THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

Research Newsletter

INNOVATION DIGEST

Issue 9 | Aug 2026

Gear Up to the Summit:

Next-Gen Sports Science Elevating Athletes to Their Zenith



Sports Medicine and Rehab

A Winning Stride for Marathon Runners

Sports Gear

Transforming Sweat Management with Novel Leaf-Inspired Sportswear

INNOVATION DIGEST



Contents

Issue 9 | Aug 2026

Research Highlights



A Winning Stride for Marathon Runners

Marathon routes reshape performance. A new study reveals runners adapt lower-limb coordination and impact loading for smarter race strategies.



Fencing Injuries Under the Spotlight

The first systematic review and meta-analysis exposes fencing injury risks delivering critical insights to protect athletes and drive safer training.



Breaking the Vicious Cycle: Psoas Major Stiffness and Low Back Pain

Elite athletes with chronic low back pain display higher psoas major stiffness tied to sport dysfunction. Does this point to a vicious cycle?



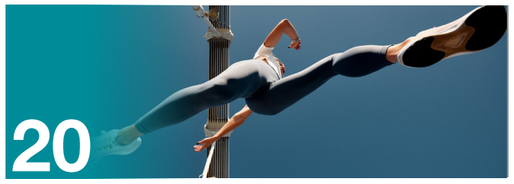
Transforming Sweat Management with Novel Leaf-Inspired Sportswear

Keeping athletes dry, light and comfortable under heavy sweat is a critical sportswear challenge. A leaf-vein-inspired biomimetic fabric boosts drying, comfort and cooling.



Next-Generation 3D Self-Folding Fabric for Adaptive Thermoregulation in Athletes

Athletes confront rapidly changing environments, but traditional sportswear handles only one. A 3D self-folding knitted fabric adapts to cold and heat via structural transformation.



More Than Just a Tight Fit?

Traditional compression wear targets external tightness alone. A subject-specific 3D biomechanical model of the female lower body enables precise pressure and muscle loading evaluation for next-generation designs.



Beyond the Shoe: The Overlooked Role of Running Socks in Foot Protection

Running socks are often overlooked despite their direct role in impact protection. A recent study shows specialised designs including five-toed styles cut forefoot pressure and boost cushioning for runners.

25 Engagement & Partnership

30 Student Corner

Editor's Message

Welcome to this issue of *Innovation Digest*, themed "Gear Up to the Summit: Next-Gen Sports Science Elevating Athletes to Their Zenith". The year 2026 marks an extraordinary milestone for global sport. Fresh from the excitement of the FIFA World Cup in July, attention now turns to the 2026 Asian Games in September, when elite athletes will once again take centre stage.

At the same time, Hong Kong has reinforced its commitment to high-performance sport through substantial investment in world-class infrastructure and advanced technologies. At the forefront of these efforts, The Hong Kong Polytechnic University (PolyU) brings together leading scholars whose rigorous research helps athletes optimise their physical capabilities and achieve peak performance.

In this issue, we spotlight PolyU's latest breakthroughs in two key areas. The "Sports Medicine & Rehab" section presents new insights into:

- runners' adaptive strategies during a marathon
- fencing injuries and associated risk factors
- the correlation between psoas major stiffness and low back pain in elite athletes

Meanwhile, the "Sports Gear" section explores advances in wearable technology, including:

- a novel vascular cool fabric for advanced sweat management
- an all-weather 3D self-folding fabric for adaptive thermoregulation
- a 3D finite element model for investigating the biomechanical effects of compression leggings
- an assessment of the cushioning performance of specialised running socks

Furthermore, "Engagement & Partnership" continues to feature recent PolyU collaborations with external organisations as well as engagement activities. Finally, "Student Corner" proudly showcases some of the achievements of our students.

As you explore these pages, we invite you to discover how cutting-edge research bridges the gap between laboratory innovation and performance in the field. We hope this issue offers new perspectives on how science empowers today's athletes to push boundaries, break records and redefine human potential.

Enjoy the read.

Prof. Cheng DONG
Chairman of the Editorial Committee
Associate Vice President (Knowledge Transfer)
Chair Professor of Cell Engineering and ImmunoMedicine,
Department of Biomedical Engineering



A Winning Stride for Marathon Runners

How Coordination and Impact Control Shape Endurance Performance

Long-distance running, and marathons in particular, has become one of the most popular sports in recent years, with a growing number of amateur runners taking part in major international events. Beyond running form, how does the race route itself influence performance? Prof. Zhang's latest research reveals how runners adapted their lower-limb coordination and impact loading during a full outdoor marathon, offering insights that can help athletes develop more effective strategies.



Ir Prof. Ming ZHANG
Head and Chair Professor of Biomechanics, Department of Biomedical Engineering
Director, Research Institute for Sports Science Technology

Running continues to grow in popularity worldwide as an accessible way to improve fitness, health and well-being. Marathon running, in particular, has become increasingly popular among recreational and competitive runners. Yet a marathon is not simply a test of endurance. Over 42 km, the body experiences thousands of repeated impacts, while fatigue gradually challenges movement control, balance and shock absorption.

As runners tire, their gait may change. Some changes may help them maintain stability, while others may increase mechanical load on muscles, joints and soft tissues. Understanding these adaptive strategies is important for coaches and runners who aim to improve their marathon preparation and reduce injury risk.

As published in the *Journal of Science and Medicine in Sport* [1], Prof. Ming ZHANG, Head and Chair Professor of the Department of Biomedical Engineering at The Hong Kong Polytechnic University, and his research team investigated how runners adapted their lower-limb coordination and impact loading during a full outdoor marathon, with particular attention to the effects of mileage and straight versus curved running paths.

The study aimed to examine two key biomechanical indicators during prolonged running: intersegment coordination variability and impact shock. Intersegment coordination variability describes how consistently body segments, such as the pelvis, thigh, shank and rearfoot, move together from stride to stride. Some variability is normal and may help the body adapt. However, large or poorly controlled variability may indicate fatigue-related changes in motor control and load distribution. Impact shock refers to the acceleration transmitted through the body during landing. In this study, shock was measured at the tibia and pelvis, providing insight into how effectively

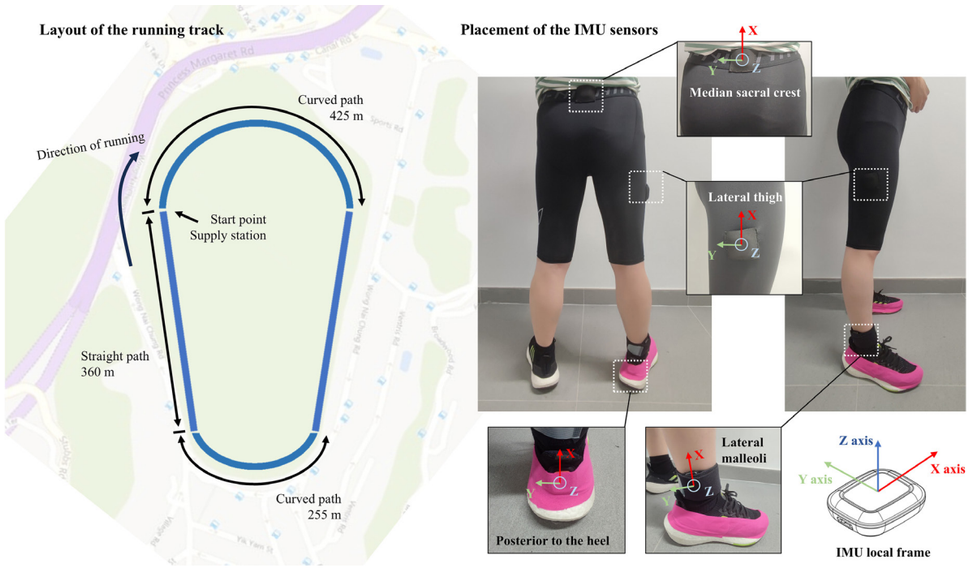


Figure 1. The layout of the running track and placement of IMU sensors on a runner's body

runners absorbed repeated impacts as the marathon progressed. The team expected both coordination variability and impact shock to increase with mileage and to be affected by curved running.

Outdoor Marathon Monitoring with IMUs

Twenty-three experienced male amateur runners completed a self-paced 42 km run on a circular outdoor track. They were sub-elite marathoners, with an average marathon performance of under 3.5 hours in the previous year.

The track was 1.4 km long and included two straight sections and two curved sections (*Figure 1*). Each runner completed 30 laps. Unlike treadmill-based studies, speed was not controlled, allowing runners to pace themselves naturally.

Four wearable inertial measurement units (IMUs) were attached to the pelvis, right thigh, right shank and right rearfoot respectively (*Figure 1*). These sensors recorded three-dimensional movement continuously throughout the run. IMUs are valuable in sports science because they allow researchers to monitor athletes in real-world environments without the restrictions of a laboratory.

Data were analysed every 5 km from the 2nd km to the 42nd km. The first 2 km were excluded to avoid early habituation effects. The team compared movement patterns on straight and curved paths and adjusted the analysis for factors including running speed, age, BMI, running experience and the amount of weekly training.

Sagittal-Plane Variability Increased

One major finding was that coordination variability generally increased in the sagittal plane as mileage accumulated (*Figure 2*). The sagittal plane includes forward-backward movements such as hip, knee and ankle flexion and extension, which are central to running propulsion and landing shock absorption.

The most significant mileage-related change was found in the coordination between the shank and rearfoot in the sagittal plane. Variability in this coupling was significantly higher at the 37th km and 42nd km than at the 2nd km. On average, running for 40 km increased shank–rearfoot sagittal coordination variability by 2.15°. This suggests that, near the end of a marathon, the relationship between lower-leg and foot motion becomes less consistent. Since the shank and rearfoot are important for foot strike, ankle control and impact absorption, this change may reflect fatigue-related disruption to the normal landing strategy.

The results show that running form does not remain constant during a marathon. Even experienced runners show measurable changes in lower-limb coordination, especially in the latter stages of a race.

