Biomechanical Study on Downhill Running for Sprint Training

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Abstract

To collect fundamental data on downhill running for spring training, supramaximal velocity, biomechanical parameters and velocity curve on four downhill gradients (−1.59%, −3.57%, −5.01%, −6.50%) were compared with those for horizontal running.

Introduction

With the development of sports biomechanics, interest in supramaximal velocity seems to be increasing these days. Research on downhill running is seldom found (2), although there has been rather extensively studied basic research on Towing (1, 3, 4, 5). The purpose of this study was to collect fundamental data on downhill running for sprint training.

Methodology

The subjects for this study were 10 male sprinters at Kanagawa Institute of Technology. Their age was 19.8±1.2 yrs (mean±SD) ; height 1.69±0.05 m ; body weight 61.4±7.2 kg ; and 100 m record 11.4±0.4 seconds. The mean values of the downhill gradients of the 100 m slopes selected were horizontal, −1.59%, −3.57%, −5.01%, and −6.50%. Each gradient is the mean value of 5 points at 20 m intervals in the 100 m. Runnings were filmed with a 16-mm high-speed camera, for approximately 5 seconds, with the 45 m point covering. The camera was set at 100 frames per second. An electric running timer was used to determine the velocity at 5-m intervals during 100 meters of running. In this study, asphalt roads were used, for all the runnings. So the subjects used warm-up shoes. The running distance was 100 m and crouching start was used. The subject ran with his maximum effort. The experiment was conducted in the middle of November 1990, when the track meet season was finished.

Results and discussion

Fig. 1 shows running velocity, stride length, stride rate, time of support, and time of flight in the horizontal running and each downhill running. Mean value, standard deviation and

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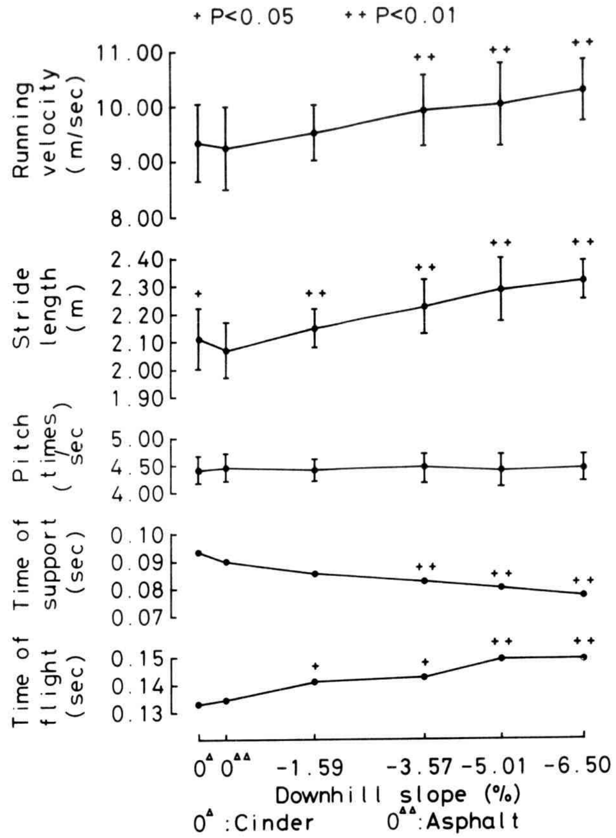

Fig. 1. Running velocity, stride length, stride rate, time of support, time of fiight in the horizontal running and each downhill running. Mean±SD and paired t-test results are shown.

paired t-test results are also shown. Running velocity increased with increasing downhill gradient. No significant difference in running velocity was found between horizontal running and −1.59% gradient downhill running. Statistically significant ($P<0.01$) supramaximal velocity was found in −3.57% and steeper gradient downhill running. Stride length also was greater, the greater the downhill gradient. The stride length increase was paralleled almost proportionally by that in running velocity. A statistically significant ($P<0.01$) increase in stride length can be recognized in both −1.59% and steeper gradient downhill running. There was not much change in stride rate between horizontal running and any downhill running. No statistically significant difference in stride rate can be recognized between horizontal running and any downhill running. The data suggests that the supramaximal velocities found in the downhill running were caused by the increase in stride length rather than stride rate. Time of support decreased with increasing downhill gradient, but on the other hand time of flight increased with increasing downhill gradient.

