr) was similar at all collections, 5 of the horses had decreased excretion of Ca, and 2 horses had increased excretion of P in the subsequent samples. The values obtained for urine samples collected from one 5-year-old gelding during the period are shown in Table 3.

There was considerable variation between horses supervised by individual trainers. The mean values obtained for a group of horses raced by any one trainer indicated whether they were receiving low Ca or high P diets. The horses sampled in 1980-81 were entered in races by 99 trainers. Horses entered by 53 of the trainers had lower amounts of Ca being excreted in urine than P.

Discussion

A high proportion of thoroughbred racehorses would appear to receive inadequate Ca and excessive P nutrition on the basis of the amounts of Ca and P being excreted in urine by horses sampled during this study. The findings support the general conclusions made by Bourke (1968) based on a survey of the feeding methods of 45 trainers. It can be calculated that the amounts of Ca and P being fed to thoroughbred racehorses are not within the currently recommended guidelines where mature horses should receive a diet containing 3 g Ca/kg and 2 g P/kg (Bourke 1968; NRC 1978). The diet commonly fed to thoroughbred racehorses in Victoria contains 0.8 g Ca/kg and 2.8 g P/kg if calcium supplements are not added and minimal amounts of lucerne are fed (see Bourke 1968). Most thoroughbred horses trained in Victoria are maintained in the metropolitan area or in the larger provincial cities, and very few have access to pastures while in work.

Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Horses Sampled</th>
<th>Adequate Ca</th>
<th>Adequate P</th>
<th>Low Ca</th>
<th>Low P</th>
<th>High P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>90</td>
<td>43 (48)</td>
<td>12 (13)</td>
<td>19 (21)</td>
<td>16 (8)</td>
<td></td>
</tr>
<tr>
<td>1980-81</td>
<td>139</td>
<td>56 (40)</td>
<td>28 (20)</td>
<td>22 (16)</td>
<td>33 (24)</td>
<td></td>
</tr>
</tbody>
</table>

†Fiske Associates, Uxbridge, Massachusetts, United States of America.

‡Erma Optical Works Ltd., Tokyo, Japan.

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Hay, either meadow, oaten or lucerne hay, may be available in the stable but it is usually limited to ensure all the grain offered is eaten. As peak fitness approaches, the proportion and amount of grain fed is increased. Trainers attempt to keep the level of grain as high as possible and reduce the roughage intake which is commonly a mixture of oaten and lucerne chaff.

The urine samples collected at the racetrack would reflect the extreme range of Ca and P nutrition of thoroughbred horses. If horses are receiving adequate Ca and not excessive P then the amounts of Ca excreted in urine always exceed the amounts of P (Caple et al 1982). This can be determined from single samples by measurement of concentrations of the minerals (Joyce et al 1971), or by expressing the concentration of each mineral as a ratio of the urine solute concentration (Caple et al 1982). An alternative method is to calculate the creatinine clearance ratio (%Cr) of Ca and P (Caple et al 1982; Traver et al 1976).

Traver et al (1976) reported that the P-%Cr in normal horses ranged from 0 to 0.5%, but made no estimates of Ca intake or excretion. Horses do not excrete much P in urine until dietary levels exceed 2 g/kg, and excretion is higher when dietary Ca is low (Caple et al 1982). All but 2 of the racehorses sampled were excreting P. Only 22 of the 139 racehorses sampled in 1980-81 had P-%Cr values within the range quoted by Traver et al 1976. About 25% of the horses sampled had urine concentrations of Ca and P, and P-%Cr indicative of nutritional secondary hyperparathyroidism (Joyce et al 1971; Traver et al 1976).

### Table 3

Concentration and Excretion of Ca and P in Urine Samples Obtained from a 5-year-old Gelding

<table>
<thead>
<tr>
<th>Collection Day*</th>
<th>Urine Concentration</th>
<th>Mineral Excretion</th>
<th>Ca-%Cr†</th>
<th>P-%Cr (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca (mM)</td>
<td>P (mosmole/kg)</td>
<td>Ca (μmole/mosmole)</td>
<td>P (%)</td>
</tr>
<tr>
<td>1</td>
<td>21.7</td>
<td>58.0</td>
<td>1175</td>
<td>18.5</td>
</tr>
<tr>
<td>13</td>
<td>9.9</td>
<td>58.0</td>
<td>1000</td>
<td>9.9</td>
</tr>
<tr>
<td>18</td>
<td>14.1</td>
<td>45.0</td>
<td>1050</td>
<td>13.4</td>
</tr>
<tr>
<td>35</td>
<td>18.2</td>
<td>43.0</td>
<td>1100</td>
<td>16.5</td>
</tr>
</tbody>
</table>

*Urine was collected one hour after racing on each occasion
†Creatinine clearance
In this study, horses were considered to have high P intakes if they were excreting greater than 15 μmole P/mosmole, and had a P-%Cr greater than 4%. The slope of the line relating μmole P/mosmole and P-%Cr in the thoroughbred horses was less than that found in brumby mares fed diets containing inorganic phosphate (Figure 1; Caple et al 1982). The slopes of the lines relating μmole Ca/mosmole and Ca-%Cr in the thoroughbred racehorses and the brumby mares were similar (Figure 1: Caple et al 1982).

Schryver et al (1978) reported that horses excreted up to 50% less Ca in urine during exercise periods than during periods of no exercise. The data published by Schryver et al (1978) did not indicate whether there was any change in urinary solute excretion in the horses during exercise periods, or whether the decreased Ca excretion was associated with reduced urine formation. All of the racehorses sampled in this study had been in work for several months. One horse examined before and after racing showed no significant change in excretion of the minerals when Ca and P concentrations were expressed as a ratio of the urine solute concentration (Table 2).

If horses are fed insufficient Ca, increased secretion of parathyroid hormone leads to mobilisation of Ca from bone and decreased excretion of Ca in urine. Clearly, the aim of good Ca nutrition of horses is to provide enough dietary Ca to prevent excessive and detrimental losses from bone. At least 56 g daily of Ca supplement such as calcium carbonate, calcium lactate or calcium gluconate would be required to provide thoroughbred racehorses with enough Ca when they are fed high P diets while in full work. The high proportion of horses found to have inadequate Ca and P nutrition by the criteria used is a matter for some concern, and further research is required to determine how much of the lameness seen is related to faulty feeding. Many racehorses obviously are not receiving adequate supplemental Ca despite the widespread use of a variety of mineral and vitamin supplements in stables.

References

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