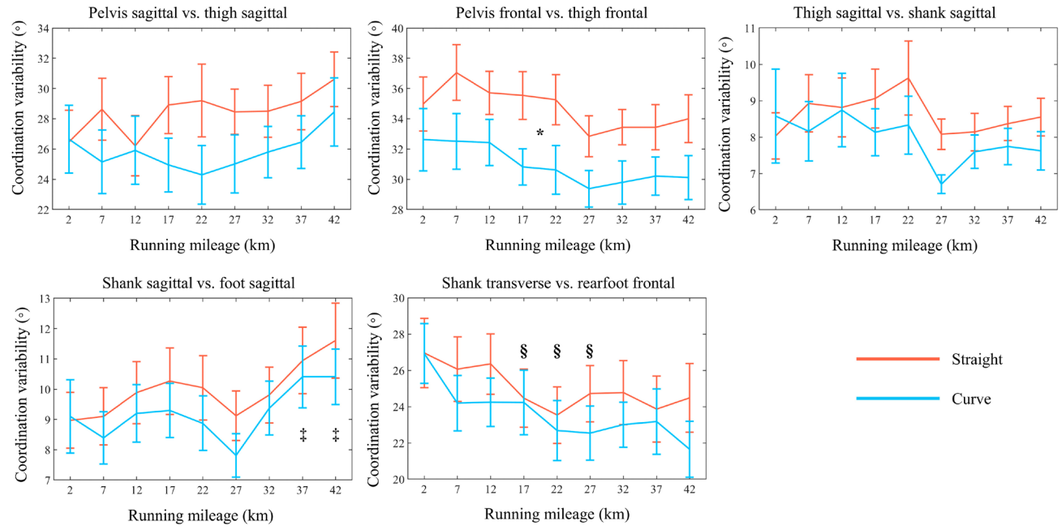


Figure 2. Changes in the coordination variabilities of all coupling pairs during the marathon. The bars represent the standard errors of the mean. ‡ and § indicate significant differences between the 2nd km and other mileage checkpoints when pooling all track types. * indicates significant differences between the straight path and the curved path.

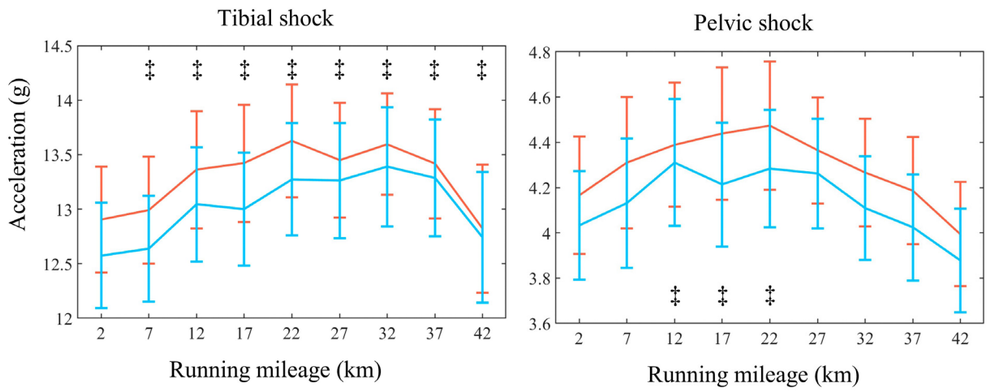


Figure 3. Changes in tibial shock and pelvic shock during the marathon. The bars represent the standard errors of the mean. ‡ indicates significant differences between the 2nd km and other mileages checkpoints, pooling all track types.

Non-Sagittal Variability Contained

The study also found a contrasting pattern in non-sagittal movements. These include frontal-plane and transverse-plane motions, such as side-to-side control, rotation and foot inversion or eversion.

Variability between shank transverse motion and rearfoot frontal motion significantly decreased by the 22nd km compared with at the 2nd km. This reduction occurred on both straight and curved paths, with decreases of 3.32° and 3.55°, respectively.

This suggests that runners may tighten control of lateral and rotational movements as a race progresses. Such a strategy may help maintain lower-limb alignment and stability when fatigue increases. However, reduced variability may also limit the body's ability to distribute forces across different tissues. If movement becomes too constrained, certain muscles or joints may experience greater repeated loading.

This finding highlights the importance of training lower-limb control in multiple movement planes, not only in forward-running mechanics.

Curved Paths Demanded More Control

Curved track also had a significant effect. Coordination variability was generally lower on curved paths than on straight paths. The strongest result was observed in the pelvis–thigh coupling in the frontal plane, where curved running reduced coordination variability by 3.56°.

Running on curves requires the body to manage additional balance and directional demands. Runners must control centrifugal forces, adjust limb placement and maintain stability while continuing to move forward. The lower variability observed on curved sections suggests that runners adopt a more controlled and repeatable movement pattern when negotiating bends.

This may help explain why marathon routes with many turns can feel more demanding than straight courses. Curved paths may increase neuromuscular control requirements and alter workload distribution across the lower limbs. For athletes preparing for races with frequent turns, curved-path running should be included in training rather than treated as a minor course feature.

Tibial and Pelvic Shock Increased

Impact shock increased as the marathon progressed. After adjusting for running speed, tibial shock increased consistently with mileage (*Figure 3*). Every additional 5 km was associated with a 0.23 g increase in tibial shock. Tibial shock was also 0.53 g higher on curved paths than on straight paths.

Pelvic shock also increased with mileage (*Figure 3*). Every additional 5 km was associated with an average 0.07 g increase in pelvic shock and pelvic shock significantly higher at the 22nd km than at the 2nd km.

Importantly, runners slowed down during the race. On straight paths, average speed dropped from 13.83 km/h at the 2nd km to 11.97 km/h at the 42nd km. On curved paths, speed decreased from 12.85 km/h to 10.50 km/h. Since slower running would usually reduce impact loading, the finding that shock still increased after adjusting for speed suggests that fatigue may compromise shock absorption.

In practical terms, slowing down may not fully protect runners from increased loading in the later stages of a marathon. Maintaining effective landing mechanics and lower-limb strength endurance remains essential.

Strategies for Runners

These findings suggest several training implications.

First, marathon training should target coordination stability, not only aerobic endurance. Runners need to maintain effective segment coordination over thousands of strides, especially between the shank and rearfoot.

Second, strength training should include multi-plane control. Traditional exercises such as squats, lunges and calf raises are useful, but runners may also benefit from exercises targeting ankle invertors and evertors, hip abductors and hip rotators. Examples include single-leg balance drills, resisted ankle inversion and eversion, lateral band walks and controlled turning drills.

Third, runners should practise under varied course conditions. Since curved paths increase control demands and tibial shock, training on bends, loops and courses with turns may better prepare athletes for real-world races.

Finally, wearable technology such as IMUs may help coaches and sports scientists monitor fatigue-related changes in running mechanics outside the laboratory. This could support more individualised training and injury-prevention strategies.

This study provides field-based evidence that runners actively adapt their movement strategies during a full marathon. As mileage increased, sagittal-plane coordination variability rose, while non-sagittal variability was constrained. Curved paths required more controlled coordination, and both tibial and pelvic shock increased over time, even after accounting for running speed.

Marathon running is not only about endurance and pacing. It is also about maintaining coordination, absorbing impact and adapting to environmental demands. Training programmes that develop multi-plane strength, coordination stability and curve-running ability may help runners sustain performance and better manage mechanical loading during prolonged running.

Prof. Zhang was recognised by Stanford University as one of the top 2% most-cited scientists worldwide (career-long) in the field of biomedical engineering for five consecutive years, from 2021 to 2025, and one of the top 2% most-cited scientists worldwide (single-year) for six consecutive years, from 2020 to 2025. His scientific research has earned him prestigious awards, including the Natural Science Award (First Class) of the 2015 Higher Education Outstanding Scientific Research Output Awards from the Ministry of Education of China, the Huang Jiasi Biomedical Engineering Award (First Class) from the Chinese Society of Biomedical Engineering in 2017 and the Young Scholar Award at the World Congress on Bioengineering from the World Association for Chinese Biomedical Engineers in 2019. He has served as the President of the World Association for Chinese Biomedical Engineers and Chair of the Chinese Society of Rehabilitation Engineering, and currently serves as a Councillor on the World Council of Biomechanics, a Committee Member of the Chinese Society of Biomechanics and Biomedical Division of Hong Kong Institute of Engineers, a Standing Council Member of the Chinese Society of Biomedical Engineering and Vice President of the China Rehabilitation Devices Association.

References:

[1] Zhang, G., Fu, Y., Wei, L., Bing, F., Cai, H., Chen, T. L-W., Zhang, M. Continuously monitoring runners' adaptive strategies to prolonged running on an outdoor track with straight and curved paths: Insights from the varying intersegment coordination variability and shock absorption during a full marathon, *Journal of Science and Medicine in Sport*, 2025; 28, 858-866.

Fencing Injuries Under the Spotlight

Insights from the First Systematic Review and Meta-Analysis of Injury Risks in Fencing

Hong Kong has established itself as a major producer of world-class fencers, consistently achieving outstanding results on the international stage. As a result, the causes of fencing injuries remain a significant concern. Prof. Wong has completed the first systematic review and meta-analysis of injury risks in fencing, providing valuable insights that can help better protect athletes and support safer training practices.



Prof. Arnold Yu-lok WONG
Professor, Department of Rehabilitation Sciences
Associate Director, Research Institute for Smart Ageing

Fencing has moved rapidly into the public spotlight in Hong Kong over the past decade, driven by the City's impressive Olympic success in the sport. Historic gold-medal victories and continued international achievements have transformed fencing from a relatively niche activity into one with growing visibility, participation and professional ambition.

Modern fencing is a fast, technically demanding combat sport with three main weapons: foil, épée and sabre. Each has its own rules, target areas and tactical demands. All three require repeated changes of direction and precise weapon control. In able-bodied fencing, these are supplemented by rapid footwork and explosive lunges.

To address the lack of comprehensive data on fencing injuries, Prof. Arnold Yu-lok WONG, Professor of the Department of Rehabilitation Sciences and Associate Director of the PolyU Research Institute for Smart Ageing, and his research team conducted a systematic review and meta-analysis of existing studies. The review, published in the *Clinical Journal of Sport Medicine* [1], aimed to summarise the prevalence and incidence of fencing-related injuries and pain, and to identify factors associated with injury risk among able-bodied and wheelchair fencers. By consolidating existing research, the analysis provides a clearer picture of whom is most at risk, which body regions are most affected and what factors should be considered in injury prevention and athlete management.

The review found that fencing injuries were common, with injury prevalence among able-bodied fencers ranging from 51.5% to 92.8%. Professional fencers generally showed higher rates of injury than non-professional fencers. Moderate-quality evidence linked older age and longer fencing experience with higher injury prevalence. Able-bodied fencers were mainly affected by lower-limb injuries, while wheelchair fencers showed a higher proportion of upper-limb injuries.

Evidence gathered from 19 studies

The review followed PRISMA guidelines and was registered with PROSPERO. Seven databases were searched from inception to 30 June 2023. Studies were included if they reported the prevalence and/or incidence of fencing injuries or pain, or investigated associated factors using relevant statistical measures.

A total of 19 studies were selected from 298 identified records, comprising cross-sectional, retrospective and prospective studies published between 1990 and 2022. The data covered 1,151 able-bodied fencers in prevalence studies and 164,485 able-bodied fencers plus 14 wheelchair fencers in incidence studies. Two independent reviewers screened the literature, extracted data and assessed methodological quality. Where appropriate, random-effects meta-analyses were conducted, and the certainty of evidence for each factor was evaluated using the GRADE approach.