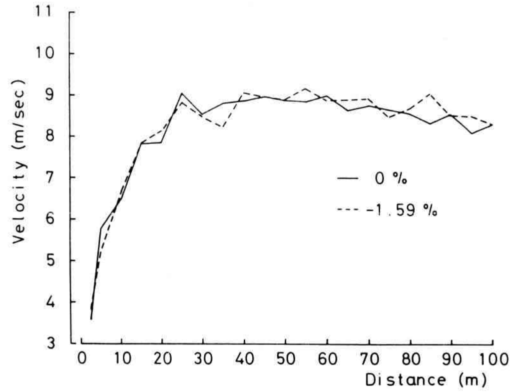

Fig. 2. Comparison of velocity curve for horizontal running and −1.59% gradient downhill running.

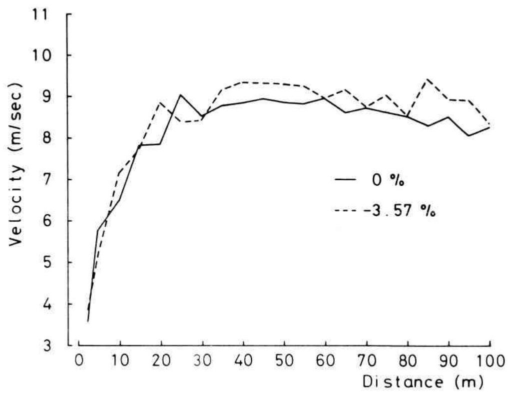

Fig. 3. Comparison of velocity curve for horizontal running and −3.57% gradient downhill running.

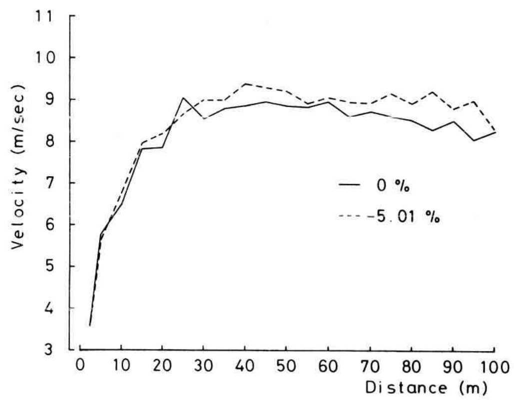

Fig. 4. Comparison of velocity curve for horizontal running and −5.01% gradient downhill running.

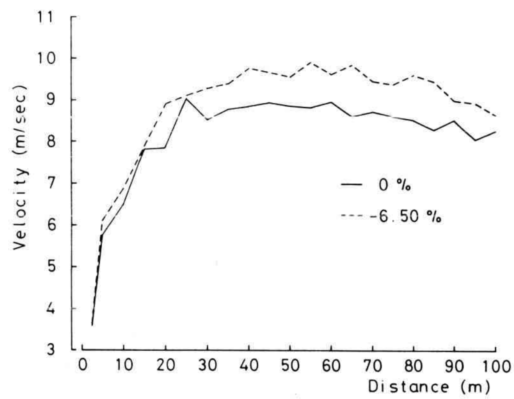

Fig. 5. Comparison of volocity curve for horizontal running and −6.50% gradient downhill running.

Fig. 2 shows velocity curves of the horizontal running and of −1.59% downhill running. The data used were mean values of 10 subjects. The horizontal axis represents distance (m), and the vertical axis represents running velocity (m/sec). The solid line represents the velocity curve of the horizontal running, and the broken line represents that of −1.59% gradient downhill running. No remarkable difference in velocity curve can be observed between horizontal running and −1.59% gradient downhill running. As a result, it can be said that the −1.59% downhill gradient was too gentle to create meaningful supramaximal velocity. Therefore, this downhill gradient is not suitable for sprint training using supramaximal velocity. Fig. 3 shows velocity curves of the horizontal running and of −3.57% gradient downhill running. The broken line represents the velocity curve of the −3.57% gradient downhill running. Supramaximal velocity was found, with a series of small waves throughout the 100 meters. The broken line in Figs. 4 and 5 show the velocity curves of −5.01% and −6.50% gradient donhill running. Supramaximal velocity was found throughout the 100 meters in both cases. These results show that in −3.57% and steeper gradient downhill running, a sprinter can experience a higher level of velocity than his maximal velocity.

Conclusions

Within the limitations of this study, the following results were obtained.

1. The data suggest that the −1.59% gradient downhill is not suitable for sprint training using supramaximal velocity.

2. It was shown that a sprinter can experience supramaximal velocity, which is, as it were, a higher level of ability than his running ability, on −3.57% and steeper downhill gradients.

3. The data suggest that the supramximal velocities found in the downhill running were caused by the increase in stride length rather than stride rate.

References

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