

PHYSIOLOGY

**Athletic Performance at High Altitude**

OWING to the lower partial pressure of oxygen the maximum oxygen intake of acclimatized adults at high altitude is less than the sea-level value. The reduction in the maximum oxygen intake at the 7,500 ft. altitude of Mexico City, where the 1968 Olympic Games are to be held, is expected to be 8 per cent following the trend of experiments made in the Himalayas<sup>1</sup>. From this result it has been predicted that the times for the running events at Mexico City would be 8 per cent longer than the expected sea-level times<sup>2</sup> except for the shorter events where the oxygen requirement could be covered anaerobically.

Pugh<sup>2</sup> compared the results of the 1955, Mexico City, Pan-American Games, with the results of the 1956 Melbourne Olympic Games and found a linear relationship between the increase in time and the logarithm of the distance of the race. The increase varied from 2.6 per cent for the 800 m event to 14.9 per cent for the 10,000 m event. This comparison, however, does not take into account the generally lower standard of performance of the athletes who were eligible to compete in the Pan-American games when compared with the standard of the athletes who competed in the Olympic Games.

Table 1. COMPARISON OF HIGH-ALTITUDE AND SEA-LEVEL PERFORMANCES

Event and athlete	Mexico City time	Best sea-level time (1954-1955)	Percentage increase in time
400 m			
Jones	45.4	46.4	-2.2
Lea	45.6	46.3	-1.5
Mashburn	46.3	46.1	+0.4
800 m			
Sowell	1: 49.7	1: 48.3	1.3
Spurrier	1: 50.0	1: 46.8*	3.0
Sandoval	1: 52.4	1: 50.9	1.4
1,500 m			
Miranda	3: 53.2	3: 53.8	-0.3
Santee	3: 53.2	3: 42.8	4.7
Dwyer	3: 55.8	3: 45.4*	4.6
5,000 m			
Suarez	15: 30.6	14: 26.2	7.4
Ashenfelder	15: 31.4	14: 42.2*	5.6
Correa	15: 39.2	14: 42.2	6.5
10,000 m			
Suarez	32: 42.6	30: 30.0	7.2
Sanchez	33: 00.4	Not available	-
Correa	33: 42.6	31: 41.0	6.4

\* Time adjusted from the equivalent "English" distance.

A better method of checking the decrement in performance at Mexico City is to compare the times of the athletes placed in the 1955 Pan-American Games events<sup>3</sup> with their best sea-level times for the years 1954<sup>4</sup> and 1955<sup>3</sup> (Table 1). The percentage difference in time for each athlete was calculated and the mean for each event plotted against the distance of the race (Fig. 1). The 100 m and 200 m events were excluded as wind conditions can considerably affect the best recorded times of the athletes concerned.

Table 2. DECREMENT IN PERFORMANCES

Distance	Observed mean percentage decrement	Calculated percentage decrement from equation
400 m	-1.1	-
800 m	1.9	1.95]
1,500 m	3.0]	3.20
3,000 m	-	4.96]
5,000 m	6.5]	6.14
10,000 m	6.8]	6.97

The increase in the times for the distance events are less than those calculated previously and range from 1.9 per cent for the 800 m to 6.8 per cent for the 10,000 m (Table 2). The 400 m runners at Mexico City seem to have been assisted by the low aerodynamic drag at the high altitude; their times were reduced by an average of 1.1 per cent.