The selected studies varied considerably in their definitions of injury, follow-up period, competition level and outcome measures. As a result, not all findings could be pooled statistically. While the review provides valuable direction for injury prevention and future research, not all identified factors carry the same strength of evidence.

Older age, greater exposure

The review highlights that fencing places meaningful physical demands on athletes. Among able-bodied fencers, lower-limb injuries were the most common, accounting for more than half of the reported injuries. This pattern is consistent with the biomechanics of fencing. Lunging, retreating and rapid directional changes repeatedly load the knees, ankles and thighs, especially on the dominant front leg. The front leg must decelerate the body during landing and absorb high eccentric forces, increasing stress on the hamstring, knee joint and ankle structures.

The most robust findings came from moderate-quality evidence. Being at an older age was associated with a higher prevalence of fencing injuries among non-professional able-bodied fencers. Professional fencers in senior divisions also had a higher risk of time-loss injuries than those in junior or cadet divisions. Age itself is not necessarily the direct cause of injury, but it may represent accumulated load, higher competitive intensity and longer sport participation.

Experience as accumulated load

A greater number of years of fencing experience was also linked to higher injury prevalence among non-professional able-bodied fencers. Athletes with five or more years of fencing experience had higher injury prevalence than those with fewer than two years of experience. This may appear counterintuitive, as experienced fencers are often technically better prepared; however, greater experience usually means greater cumulative exposure. More years in the sport may bring more repetitive loading, more bouts and a higher likelihood of having sustained at least one fencing-related injury.

Movement quality matters

Functional Movement Screen (FMS)[1] scores below 15 were associated with higher injury prevalence, although the evidence for this factor was very low and should be interpreted with caution. The notion is still clinically relevant: movement quality, dynamic control and compensatory movement patterns may influence injury risk. However, general screening tools may not fully capture the specific demands of fencing, such as in asymmetrical lunging, rapid retreats, blade-arm coordination and sport-specific balance requirements.

Weapon, sex and competition level: plausible, not definitive factors

Several factors that may seem intuitively important were supported only by low- or very low-quality evidence. Weapon type is one example. Many coaches and athletes may assume that foil, épée and sabre have clearly different injury risks because of the different tactics, rules and movement patterns involved in their use. Despite this, the review found that weapon type was not consistently associated with injury prevalence among non-professional able-bodied fencers. However, low-quality evidence suggested that professional sabreurs may have a higher risk of time-loss injuries than épéeists. This possible sabre effect is biomechanically plausible. Sabre fencing is fast-paced and explosive, involving frequent attacking and defensive actions, rapid changes of direction and short bursts of high-intensity movement. These demands may increase neuromuscular fatigue, impair dynamic balance and raise the risk of lower-limb injury. Nevertheless, weapon type should be viewed as a potential contributing factor rather than a confirmed independent predictor.

Sex was another factor supported with mixed evidence. Although some very low-quality evidence suggested that female fencers may be more likely to sustain certain thigh strains, meta-analysis did not show a clear overall difference in time-loss injuries between male and female professional fencers. In fencing, injury risk may be shaped more by training load, weapon type, competition level, biomechanics and experience than by sex alone.

Level of competition deserves careful interpretation. Professional and international-level fencers generally appeared to have higher rates of injury than non-professional or university-level fencers. This likely reflects greater amounts of training, higher match intensity and longer exposure to the risk of injury. However, the evidence linking competitive level to injury prevalence was of very low quality. The practical message is not simply that elite fencing is "more dangerous", but that higher-performance environments require more systematic monitoring, recovery planning and injury prevention support.



Notes

1 Functional Movement Screen (FMS) is a screening tool for evaluating 7 functional patterns in individuals with no current pain complaint or musculoskeletal injury.

Fitness programmes: a misleading signal

One unexpected finding was the positive association between regular participation in fitness programmes and higher injury prevalence. At first glance, this seems to challenge the value of conditioning. A likely explanation is reverse causality or exposure bias: athletes with higher performance goals, previous injuries or heavier training loads may be more likely to participate in fitness programmes. Indeed, the evidence was of very low quality, with a wide confidence interval, so this should not be interpreted as meaning that fitness training increases injury risk. Instead, it highlights the need for well-designed, fencing-specific conditioning that supports movement control, strength balance, recovery and load management.



Wheelchair fencing and trunk control

For wheelchair fencers, the injury patterns were different. Upper-limb injuries were the most common, particularly around the shoulder, elbow and forearm. Without lower-limb footwork, wheelchair fencers rely more heavily on trunk movement and repeated weapon-arm actions to generate reach, speed and power. When trunk control is limited, the upper limbs may compensate, increasing the risk of overuse and acute injury.

Poor trunk control emerged as a risk factor for injury. Although the evidence was of very low quality and based on limited data, this finding is highly relevant from a sports science perspective. Trunk stability is central to force transmission, reach control and repeated weapon-arm movement in wheelchair fencing. For practitioners, trunk control should therefore be considered a key performance and injury-management variable in wheelchair fencers.

Tailored protection for a demanding sport

This review provides the first systematic synthesis of research findings focused on injury prevalence and incidence, and associated factors in able-bodied and wheelchair fencing. The findings show that fencing injuries are common, particularly among professional and more experienced athletes. Able-bodied fencers are most vulnerable to lower-limb injuries, while wheelchair fencers face greater upper-limb injury risk. Being an older practitioner and with longer fencing experience are the most consistently supported factors linked with higher injury prevalence. For coaches, clinicians and sports science professionals, the various insights derived from the meta-analysis underscore the importance of targeted injury monitoring, fencing-specific conditioning and tailored support for athletes across different fencing formats.

Prof. Wong has been recognised by Stanford University as one of the top 2% most-cited scientists worldwide (single-year) in the field of orthopaedics for three consecutive years, from 2023 to 2025. He is a renowned leader in spinal pain research. By integrating AI and advanced technologies, his work on low back pain and scoliosis earned him the 2026 International Society for the Study of the Lumbar Spine Prize in the Bioengineering Category. His research also gained him the SOSORT Award from the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment in 2019 and 2025. Prof. Wong actively contributes to the international spinal research community through multiple leadership roles. He serves as Deputy Editor of the European Spine Journal, Treasurer of the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment, Education Committee Member of the International Society for the Study of the Lumbar Spine (ISSLS), Co-Chair of the ISSLS Task Force on Diagnosis and Treatment of Lumbar Spinal Stenosis, and Chair of the Organising Committee of the 20th International Forum for Back and Neck Pain Research in Primary Care.

References:

[1] Grivas, T. B., Wong, S. C. Y., Chan, L. L. Y., Lee, M. S. H., Fong, H. H. K., Wong, A. Y. L., Samartzis, D., Chang, J. R., & Fu, S.-N. (2025). The Prevalence and Incidence of Fencing Injuries and Associated Risk Factors: A Systematic Review and Meta-Analysis. *Clinical Journal of Sport Medicine*, 35(6), e105-e133. https://doi.org/10.1097/JSM.0000000000001386

Breaking the Vicious Cycle: Psoas Major Stiffness and Low Back Pain

New Insights from Elite Athletes in High-Risk Sports

Lower back pain is one of the most common injuries among elite athletes. Intensive training often tightens the psoas major muscles, causing pain that further disrupts posture and performance. Prof. Fu, a sports rehabilitation expert with the National and Provincial Sports Bureaux of the Chinese Mainland, led research on high-risk athletes that clarifies this correlation, helping athletes break the vicious cycle.

Prof. Amy Siu Ngor FU
Associate Head (Rehabilitation Sciences) and Peter Hung Professor in Pain Management, Department of Rehabilitation Sciences
Associate Director, Research Institute of Sports Science and Technology



Low back pain (LBP) is a major challenge in sport, particularly in disciplines that demand repeated spinal loading, extreme ranges of motion and explosive trunk–hip control. For athletes, LBP is not only a clinical problem. It affects athletes' competitive performance and also leads to an early ending of their sporting life. The psoas major (PM) muscle, the only muscle that links the torso and the leg, has long been proposed as being a contributor to LBP; the evidence, however, has remained unclear.

Located deep in the low back, the PM muscle attaches directly to the lumbar vertebrae of T12 to L5 and their intervertebral disc. It travels downward at the front of the hip and ends as a tendon into the lesser trochanter of the hip. It plays an important role in stabilisation of the spine; it contributes to flexion and allows for extension of the hip joint. In sports involving rapid kicking, trunk bending, jumping, landing and high-speed changes in body position, requiring both strength and flexibility, the PM muscle are the foundation for trunk- hip control. The question is whether muscle stiffness could be associated with chronic LBP in high-performance athletes.

To address this issue, Prof. Amy Siu Ngor FU, Associate Head (Rehabilitation Sciences) and Peter Hung Professor in Pain Management of the Department of Rehabilitation Sciences at The Hong Kong Polytechnic University, and her research team investigated whether the mechanical properties of the PM muscle, particularly stiffness, are associated with chronic LBP in elite athletes. Their research compared PM stiffness, strength and joint flexibility in elite athletes with and without chronic low back pain, and examined whether these muscle properties were related to pain intensity and sport-related dysfunction among symptomatic athletes. The results were published in *Sports Medicine – Open* [1].

The team found that elite athletes with chronic LBP showed higher PM stiffness on the pain-affected side compared with athletes without LBP. This was more pronounced when pain occurred on the dominant side. Importantly, greater PM stiffness was also associated with greater LBP-related dysfunction. By contrast, PM strength and hip extension range, used as an indicator of flexibility, were not significantly associated with chronic LBP.

A high-risk athletic setting

The study recruited 99 full-time elite athletes aged 10 to 32 years from provincial gymnastics and wushu teams. Of these, 53 athletes had chronic LBP, defined as pain located between the lower margin of the 12th rib and the buttock crease, with or without persisting or fluctuating leg pain for more than three months. The control group comprised athletes who had not experienced LBP in the previous three months.

Gymnastics and wushu participants are particularly relevant populations for this investigation. Both sports place high physical demands on the lumbar spine and hip complex. Gymnasts frequently perform repeated trunk extension, flexion, rotation, jumping, landing and extreme-range movements. Wushu athletes perform rapid kicking, deep stances, high-velocity trunk movements and dynamic transitions that require precise control of the pelvis, spine and lower limbs.

In both sports, the PM muscle must contribute to hip motion while helping to stabilise the lumbar spine under demanding and often asymmetrical loading conditions. This makes it a muscle of particular interest. If excessive stiffness develops, it may alter trunk-hip control. If LBP changes muscle activation patterns, the PM muscle may also become stiffer as a protective or compensatory response. This raises the possibility of a vicious cycle: pain may increase stiffness, and increased stiffness may further compromise movement and spinal loading.

