Does an increase in breast mass affect running economy, exercise induced breast pain and running biomechanics?

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Summary

This study experimentally added external mass to participant's breast to simulate the effects of a larger breast size. Adding mass to the breasts increased breast motion and exercise induced breast pain, worsened running economy and altered running biomechanics.

Introduction

Adding mass to a shoe is known to increase the lower limb's inertial properties and total mass of the system [1], decreasing running performance [2]. An increased breast mass is known to increase breast motion [3]. This is theorized to increase inertia about the trunk segment, which may translate to worsened running economy. To date no research has explored the association between breast size and running economy, nor how the runner with a large breast mass biomechanically compensates for an increased inertia about the trunk. The aim of this study was to examine the effect of added breast mass, to simulate the effects of a larger breast size, on running economy, exercise induced breast pain (EIBP) and running biomechanics using a within-subject research design.

Methods

Thirty female recreational runners (mean ± SD age: 26.7 ± 9.8 years; breast mass: 339 ± 195 g; running experience: 8.6 ± 4.7 years) completed a 12-minute treadmill running protocol on an instrumented treadmill in view of a Vicon motion analysis system while kinematic, kinetic and oxygen uptake ($\dot{V}O_2$) data were collected. Participants ran at a velocity of 10 km·h^{-1} in three experimental conditions (i) no mass (wearing only a standardised sports bra), (ii) absolute mass (100 g added to each breast) and (iii) relative mass (20% of breast mass added to each breast). In both loading conditions, the mass was secured externally to the bra and evenly distributed across four quadrants of the breast.

Following each experimental loading condition, participants EIBP was reported using a VAS (rated 0 to 10). Linear mixed models were used to model the effect of the experimental loading conditions on $\dot{V}O_2$, vertical breast displacement (VBD), lower limb joint angles and moments (R, V4.4.0).

Results and Discussion

The absolute mass experimental loading condition increased vertical breast displacement and subsequently worsened running economy (Fig 1). Reduced peak trunk to pelvis flexion, reduced peak hip flexion and an increase in peak hip extensor moment were observed in both absolute and relative mass loading conditions. These biomechanical changes, along with a posterior shift in trunk centre of mass, are proposed to compensate for the perturbation induced by added breast mass. An increase in knee flexion angle, dorsi flexion angle and knee and ankle joint moments were also observed alongside changes to trunk and hip movement. These changes are proposed to attenuate ground impact in response to the perturbation to the system.

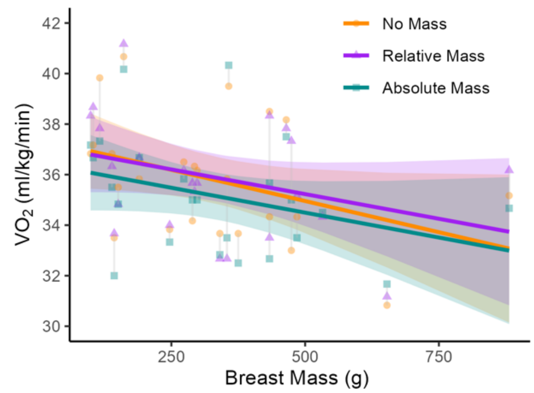

Figure 1: Steady state $\dot{V}O_2$ during each condition.

Conclusions

These findings motivate the development of evidence-based strategies, such as technique-based training interventions alongside enhanced equipment design, to minimise breast mass related performance detriments.

References

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[2] Hoogkamer W et al. (2016). *MSSE,* **48**:2175-2180.
[3] McGhee DE et al. (2012). *Appl. Ergon*, **44**: 112-118.

Table 1: Mean ± SD for biomechanical outcome variables, all variables are peak values (F = flexion; DF = dorsiflexion, M = moment).

	EIBP	Left VBD	Trunk F	Hip F	Knee F	Ankle DF	Hip M	Knee M	Ankle M
No Mass	1.4 ± 2.5	39.2 ± 16.4	-3.1 ± 5.5	35.5 ± 5.9	40.9 ± 4.9	22.8 ± 3.8	E:1.92 ± 0.53 F: 0.80 ± 0.40	E: 0.59 ± 0.43 F: 0.86 ± 0.55	4.7 ± 1.9
Absolute Mass	2.4 ± 1.8	42.7 ± 14.0	-3.7 ± 5.9	35.5 ± 5.8	43.1 ± 7.3	28.7 ± 12.0	E: 1.97 ± 0.54 F: 0.74 ± 0.26	E: 0.68 ± 0.41 F: 0.86 ± 0.53	4.3 ± 1.7
Relative Mass	2.5 ± 2.7	41.1 ± 16.1	-3.4 ± 5.7	34.2 ± 5.5	43.0 ± 5.6	30.2 ± 14.1	E: 1.96 ± 0.45 F: 0.76 ± 0.33	E: 0.68 ± 0.46 F: 0.89 ± 0.63	4.6 ± 2.1