An exponential curve was fitted to the points from 800 m to 10,000 m by minimizing the squares of the differences between the observed mean decrements and the calculated decrements. The equation for this curve was

$$P = 7.1 (1 - e^{-0.00040D})$$

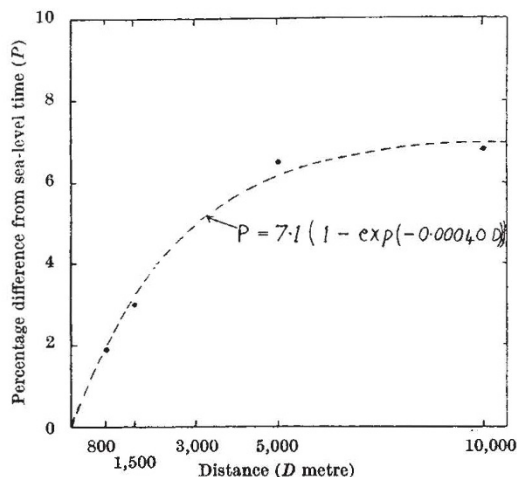


Fig. 1

where *P* is the percentage increase in time taken to run the distance in metres, *D*, at 7,500 ft. altitude. This equation indicates that the increase in time taken to run an event approaches the value of 7.1 per cent for the very long races. This is in excellent agreement with Pugh's estimate of 8 per cent based on maximum exercise tests as some assistance is probably gained from the lower aerodynamic drag on an athlete at an altitude of 7,500 ft.

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<sup>1</sup> Pugh, L. G. C. E., Gill, M. B., Lahiri, S., Milledge, J. S., Ward, M. P., and West, J. B., *J. App. Physiol.*, **19**, 431 (1964).

<sup>2</sup> Pugh, L. G. C. E., *Nature*, **207**, 1397 (1964).

<sup>3</sup> 1956, *World Sports, International Athletics Annual*, edit. by Quercetani, R. L.

<sup>4</sup> 1955, *World Sports, International Athletics Annual*, edit. by Quercetani, R. L., and Regli, F.

**Tolerance of Chickens to Thiabendazole**

THIABENDAZOLE, a broad-spectrum anthelmintic<sup>1,2</sup>, is well tolerated by mice, rats and rabbits, with *LD*<sub>50</sub> values exceeding 3.1 g/kg in oral acute toxicity experiments<sup>3</sup>. Furthermore, rats and dogs tolerated the drug quite well in chronic toxicity experiments<sup>3</sup>.

Recent unpublished experiments with adult chickens fed thiabendazole continuously for 3 weeks revealed that a level of 0.1 per cent in the diet has no effect on reproduction, egg production or feed intake, but that levels exceeding 0.2 per cent produced lower values for all three criteria. In addition, the birds fed these high levels of thiabendazole appeared anaemic and about 7 per cent mortality occurred at the 0.2 per cent level with progressively higher mortality at higher drug levels. Post-mortem examination of the hens revealed haemorrhaging throughout most internal organs, but particularly at the ovary. Haematological data were obtained in a series of experiments in which thiabendazole was fed for 21 days to

Table 1. HAEMATOLOGICAL DATA ON ADULT FEMALE CHICKENS FED THIABENDAZOLE FOR THREE WEEKS OR THIABENDAZOLE WITH B<sub>12</sub>, ASCORBIC ACID AND MENADIOLNE

	Control	0.2% Thiabendazole	0.4% Thiabendazole	0.4% Thiabendazole + 1 mg B <sub>12</sub> /kg + 100 mg ascorbic acid/kg + 20 mg menadiolone/kg
No. birds	8	4	3	4
Haemoglobin (g %)	8.4 ± 0.3*	5.4 ± 0.7	4.4 ± 0.4	8.1 ± 0.2
Haematocrit (vol. %)	30.1 ± 0.8	20.9 ± 2.8	17.8 ± 1.4	27.5 ± 0.8
Sedimentation rate (mm/h)	0.5 ± 0.0	1.3 ± 0.3	1.3 ± 0.3	0.6 ± 0.2
Prothrombin clotting time (sec)	15.9 ± 0.9	17.4 ± 1.6	15.2 ± 0.9	14.0 ± 0.7
Whole-blood clotting time (min)	30 ± 3	24 ± 5	39 ± 11	29 ± 6
General appearance of birds	Normal	Pale skin combs Partial moult	Pale skin combs Partial moult	Normal

\* Mean ± standard error of the mean.