Measuring stiffness with ultrasound imaging

A major strength of the study was the development of an objective approach for measuring the stiffness of the PM, which is located about 5cm from the skin surface. An ultrasound shear wave elastography (SWE), a non-invasive imaging technique that quantifies muscle stiffness by measuring shear-wave propagation through tissue, was used to quantify regional information about the mechanical behaviour of the muscle itself.



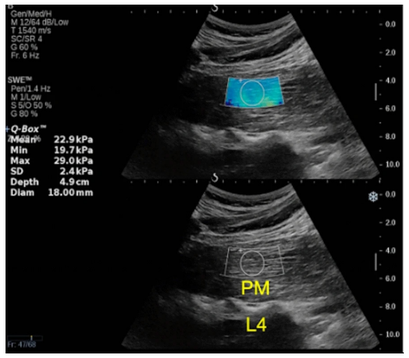


Figure 1. Anatomical adjacencies and ultrasound SWE measurement of PM

During imaging, athletes were positioned side-lying with the spine and upper leg maintained in neutral alignment. Cushions were used to support consistent positioning of the trunk, hips and lumbar spine. A low-frequency curvilinear ultrasound probe was placed above the iliac crest along the mid-axillary line and adjusted to visualise the L4 vertebra beneath the psoas major. Images were acquired along the long axis of the muscle fibres (*Figure 1*). To minimise the influence of recent training, all assessments were performed approximately 30 hours after the athletes' last scheduled training session. This method was found to have high test-retest reliability.

PM strength was measured using a handheld dynamometer in a position designed to target the psoas more specifically than general hip flexor testing. Flexibility was assessed using the modified Thomas test, with hip extension range measured by a goniometer. Pain severity was assessed using the Numeric Pain Rating Scale, while sport-related dysfunction was assessed using the Oslo Sports Trauma Research Center (OSTRC) Questionnaire on Health Problems.

Greater stiffness in athletes with low back pain

The results showed a significant association between chronic LBP and increased PM stiffness on the affected side. After adjusting for potential confounding factors including age and body mass index, athletes with pain on the dominant side had 17.2% higher PM stiffness than controls (*Figure 2a*). This represented a mean difference of 3.21 kPa and exceeded the minimal detectable change reported in previous reliability work, suggesting that the difference was not only statistically significant but also clinically meaningful.

Athletes with pain on the non-dominant side also showed higher PM stiffness than those in the control group, although the difference was smaller. Their affected-side PM stiffness was 8.7% higher, with a mean difference of 1.65 kPa (*Figure 2b*). This finding was statistically significant, but the magnitude was below the minimal detectable change, indicating that it should be interpreted more cautiously.

The stronger effect on the dominant side is particularly relevant in elite sport. Dominant-side movements often involve greater technical emphasis, repeated loading and higher force production. In sports such as wushu, for example, the dominant leg may be used more frequently for high-speed kicking or leading movements. Over time, this may expose the dominant-side PM muscle to greater mechanical demand, potentially contributing to regional adaptations in stiffness.

Stiffness relates to sport-related dysfunction

One of the most important findings was that PM stiffness was not merely different between groups. It was also related to functional impact among athletes with chronic LBP. In athletes who experienced pain on the dominant side, higher PM stiffness showed a moderate positive correlation with scores on the OSTRC Questionnaire (*Figure 3*). In practical terms, athletes with stiffer PM muscles tended to report greater problems in sport participation, amount of training, performance and pain.

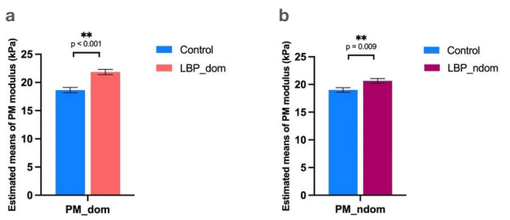


Figure 2. PM stiffness of the **(a)** dominant side and **(b)** non-dominant side between LBP and non-LBP control groups

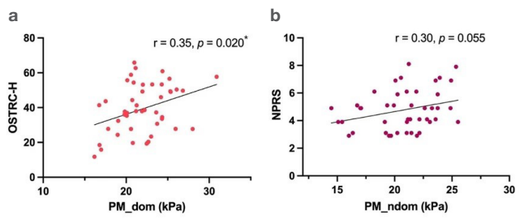


Figure 3. Association between PM stiffness and severity of LBP on the **(a)** dominant side and **(b)** non-dominant side



This association is important because athletic LBP should not be evaluated only by pain intensity. In competitive sport, the key concern is often whether an athlete can train fully, perform technical skills and tolerate sport-specific loading. A muscle property that relates to sport-related dysfunction may therefore be highly relevant to performance management and rehabilitation planning.

Interestingly, PM stiffness did not show the same clear relationship with pain intensity. This suggests that stiffness may be more closely linked to movement limitation and performance-related consequences than to perceived pain alone. Increased stiffness might act as a protective strategy to restrict movement around the painful region, but this same response could interfere with the mobility, coordination and dynamic control needed in gymnastics and wushu.

By contrast, PM strength and hip extension range were not significantly associated with chronic LBP, pain intensity or dysfunction. This does not mean strength and flexibility are unimportant in athlete care. Rather, it indicates that conventional measures may not fully capture the relevant changes in a deep stabilising muscle such as the PM muscle.

Towards a stiffness–pain cycle

The findings support a possible two-way relationship between PM stiffness and LBP. Increased psoas tension may raise compressive and shear forces on the lumbar spine, particularly around the lower lumbar segments, potentially contributing to discomfort or dysfunction. At the same time, chronic pain may alter neuromuscular control, leading to protective muscle activation, co-contraction or spasm, which could increase PM stiffness.

In this sense, PM stiffness and LBP may reinforce each other. A stiffer PM muscle may alter spinal loading and reduce dynamic control. Pain may then promote further protective stiffness. For athletes in high-risk sports, this cycle could affect both symptoms and performance.

Overall, this study provides evidence that PM stiffness is associated with chronic LBP and sport-related dysfunction in elite gymnastics and wushu athletes. The association was strongest when pain occurred on the dominant side. In contrast, PM strength and flexibility were not significantly related to LBP. The findings highlight the potential value of assessing regional PM stiffness when managing athletes with LBP. While further longitudinal and interventional studies are needed to clarify cause and effect, PM stiffness may become an important marker for understanding LBP risk, guiding rehabilitation and supporting performance in high-demand sports.

Prof. Fu is a physiotherapist specialising in sports training and rehabilitation. She is the Programme Leader of the Master of Science in Sports Physiotherapy programme at PolyU. Her research focuses on sports injuries, particularly chronic pain and dysfunction associated with tendons and muscles, as well as the early detection, assessment and rehabilitation of musculotendinous problems to optimise athletes' movement and sports performance. She has developed several wearable devices for knee pain, earning a Silver Medal at the 2023 Geneva International Exhibition of Inventions, a Gold Medal in 2024 and a Bronze Medal at the 4th Asia Exhibition of Innovations and Inventions Hong Kong in the same year. Since 2008, Prof. Fu has been invited by the National and Provincial Sports Bureaux of the Chinese Mainland to serve as a sports rehabilitation expert for major games, including the Paris 2024 Olympic Games. She has led the Departmental Sports Physiotherapy team, serving the Sport Associations under the China HK Olympic Committee, sport teams within PolyU and the Sports Clinic under the PolyU Rehabilitation Clinic.

References:

[1] Zhou, E.F.M., Wong, A.Y.L., Lin, G., Huang, J., Fang, J., Liang, W., Cai, X. & Fu, S.N. Differences in Psoas Major Muscle Properties Between Elite Athletes with and Without Chronic Low Back Pain. *Sports Med - Open* 12, 20 (2026). https://doi.org/10.1186/s40798-026-00983-5

Transforming Sweat Management with Novel Leaf-Inspired Sportswear

Vascular-Patterned Fabric Enhances Drying, Comfort and Cooling Under Heavy Perspiration

Effective moisture management is vital for athletes, yet conventional sportswear often saturates under heavy sweating. Prof. Fan's team developed a biomimetic vascular cool fabric inspired by leaf veins. Compared with a fully wet surface, it achieved 54.2% higher evaporation per unit wet area, 18% better drying efficiency, 15% less sweat accumulation and a 24.1% comfort gain.

Prof. Jintu FAN
Chair Professor
and Lee Family Professor in Textiles Technologies,
School of Fashion and Textiles
Director, Research Centre of Textiles
for Future Fashion



For athletes, sweating is essential. It is the body's natural cooling system, helping dissipate heat during intense exercise or in hot environments. However, when sweat accumulates faster than clothing can transport and evaporate it, garments become heavy, sticky and clammy. This not only reduces comfort but may also impair performance, especially during prolonged training or competition.

Conventional moisture management textiles are designed to move sweat away from the skin and spread it across the fabric surface for evaporation. They work well under low to moderate perspiration, but often struggle under heavy sweating. Once saturated, clothing may cling to the skin, restrict comfort and cause a post-exercise "clammy chill".

Prof. Jintu FAN, Chair Professor and Lee Family Professor in Textiles Technologies of the School of Fashion and Textiles at The Hong Kong Polytechnic University, led his research team to address a key sportswear challenge: how to manage large amounts of sweat while keeping the wearer drier, lighter and more comfortable.

Novel Invention: Vascular Cool Fabric

In their research published in *Advanced Functional Materials* [1], the team introduced a vascular cool fabric, a biomimetic textile patterned like leaf veins. By combining hydrophilic sweat-wicking channels with hydrophobic dry regions, the fabric distributes sweat efficiently while avoiding full-surface wetting. The optimised design achieved a 54.2% higher evaporation rate per unit wet area and an 18% improvement in drying efficiency compared to a fully wet fabric surface, 15% less sweat accumulation in T-shirts and a 24.1% improvement in overall comfort during human wear trials.

Inspiration from Leaf Veins

The design was inspired by the plant vascular system. In leaves, vein networks transport water rapidly and distribute it across broad areas, supporting efficient transpiration from small wet regions. The team translated this principle into textile engineering by creating a fabric surface with a leaf-vein-like vascular pattern (*Figure 1*).

