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Optimizing Padding Design to Enhance Sports Bra Breathability

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Structured Abstract

Background: Breathability is a crucial factor influencing comfort and performance in sports bras, particularly in the padded cup area where heat and moisture easily accumulate during physical activity. While sports bras are typically designed using breathable and moisture-wicking fabrics, the padding component often restricts airflow and moisture transport. Recently, perforated padding designs have been introduced in the market with claims of enhanced breathability. However, scientific validation of their effectiveness remains limited. Therefore, this study aims to investigate the effect of perforated padding structures and different hole densities on the breathability performance of sports bra padding.

Methods: The study was conducted in two parts. In Part 1, the breathability performance of normal padding without holes (BP-Normal) was compared with perforated padding featuring a medium hole density (BP-Holes). In Part 2, the effect of different hole densities low (BP-A), medium (BP-B), and high (BP-C) on breathability was examined. All padding samples were prepared using mechanical punching with a constant hole diameter. Breathability performance was evaluated through air permeability (ASTM D737-04), water vapour permeability (ASTM D1518-85), and moisture management testing (AATCC 195).

Results: The results demonstrated that perforated padding significantly enhanced breathability compared to normal padding. Air permeability of BP-Holes increased by 92.17% relative to BP-Normal, indicating better airflow. Water vapour permeability was also higher for BP-Holes, suggesting reduced resistance to vapour diffusion and more efficient moisture release. In moisture management, BP-Normal showed a negative one-way transport index, indicating poor moisture transport, while BP-Holes showed a high positive value, reflecting effective one-way moisture transfer.
In Part 2, breathability performance increased consistently with increasing hole density. Higher hole densities resulted in greater air permeability, water vapour permeability, and overall moisture management capacity. Among all samples, BP-C demonstrated the highest breathability performance.

Conclusion: In conclusion, the finding shows that perforated structures significantly improve the breathability of sports bra padding. Even though BP-C provide the highest breathability performance, BP-B is considered the optimum design for enhancing airflow and moisture management.

Keywords: Sports bra, Perforated padding, Breathability, Air permeability, Moisture management

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