The Sports Bra Trade-Off: Balancing Support and Pressure to Enhance Running Economy

Nicole Y. Kelp[1,2], Adrian Lai[2], Sian Allen[2], Michael J Asmussen[1]
[1] Vancouver Island University, Nanaimo, Canada
[2] Product Innovation, lululemon athletica, Vancouver, Canada
Email: nkelp@lululemon.com

Summary

Sports bras reduce breast movement but may limit comfort and performance. This study examined the effects of bra support, breast size, and bra pressure on running economy. A high support bra reduced breast accelerations, but underband pressure may hinder running economy, while strap support may be linked to improvement. A well-designed sports bra that balances pressure distributions at key locations to optimize support, could enhance comfort and performance during running.

Introduction

Sports bras minimize breast discomfort during exercise by reducing breast displacement and accelerations, particularly in larger breast sizes [1]. High-support bras reduce breast displacement and accelerations, which may improve running economy at higher speeds [2], but their compressive underband may limit respiratory function and breathing mechanics during maximal exercise [3]. The aim of this study was to examine the effect of breast support, breast size, and underband/strap pressure, on running economy at a high aerobic intensity.

Methods

Preliminary data was collected on 10 recreationally active females (25 ± 4yrs, bra sizes 32C–36D, avg. breast volume 565 ± 142ml) who wore a moderate (Energy) and high-support (Energy High Support) sports bra (lululemon). Pressure (Kikuhime) was measured at the underband (front, side, back), strap apogee, and cup during maximal inhalation and exhalation at rest. Participants ran for 5 min in each bra for 2 trials (randomized pyramid order: ABBA, BAAB) at a running speed that equated to an RER of 0.9, determined using indirect calorimetry (Cosmed K5) during a ramped running test. VO_2 (ml/kg/min) and breast accelerations from inertial measurement units (Vicon Blue Tridents, 1600Hz) were collected in each condition. Breast acceleration (peak-to-peak resultant) was computed over 60 gait cycles in the final minute, and VO_2 was averaged over the last two minutes of each condition. Running economy (ml/kg/km) was calculated as VO_2 / (Speed/ 60). Linear mixed-effects models assessed bra support (moderate vs. high) and breast size (grouped larger vs. smaller), on breast impact acceleration and running economy, while linear regression examined running economy and pressure relationships.

Results and Discussion

The Energy High Support bra significantly reduced breast impact acceleration ($p<0.001$) regardless of breast size. Running economy was not significantly affected by bra support or breast size ($p>0.05$), though a trend suggested improved economy for larger breasts with higher support.

Higher underband pressure in the Energy moderate-support bra correlated with worse running economy ($R^2= 0.22$, $p=0.038$) (Fig. 1A), while greater strap pressure in both bras was moderately related to improved running economy (moderate-support $R^2= 0.39$, $p=0.003$; high-support $R^2= 0.24$, $p=0.029$) (Fig. 1B). Participant feedback aligned with these findings, with the moderate-support bra's underband perceived as "tight and restrictive" while the high-support bra was "supportive but slightly looser underband".

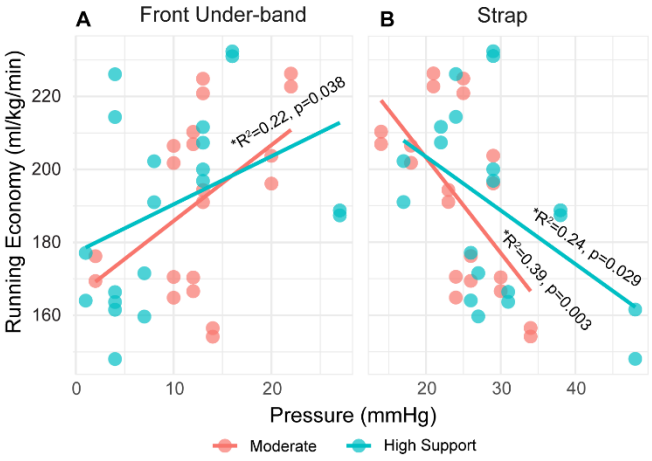

Figure 1: Linear regression analysis of running economy and pressure in the front underband (A) and straps (B) for a moderate (pink) and high support (blue) bra.

Conclusions

Sports bras often present a trade-off between support, comfort and performance. However, a well-designed, well-fitting sports bra can attempt to provide balanced support profiles across different areas of the bra to reduce both breast impact accelerations and discomfort, while also allowing proper rib-cage expansion. Further research is needed to examine the influence of breast volume, breast accelerations, and running energetics across a broader range of support levels to identify optimal bra design.

Acknowledgments

This work was funded by MITACS through a partnership with lululemon athletica.

References

[1] Mason BR (1999). *JSAMS, **2**(2):134-144*
[2] Fong HB and Powell DW (2022). *Frontiers, **4***
[3] Kipp S et al. (2024). *MSSE*, ***56***(6): *1168-1176*