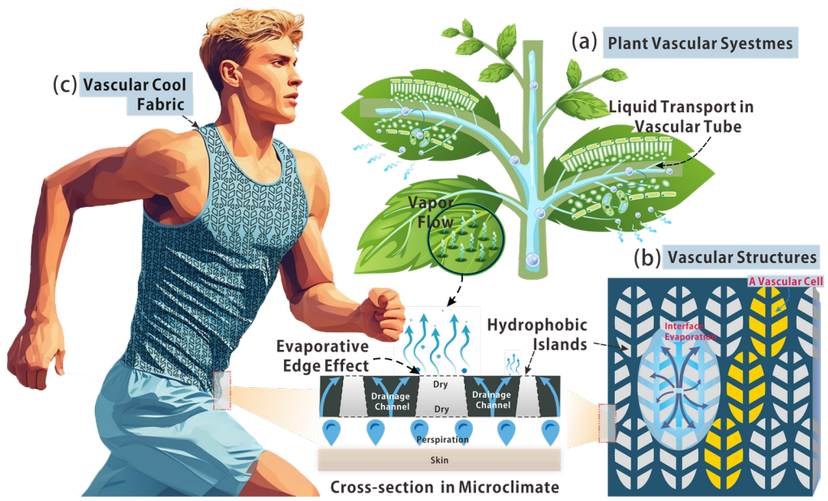


Figure 1. Schematic illustration of the mechanism behind the vascular cool fabric

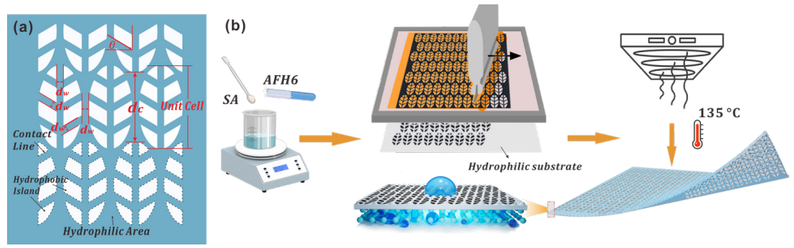


Figure 2. Characterisation and fabrication of the vascular pattern in fabric

Instead of making the whole fabric uniformly absorbent, the novel fabric uses a biphilic surface: some regions are hydrophilic and attract water, while others are hydrophobic and repel it (*Figure 2a*). Sweat is guided through the hydrophilic channels, while the hydrophobic "islands" remain relatively dry. This structure allows sweat to spread across the garment without saturating the entire surface.

A key mechanism behind the design is the evaporative edge effect. Evaporation is especially efficient at the boundary between wet and dry areas, where the vapour concentration gradient is steeper. By creating many wet–dry interfaces, the vascular pattern increases the effective evaporation edge, improving evaporation efficiency without requiring the whole fabric to become wet.

Optimised Vascular Design

The vascular cool fabric was produced using a screen-printing process (*Figure 2b*). A hydrophobic sol–gel mixture was selectively printed onto hydrophilic fabric, leaving vein-like wicking channels uncoated. This created a clear dissimilarity between water-attracting and water-repelling regions in the treated fabric. The wicking channels were highly hydrophilic, with contact angles of ≤5°, meaning water spread rapidly through them. The coated islands were hydrophobic, with contact angles of ≥120°, helping them resist wetting and reduce next-to-skin stickiness. According to the test subjects' feedback on their wearing experience, the treated fabric with biphilic properties exhibited essentially the same hand feel and surface texture as the original fabric.

The team optimised three main design parameters: the branch angle, branch width and vertical distance between vascular units. The best-performing pattern used a 33° branch angle, 4 mm wicking branch width and 34 mm vertical wicking distance. This configuration balanced fast lateral spreading with efficient upward wicking.

The 33° branch angle was particularly important. Because knitted fabrics wick liquid at different speeds along their length and width, the orientation of the branch channels directly affects how quickly liquid spreads across the fabric. The optimised angle provided the best balance between longitudinal continuity and lateral dispersion, enabling the fastest expansion of the wet surface.

The 4 mm width enabled smooth and continuous liquid propagation. Channels that were too narrow could temporarily trap liquid and slow lateral movement, while overly wide channels lacked sufficient capillary pressure, diminishing the forward drive of the droplets in the saturated fibre yarn.

54.2% Higher Evaporation Per Wet Area

In sweat management testing, the optimised vascular pattern demonstrated clear advantages under heavy sweating conditions. Although the fabric used only around 62–63% of its surface as wet area, it achieved substantially improved evaporation performance. Compared with a fully wet pristine polyester fabric, the optimised vascular cool fabric delivered a 54.2% higher evaporation rate per unit wet area and improved 18% in drying efficiency.

Compared with other pattern configurations of identical hydrophilic area ratio, the vascular design also demonstrated superior performance in real-time sweat transport and evaporation. Its effectiveness originated from the vein-inspired geometry, which combines a favorable span-to-diameter ratio with a higher unit-area contact line density. These structural advantages facilitated rapid capillary wicking along the vein-like channels and intensified evaporation at the extended wet–dry boundaries, thereby outperforming alternative designs.

Importantly, the approach was not limited to one textile substrate. The same vascular pattern was applied to different fabrics, including one-way moisture transport fabric, super-hydrophilic polyester and cotton blends. Across these substrates, the treated fabrics showed an average 1.7-fold increase in evaporation capacity compared with their pristine versions, supporting the versatility of the design for sportswear applications.

Wash durability was also considered. Suitable polyester substrates retained their biphilic performance for over 20 cycles, while cotton fabrics demonstrated even greater robustness, sustaining effective performance through more than 40 laundering cycles. Super-hydrophilic substrates were especially effective in preserving the long-term wicking function of the vascular channels.

Human Wear Trials in Heat and Humidity

To evaluate real-world comfort, the team first conducted human wear trials in a hot and humid environment of 30 °C and 65% relative humidity. Participants wore

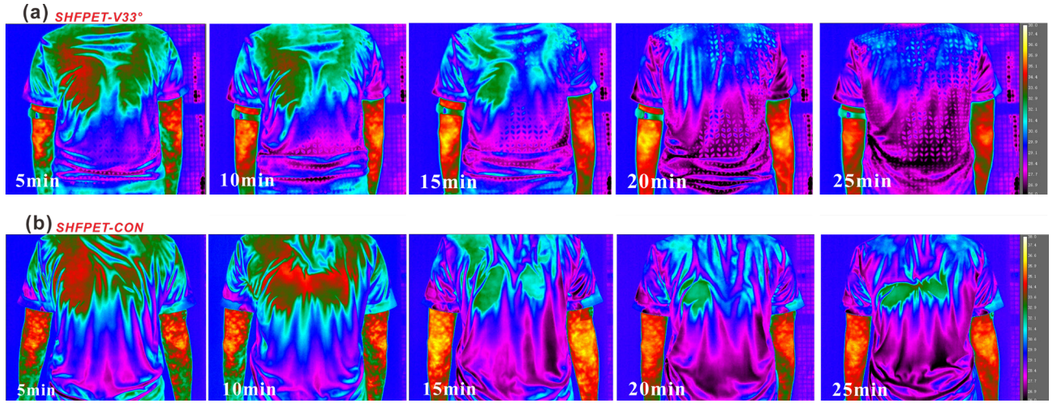


Figure 3. Infrared images of back-side wetting in **(a)** the vascular-patterned T-shirt and **(b)** and the control fabric T-shirt during resting. The red-green areas indicate the sweat distribution.

T-shirts made from the vascular-patterned fabric and from the control fabric during exercise and recovery.

The vascular T-shirt consistently maintained a cooler and drier skin microclimate, with measurable reductions in both skin temperature (up to 0.208 °C) and humidity (up to 2.7% RH). Sweat accumulation data further confirmed the benefits. Compared with the control group, the vascular-patterned T-shirt showed 15% less sweat accumulation at the end of experiment. Infrared imaging also revealed reduced sweat adhesion: wet fabric clinging to the body disappeared around 10 minutes earlier in the vascular group during the resting stage (*Figure 3*).

These physiological improvements translated into pronounced perceptual benefits: during recovery, the vascular fabric improved dampness sensation by 13.6%, reduced stickiness by 18.2% and reduced stuffiness by 21.4%. Overall comfort improved by 24.1% by the end of the test.

The performance of vascular cool sportwear was also validated under neutral thermal conditions (25 °C, 65% RH). Controlled tests showed that vascular cool fabric sustained efficient sweat management, whereas the control fabric tended to form a continuous liquid film on the skin in human wear trials. This film increased fabric thermal conductivity, leading to a more pronounced damp–cold discomfort response during rest and a sharper skin temperature drop under 32.5 °C (a threshold close to the skin's thermal comfort zone, where deviations either higher or lower can cause discomfort).

The study finally found a strong relationship between sweat accumulation and perceived discomfort. Sweat accumulation accounted for 87.4% of the variance in overall comfort perception, highlighting that comfort under heavy perspiration depends not only on heat dissipation, but also on how much residual moisture remains on the skin and in the garment.

This study presents a promising biomimetic strategy for next-generation thermoregulatory sportswear. By mimicking leaf vascular networks, the vascular cool fabric guides sweat through hydrophilic channels while keeping part of the garment surface dry. The resulting wet–dry interfaces enhance evaporation through the edge effect, while the reduced wet area helps minimise stickiness, dampness and clammy discomfort. Notably, this design is compatible with common textile processes and multiple fabric substrates, giving it strong potential for future sportswear, outdoor apparel and occupational heat-protection applications.

Prof. Fan was recognised by Stanford University as one of the top 2% most-cited scientists worldwide (career-long) in the field of materials and polymers in for six consecutive years, from 2020 to 2025, and one of the top 2% most-cited scientists worldwide (single-year) for seven consecutive years, from 2019 to 2025. He is a renowned expert in the field of fashion and textiles. In recognition of his contributions to the field, he was honoured with the Morgan Sesquicentennial Fellow from Cornell University, the Honorary Fellow of The Textile Institute in 2010, which is the highest honour within the Institute for creativity and advancement of knowledge, and the Distinguished Achievement Award from the US-based International Fibre Society in 2003. His outstanding research and innovations have earned him numerous prestigious awards, including the Warner Memorial Medal from The Textile Institute in 2016 and a Gold Medal at the 32nd International Exhibition of Inventions of Geneva in 2004. Prof. Fan has a prominent international standing in the field and served as the President of the US-based International Fibre Society in 2018, the Director of the Shanghai International Fashion Innovation Centre from 2016 to 2019 and the Chairman of the Hong Kong Institution of Textiles and Apparel from 2019 to 2022.

References:

[1] Wu, Y., Pu, Y., Shahzad, A., Zhang, H., Yuan, L., Kang, Z., Fan, J. Leaf Vascular Patterned Fabric for Advanced Liquid Sweat Management. *Advanced Functional Materials* 36, no. 13 (2026): e13020. https://doi.org/10.1002/adfm.202513020

Next-Generation 3D Self-Folding Fabric for Adaptive Thermoregulation in Athletes

Novel Dual-Mode Textile Enables Switching Between Warming and Cooling

Athletes often face rapidly changing environments, yet traditional sportswear is designed for only one condition. Prof. Shou, a rising young scholar in advanced textiles, developed a novel 3D self-folding knitted fabric for next-generation sportswear. In its relaxed state it provides high thermal resistance for warming; when stretched, it achieves 89.5% solar reflectivity, 93.5% infrared emissivity and a 4.3 °C cooling effect under sunlight.

