Locomotor-Respiratory Coupling Patterns in Athletes: Differences Between Team and Individual Sports

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Summary

This study examines locomotor-respiratory coupling (LRC) differences between team and individual sport athletes during incremental running. LRC, the synchronisation between breathing and movement, is linked to improved ventilatory efficiency and endurance performance. Fifteen athletes (six team sport, nine individual sport) completed a treadmill protocol while cadence and breathing frequency were recorded to quantify LRC stability. Results showed that individual sport athletes maintained a consistent cadence-breathing frequency ratio (CBFR) of ~4 throughout exertion and recovery, whereas team sport athletes exhibited a progressive decline, reaching a CBFR of 4 at exhaustion. These differences likely reflect sport-specific adaptations, with individual sport athletes developing more consistent breathing strategies due to sustained exercise demands. Optimising LRC stability in team sport athletes could enhance endurance and delay fatigue. Future research should explore training interventions to improve breathing efficiency in both sport contexts.

Introduction

Locomotor-respiratory coupling (LRC) refers to the synchronisation between breathing and movement, linked to improved ventilatory efficiency and reduced respiratory muscle fatigue. A consistent 4:1 coupling ratio (four steps per breath) is associated with enhanced running economy and reduced respiratory stress, particularly in endurance athletes. However, LRC patterns vary among individuals, and its contribution to running efficiency remains debated. This study examines LRC stability in team and individual sport athletes during incremental running. We hypothesise that sporting background influences coupling stability, with individual sport athletes displaying more consistent LRC patterns. Findings may provide insights into LRC's role in endurance performance and inform training strategies to optimise breathing mechanics.

Methods

Fifteen participants (7 female; age: 23 ± 3 y; mass: 71.3 ± 8.7 kg) completed an incremental treadmill running protocol to exhaustion. Participants were classified as either team sport (n = 6) or individual sport athletes (n = 9) based on their sporting history. The protocol included a 4-minute warm-up at 8 km/h, speed increments of 1 km/h every 2 minutes until exhaustion, and a 6-minute cool-down at 8 km/h. Step frequency was recorded using a force plate, and breathing frequency was measured with a flow direction mask connected to an Arduino microcontroller. Locomotor-respiratory coupling (LRC) was quantified using the cadence-breathing frequency ratio (CBFR).

Results and Discussion

Figure 1 shows CBFR trends for team and individual sport participants during the incremental running test. Team sport participants had a higher CBFR at lower speeds (~7.5 at 8 km/h), which declined to 4 at exhaustion. In contrast, individual sport participants maintained a consistent CBFR around 4, only decreasing to 3-4 near exhaustion. These findings indicate that individual sport athletes exhibit greater LRC stability, while team sport athletes show a more pronounced shift in breathing mechanics with increasing exertion. The decline in CBFR among team sport athletes suggests less synchronisation between cadence and BF, likely influenced by the intermittent nature of their sport and verbal communication demands. During the cool-down phase, individual sport athletes maintained a CBFR below 4, showing sustained respiratory effort, while team sport participants exhibited a rising CBFR (~4.9), reflecting differences in post-exercise breathing strategies. Optimising LRC in team sport athletes may improve endurance and delay fatigue during high-intensity efforts.

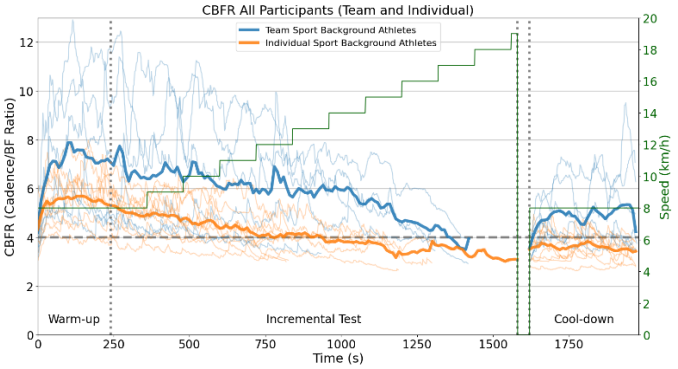

Figure 1: Cadence-Breathing Frequency Ratio (CBFR) trends during the incremental running test for team sport (blue) and individual sport (orange) participants. Individual participant shown with an alpha value of 0.3.

Conclusions

This study reveals distinct LRC patterns between team and individual sport athletes. Individual sport participants maintained a stable CBFR throughout exertion and recovery, while team sport athletes showed a progressive decline, reaching a CBFR of 4 at exhaustion. These differences likely reflect sport-specific training adaptations, with individual sport athletes developing more consistent breathing strategies due to sustained exercise demands. Enhancing LRC stability in team sport athletes may improve their ability to sustain high-intensity efforts, particularly in later stages of competition. Future research should explore the mechanisms behind these differences and investigate training interventions to optimise breathing efficiency in both contexts.