Prof. Dahua SHOU
Lee Family Young Scholar in Advanced Textiles Technology and Associate Professor,
School of Fashion and Textiles

Associate Director,
PolyU-Xingguo Technology and Innovation Research Institute

Associate Director,
Research Centre of Textiles for Future Fashion



Athletes often train and compete in environments that change quickly. A runner may start in cool morning air and finish under intense sunlight; a hiker or high-altitude athlete may face wind, cold and strong solar radiation within the same session. Traditional sportswear is usually designed for one condition: insulation for cold weather, or breathability and cooling for heat. When the environment shifts, athletes must add, remove or carry extra layers, which is not always practical.

Thermal discomfort is more than an inconvenience. Overheating can impair endurance and increase heat-stress risk, while sudden cooling after exertion can accelerate heat loss and discomfort. To address this problem, Prof. Dahua SHOU, Lee Family Young Scholar in Advanced Textiles Technology and Associate Professor of the School of Fashion and Textiles at The Hong Kong Polytechnic University, and his research team have developed a fabric that can adapt structurally, offering both warming and cooling functions in a single textile system. The novel invention was evaluated, and the results were published in *Nano-Micro Letters* [1].

The Invention: A Dual-Mode Self-Folding Fabric

The team introduced an all-weather 3D self-folding knitted fabric for adaptive personal thermoregulation. In its relaxed 3D state, the fabric traps still air and provides high thermal resistance of 0.06 m^2 K W^{-1} for warming. When stretched into a flatter 2D state, its coated surface reflects sunlight and emits infrared heat, achieving 89.5% solar reflectivity, 93.5% infrared emissivity and a 4.3 °C cooling effect under sunlight.

The key innovation is not only the material chemistry, but also the fabric architecture. Instead of relying on a static textile with fixed thermal properties, this fabric changes shape to regulate heat transfer.

As illustrated in *Figure 1*, in warming mode, the knitted textile remains in its natural 3D folded form, where the folded structure creates air-filled cavities within the fabric. Since still air has very low thermal conductivity, these cavities act as insulation, reducing heat loss from the body. The folded structure also limits air movement between cavities, reducing convective heat transfer.

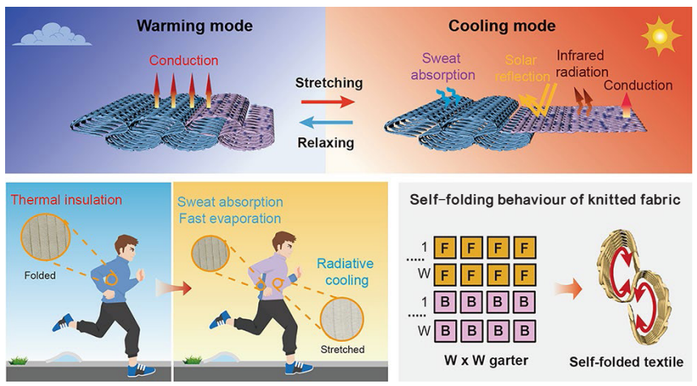


Figure 1. Schematic of a dual mode textile demonstrating warming mode and cooling mode, and the design of the fabric

In cooling mode, the fabric is manually stretched, changing the textile from a thick 3D structure into a thinner 2D form. The reduced thickness supports heat transfer away from the skin, while the coated surface manages radiative heat exchange. TiO_2 enhances solar reflection, while polydimethylsiloxane (PDMS) supports high infrared emission. Together, they help the fabric reflect incoming solar energy and release body heat through infrared radiation.

This dual-mode concept is particularly relevant for outdoor sports, where athletes need both cold protection and solar heat management without changing garments.

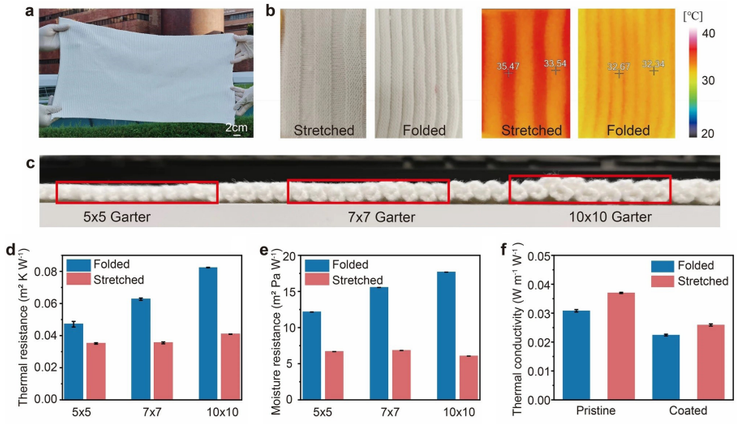


Figure 2. Thermal properties of the fabric in warming mode.
(a) The textile for warming mode
(b) The fabric under stretched and folded states
(c) The fabric with 5 × 5, 7 × 7 and 10 × 10 garters
(d-f) Thermal resistance, moisture resistance and thermal conductivity of the pristine fabric in folded and stretched states

3D Knitting: The Engine of Self-Folding

The fabric was manufactured using a scalable flat weft knitting technique with commercially available yarns, including cotton and Coolmax. Cotton contributed structural stability, while Coolmax supported moisture-wicking and evaporation.

The self-folding behaviour comes from the arrangement of front and back stitches in a garter structure. By combining these stitch types, the fabric naturally curls and folds after knitting, without requiring complex post-processing.

Different garter structures were tested, including 5 × 5, 7 × 7 and 10 × 10 configurations. Increasing the number of courses increased both thickness and elongation. For example, the 5 × 5, 7 × 7 and 10 × 10 fabrics reached elongation ratios of 100%, 140% and 200%, respectively, while larger structures became more prone to self-weight elongation and instability.

The study identified the 7 × 7 garter structure as a balanced design, offering effective folding, stretchability and stability. In this structure, the fabric thickness decreased from 4.37 mm in the folded state to 1.23 mm when stretched, enabling a clear switch between insulation and heat release.

Warming Mode: Trapping Still Air

In cold conditions, the fabric works as an insulating layer. The relaxed 3D structure traps still air within the folded cavities, reducing thermal conduction and convection.

Figure 2 shows the fabric in warming mode and illustrates the detailed testing results. The results show that the 7 × 7 garter fabric had a thermal resistance of 0.0627 m^2 K W^{-1} in its folded state. When stretched, thermal resistance decreased to 0.0355 m^2 K W^{-1}. This confirms that the fabric's thermal performance can be tuned simply by changing its architecture.

The thicker folded state is suitable for warming, while the thinner stretched state supports cooling. Thermal imaging also showed that folded fabric retained more heat than stretched fabric, with a temperature difference of more than 1 °C between the two states on a hotplate.

This structure-driven warming mechanism is valuable because it does not require batteries, phase-change packs or active heating elements. The fabric uses geometry and air management to reduce heat loss.

Cooling Mode: 89.5% Solar Reflectivity

For cooling, parts of the fabric were coated with TiO_2 and PDMS. The optimised coating used a TiO_2 particle weight ratio of 4.5% and was applied twice. This provided strong optical performance while avoiding excessive stiffness.

The coated fabric reached 89.5% solar reflectivity, compared with 78% for the pristine fabric. This higher reflectivity reduces solar heat absorption, which is crucial for athletes exposed to direct sunlight.

The coating also achieved 93.5% emissivity in the mid-infrared range. High infrared emissivity allows the fabric to release heat effectively, particularly through the atmospheric window. Under outdoor sunlight, the coated stretched fabric was up to 4.3 °C cooler than the pristine fabric. Under a solar simulator, the cooling difference reached 4.9 °C.

Wearable sleeve tests further demonstrated body-level relevance (*Figure 3*). When worn on the forearm under solar exposure, the coated fabric reduced skin temperature by more than 1 °C compared with the pristine fabric.

Breathability, Moisture and Wear Comfort

Adaptive thermal performance is only useful if the fabric remains wearable. The study thus assessed moisture transport, air permeability, stretch recovery, durability and washability.

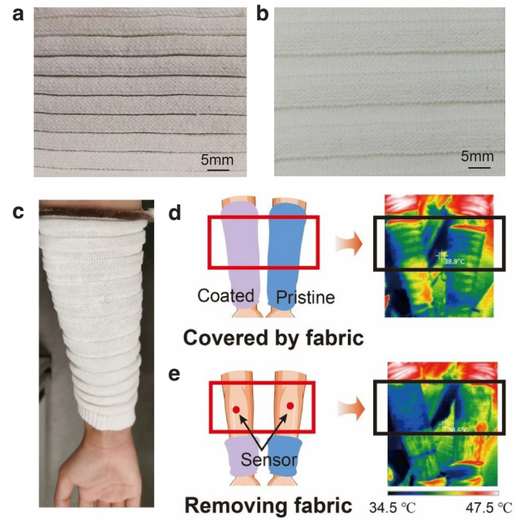


Figure 3. Thermal properties of the fabric in cooling mode.
(a) The coated folded fabric
(b) The coated stretched fabric
(c) Arm with a sleeve made of coated fabric
(d, e) Schematic and thermal images of arms covered by the coated and pristine fabrics, and the fabrics removed after exposure

The fabric retained good air permeability in both modes. For pristine fabric, air permeability decreased from 27.56 to 22.44 mL s^{-1} cm^{-2} when stretched. The fully stretched coated fabric still maintained 18.7 mL s^{-1} cm^{-2}, indicating that the coating reduced but did not eliminate breathability.

Water vapour transmission tests showed that the fabric in cooling mode still allowed moisture to escape, helping maintain comfort during exercise. The use of Coolmax yarn also improved liquid moisture management. The 3D fabric achieved a water absorption rate of 387.89%, higher than that of the commercial comparison fabric at 210.41%. Its evaporation rate was also higher, at 1.182 g h^{-1} compared with 1.035 g h^{-1}.

Durability results were encouraging. The fabric endured more than 1,000 folding and stretching cycles, with recovery improving over time. After 24 hours, coated fabrics showed stretching recovery rates below 5%, and after 48 hours the residual deformation was almost negligible. Washing tests showed minimal weight loss, suggesting good coating stability. Tensile testing also indicated that the coating strengthened the fabric, with the coated fabric reaching a maximum load of 245.9 N, approximately 2.73 times that of the pristine fabric.

Implications for Sports Science and Apparel Design

This research addresses a practical challenge in sportswear: how to support athletes across changing thermal environments without requiring multiple clothing layers. The self-folding fabric provides a passive, switchable system that can insulate in cold conditions and cool under sunlight.

Potential applications include those for endurance running, hiking, cycling, mountaineering, outdoor labour and travel apparel. For product developers, the use of scalable knitting and commercially available yarns is particularly important. The design does not depend on electronics or complex active systems, making it more realistic for textile manufacturing.

From a sports science perspective, the fabric also highlights the importance of multi-mechanism thermoregulation. Effective clothing should not only reflect sunlight or provide insulation, but also manage conduction, convection, radiation, breathability and sweat transport.

In conclusion, this study introduces a promising all-weather 3D self-folding knitted fabric that adapts to both cold and hot conditions through structural transformation. For athletes and outdoor professionals, such textiles could reduce dependence on layering, improve comfort in unstable weather and support safer performance in increasingly unpredictable climates.

Prof. Shou was recognised by Stanford University as one of the top 2% most-cited scientists worldwide (career-long & single-year) in the field of materials for four consecutive years, from 2022 to 2025. Over 100 peer-review papers have been published in prestigious journals such as Science and Science Advances. He is a leading expert in advanced textiles, intelligent wearables, and thermal and moisture management. His groundbreaking intelligent soft robotic clothing "iAdapt" recently won the Gold Award in the "Consumer Solutions" category at the 2026 Edison Awards. His innovative contributions have earned him numerous prestigious awards, including Gold Medals at the International Exhibition of Inventions of Geneva in 2024 and 2025, with Congratulations of the Jury in 2025, and the TechConnect Global Innovation Award in 2021 and 2022. In recognition of his outstanding contributions to textile research, he received the Fiber Society's 2023 Distinguished Achievement Award. Prof. Shou currently serves as a Governing Council Member and Deputy Director of The Fiber Society (USA) and Associate Director of the Intelligent Fiber and Wearable Technology Committee of the China Textile Engineering Society, and served as Chair of the Fiber Society Spring 2025 Conference in Hong Kong.

References:

[1] Zhang, X., Gu, Y., Chao, X., Wang, Z., Wu, S., Xu, J., ... & Shou, D. (2025). All-weather 3D self-folding fabric for adaptive personal thermoregulation. *Nano-Micro Letters, 17*(1), 290. https://doi.org/10.1007/s40820-025-01812-2

[2] Shou, D., & Li, Z. (2025). Sustainable personal cooling in a warming world. *Science, 389*(6763), 877-878. https://www.science.org/doi/full/10.1126/science.adt9536

[3] Shou, D., & Li, Z. (2025). Personal moisture management by advanced textiles and intelligent wearables. *Advanced Materials, 37*(48), e08831. https://advanced.onlinelibrary.wiley.com/doi/full/10.1002/adma.202508831

More Than Just a Tight Fit?

A Validated Biomechanical Model Reveals the Secrets Beneath the Fabric

Compression leggings are widely used to stabilise muscles and boost circulation, yet traditional designs focus mainly on external tightness rather than how pressure affects deep tissues. Prof. Yip's team developed a pioneering subject-specific 3D biomechanical model of the female lower body, enabling more precise evaluation of pressure distribution and muscle loading for next-generation compression wear.

Prof. Joanne Yiu Wan YIP
Associate Dean and Professor,
School of Fashion and Textiles
Interim Director,
PolyU-Zhongshan Technology and Innovation Research Institute



Designed to "stabilise muscles and boost circulation", whether for running, weight training or post-workout recovery, compression leggings are widely used by athletes and fitness enthusiasts. In the past, compression wear was designed based on how "tight" it felt on the outside. In reality, the effectiveness of compression wear depends on how pressure is distributed and how deep muscles handle the load. When a fabric hugs the body, what actually happens to the fat and deep muscles beneath the skin is something that is perhaps not widely considered.

To address this issue, Prof. Joanne Yiu Wan YIP, Associate Dean and Professor of the School of Fashion and Textiles at The Hong Kong Polytechnic University, led her research team to develop a pioneering subject-specific 3D biomechanical model of the female lower body. Their breakthrough study was published in the *Journal of Bionic Engineering* [1].

Inside the Body: Three Key Discoveries Under Compression

What makes this study unique is the team's use of high-resolution MRI data to precisely reconstruct the skin, bones and nine major muscle groups of the female lower body, including the gluteus maximus, rectus femoris and gastrocnemius (*Figure 1*). Through in vivo indentation testing, they also simulated the actual stiffness of different tissues.

When the 3D model "wore" the specialised compression leggings, three striking discoveries were revealed:

1. Pressure Distribution: Tightest at the Calves, Loosest at the Hips

Contrary to popular expectation, the compression applied to the leg is not uniform across the entire limb. The simulation in *Figure 2* shows that the calf experiences the highest surface pressure (approx. 2158 Pa), while the lower hip receives the lowest (approx. 1050 Pa). Because the calf has less fat, stiffer muscle tissue and a smaller circumference, it pushes back against the fabric with the greatest force.

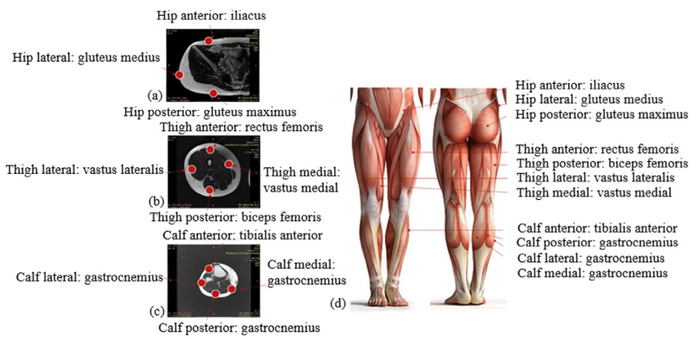


Figure 1. In vivo indentation test points on the anatomical structure of **(a)** the hip, **(b)** the thigh, and **(c)** the calf sections, evaluated at four positions: anterior, posterior, medial and lateral. **(d)** corresponding plan view

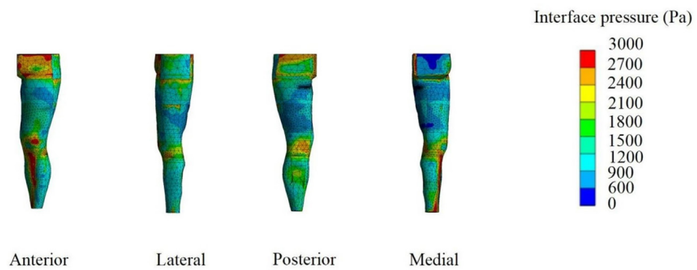


Figure 2. Simulation interface pressure caused by compression leggings

2. Soft Tissue Deformation: High Pressure Does Not Mean High Displacement

Soft tissue deformation followed a different pattern. The greatest simulated deformation occurred in the hip region and progressively decreased towards the ankle (*Figure 3*). Surprisingly, the greatest shape change occurs in the hip area—deforming by up to 9.43 mm due to its higher volume of compliant soft tissue (fat and muscle). Meanwhile, the calf, which experiences the highest pressure, deforms by a mere 0.76 mm. This indicates that designers must account for the actual "displacement" of fat when tailoring different panels of a garment.

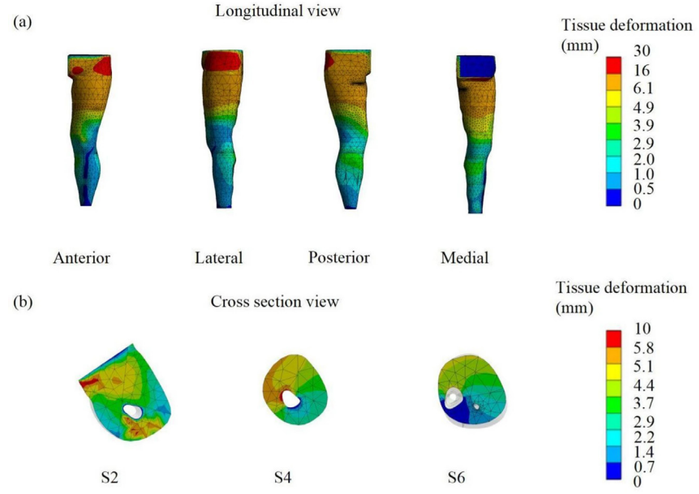


Figure 3. Simulated tissue deformation caused by compression leggings: **(a)** longitudinal views and **(b)** cross-sectional views at the low hip, thigh and calf, respectively

3. Deep Muscle Stress: The Tibialis Anterior Experiences the Most Squeeze

External pressure travels deep. The model revealed that the tibialis anterior (front of the calf) experiences the highest internal stress at 3338 Pa, followed closely by the outer thigh muscles. Moderate internal stress is beneficial—it compresses blood vessels to speed up blood flow and aid recovery. However, excessive stress can cause fatigue and discomfort.

The Future of Compression: From "Squeezing Everything" to "Precision Mapping"

Through this research, Prof. Yip suggests that the development of the deformation-aware interactive design system enables us to "communicate" with the body, rather than blindly wrapping fabric around it. With this dynamic 3D model, future compression leggings will move away from generic "one-size-fits-all-tightness" designs. Instead, they will use "precision gradient compression"—utilising fabrics with different elasticities mapped directly to local muscle stiffness and bone locations. This means firm support for the calves to boost circulation, together with comfortable shaping for the hips, achieving a true "second skin" fit.

Building on this biomechanical foundation, the team further developed a deformation-aware interactive design system powered by a physically-constrained PointNet model [2]. Trained on extensive 3D scan data, it delivers real-time predictions of soft-tissue deformation and pressure. Fashion designers can now use an intuitive interface to visualise, tweak and optimise compression leggings in a fast "tweak–predict–see–decide" cycle — transforming scientific insights into practical, precision garment design.

Prof. Yip was recognised by Stanford University as one of the top 2% most-cited scientists worldwide (career-long) in the field of materials for two consecutive years, from 2024 to 2025, and one of the top 2% most-cited scientists worldwide (single-year) for four consecutive years, from 2021 to 2024). As a leading expert in new materials and technology, her inventions have earned her numerous prestigious prizes, including four Gold Medals at the International Exhibition of Inventions of Geneva in 2012, 2015, 2017 and 2023, including the rare Congratulations of the Jury in 2017 and 2023, two Gold Medals (2019 and 2024) and the Special Prize of the Korea Invention Promotion Association (2024) at the Silicon Valley International Invention Festival, the Asia International Innovation Invention Award (Gold Award) from the Hong Kong Federation of Innovative Technologies and Manufacturing Industries in 2023, and the Champion at the 4th Hong Kong Innovation Day in 2020.

References:

[1] Li, X., Ye, C., Song, H. et al. Biomechanical Effects of Compression Leggings: 3D Finite Element Analysis of Pressure, Tissue Deformation, and Muscle Stress. *Journal of Bionic Engineering* (2026). https://doi.org/10.1007/s42235-026-00968-w

[2] Li, X., Yip, J. & Ye, C. 2026. Beyond Rigid Avatars: A Deformation-Aware Interactive System for Garment–Body Design Exploration. In Proceedings of the 2026 Conference on Creativity and Cognition (C&C '26). Association for Computing Machinery, New York, NY, USA, 1713–1717. https://doi.org/10.1145/3803784.3816884

Beyond the Shoe: The Overlooked Role of Running Socks in Foot Protection

New Findings Highlight the Cushioning Potential of Advanced Fibres and Five-Toed Designs

Running socks play a key role in comfort, impact protection and injury prevention, yet their cushioning performance is often overlooked. Prof. Yick's team found that specialised running socks provide greater impact attenuation and reduced plantar pressure in high-load forefoot areas compared with regular socks, highlighting the value of optimised materials and design for better foot protection.



Prof. Kit Lun YICK
Associate Dean and Professor,
School of Fashion and Textiles

For many runners, socks may seem less important than shoes, insoles or training devices. However, as the layer in direct contact with the skin, running socks play an essential role in comfort, impact protection and injury prevention. During running, the foot repeatedly experiences impact forces that may reach two to three times a person's body weight. Over time, this repeated loading can contribute to discomfort and common foot problems, including blisters, abrasions, calluses and other mechanical skin injuries.

Although running shoes themselves and insoles are often the main focus of performance and injury-prevention research, socks also influence how the foot interacts with footwear. A well-designed sock can help reduce local pressure, absorb impact and improve the distribution of plantar loading. In contrast, regular running socks may offer limited protection if their material and structure are not optimised for high-impact activities.

Specialised running socks have therefore become increasingly popular among recreational and competitive runners. These products often use high-performance fibres, thicker terry structures, padded areas and alternative toe designs such as five-toed construction. However, despite the wide range of commercial products available, their cushioning effectiveness has not been fully understood.

Prof. Kit Lun YICK, Associate Dean and Professor of the School of Fashion and Textiles at The Hong Kong Polytechnic University, and her research team investigated the cushioning performance of commercially available running socks, including regular running socks, specialised traditional running socks and specialised five-toed running socks. The team examined both the mechanical properties of sock fabrics and their effects on plantar pressure distribution during running. The results, published in *Materials* [1], supported the notion that specialised running socks offer better shock absorption than regular running socks.

The results found that fabric thickness, terry length and fabric mass, which were strongly linked to impact reduction, in specialised running socks showed better cushioning performance than in regular running socks. During running, specialised socks reduced peak pressure and pressure impulse in high-load areas of the forefoot, particularly the big toe and first metatarsal head, while also shortening forefoot ground contact time.

These findings suggest that advanced materials and structural design can help reduce mechanical stress on the foot during running. Notably, the five-toed sock showed comparable pressure-reduction performance to the specialised traditional sock, indicating that the split toe design may offer a promising alternative approach to managing forefoot loading.

The experimental work was conducted in two parts.

First, the team tested the mechanical properties of the fabric of the sole regions of eight commercially available running socks. These included regular running socks made from bio-based and/or synthetic materials, as well as specialised traditional and specialised five-toed running socks made with high-performance bio-composite fibres. The specifications are listed in *Table 1* and *Table 2*. Before testing, all samples were conditioned for 24 hours in a standardised environment.

Compression, tensile and shear properties were measured using standard textile testing equipment. Impact force reduction was assessed using a customised test rig simulating free-fall impact. In this test, a ball bearing was released from a fixed height onto the sock fabric, and the reduction in peak force transmitted through the material was calculated.

The impact test revealed clear differences between regular and specialised running socks (*Figure 1*). Specialised socks generally showed a higher peak force attenuation ratio, with the best-performing sock reducing peak force by nearly 30%. Notably, wool-based running socks also demonstrated relatively strong cushioning and compression recovery, which may be related to the natural elasticity of wool fibres. In addition, the peak force attenuation ratio was found to be significantly correlated with fabric thickness, terry length and fabric mass/unit (*Figure 2*).

Code	Fibre Content	Pattern Structure	Wearing Features (By Producer)	Picture	Front Organisation	Terry Structure
Regular running socks						
R1	67.9% Cotton, 27.7% Polyester, 4.4% Elastane	Welt: double-sided ribbing; Instep: single jersey; Arch part: single jersey with inlaid rubber thread; Heel and toe: terry knitted	Stretchy and comfortable			
R2	52.1% Wool, 30.7% Polyamide, 13.2% Polyester, 4% Elastane	Welt: double-sided ribbing; Instep: single jersey; Arch part: terry knitted with inlaid rubber thread (3:1); Heel and toe: terry knitted	Soft, good resilience			
R3	89% Polyester, 11% Elastane	Welt: double-sided ribbing; Instep: single jersey; Arch part: terry knitted with inlaid rubber thread (2:1); Heel and toe: terry knitted	Anti-bacterial, anti-odour, breathable			
R4	94% Nylon, 6% Spandex	Welt: double-sided ribbing; Instep: single jersey; Arch part: single jersey with inlaid rubber thread (2:1); Heel and toe: terry knitted	Moisture wicking, anti-odour			

Table 1. Specifications of tested regular running socks

Code	Fibre Content	Pattern Structure	Wearing Features (By Producer)	Picture	Front Organisation	Terry Structure
Specialised running socks (two traditional running socks and two five-toed running socks)						
P1	28% Drynamix®, 27% Mohair, 43% Nylon, 2% Elastane	Welt: double-sided ribbing; Instep: single jersey; Arch part: terry knitted with inlaid rubber thread (2:1); Heel and toe: terry knitted	Anatomically shaped for L/R, V-Tech arch support design			
P2	52% Drymax® Olefin, 32% Polyester, 11% Elastane, 5% Nylon	Welt: double-sided ribbing; Instep: single jersey; Arch part: terry knitted with inlaid rubber thread (3:1); Heel and toe: terry knitted	With Drymax dual-layer active wicking material			
F1	39% Coolmax®, 58% Nylon, 3% Lycra®	Welt: double-sided ribbing; Instep: single jersey; Arch part: terry knitted with inlaid rubber thread (2:1); Heel: terry knitted; Toe: single jersey	Five-toe design prevents blisters and redness			
F2	43% NüWoolTM, 43% Acrylic, 12% Nylon, 2% Lycra®	Welt: double-sided ribbing; Instep: single jersey; Arch part: terry knitted with inlaid rubber thread (2:1); Heel: terry knitted; Toe: single jersey	Five-toe design, moisture management			

Table 2. Specifications of tested specialised running socks

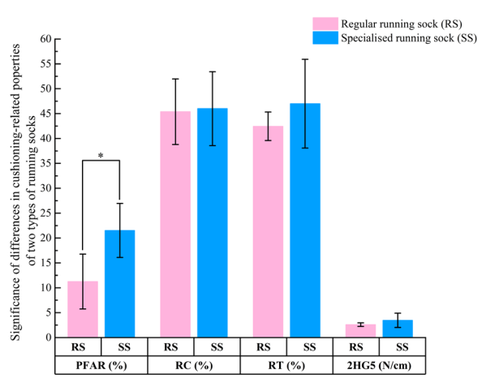


Figure 1. Difference in mechanical properties between regular and specialised running socks



Figure 2. Correlation analysis between basic specification parameters and PFAR

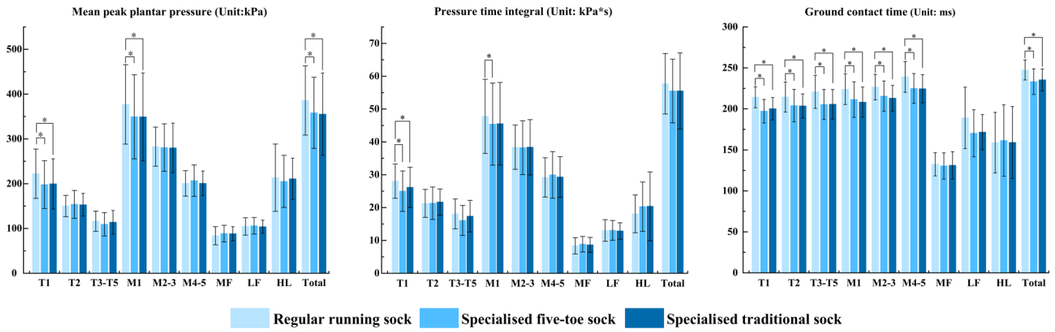


Figure 3. Comparison of plantar loading parameters for running for different socks

However, cushioning performance was not determined by thickness alone. Fibre composition and sock structure design also appeared to play an important role. Therefore, socks with similar fabric thickness and cushioning performance but different toe designs and fibre compositions were selected for the subsequent wear trial.

The second part of the study involved a treadmill wear trial with ten healthy male amateur runners. All participants were regular runners, right-leg dominant, heel strikers and free from lower-limb injury in the previous six months. Three sock types were selected for the wear test: a regular running sock, a specialised traditional running sock and a specialised five-toed running sock. To minimise external variation, all participants wore the same model of footwear and standardised sportswear.

In-shoe plantar pressure was measured using the Novel Pedar-X system while participants ran on a treadmill. The analysis focussed on maximum peak pressure, contact area, ground contact time and pressure-time integral across nine plantar regions.

Compared with the regular running sock, both specialised sock types significantly reduced maximum peak pressure in the great toe and first metatarsal head regions. They also reduced pressure-time integral in the toe regions, indicating a lower cumulative pressure load during running. Ground contact time in the toes, metatarsal regions and total foot was also shorter when runners wore specialised socks (*Figure 3*).

A notable finding was the performance of the five-toed running sock. Although its toe region was thinner than that of the traditional running socks because of its split-toe structure, it still reduced forefoot plantar loading effectively. Its pressure distribution was comparable to that of the specialised traditional running sock. This suggests that separating the toes may help optimise load distribution, offering a design strategy that does not rely solely on increasing material thickness.

Overall, this study demonstrates that specialised running socks can provide measurable cushioning benefits under both laboratory and running conditions. Compared with regular running socks, they showed greater impact attenuation and reduced plantar pressure in high-load forefoot areas. These benefits appear to result from a combination of fabric thickness, terry structure, fibre properties and toe design.

The findings highlight the importance of optimising material selection, fabric structure and sock design to enhance shock absorption and foot protection. The study also shows the value of combining textile material tests with biomechanical wear trials when evaluating sports sock performance.

As running continues to grow in popularity, scientifically informed sock design will become an increasingly important part of sportswear innovation. Specialised running socks, including five-toed designs, offer promising potential to improve comfort, reduce plantar loading and support better foot protection for runners.

Prof. Yick is a specialist in fashion production technology and product development. Her innovations have earned her numerous international awards, including Gold Medals and Special Merit Awards from the Scientific Community of Romania at the International Exhibition of Inventions of Geneva in 2015, 2017 and 2023, with Congratulations of the Jury in 2017. In addition to the analysis of running socks presented in this article, her recent research addresses exercise-induced breast motion in female athletes, leading to the development of a patented Soft Manikin System that uses 4D motion analysis to replicate human movement and soft tissue dynamics. This technology has been adopted by industry leaders and used to customise sports bras for elite athletes at the 2024 Paris Olympics.

References:

[1] Zhou, X.; Li, P.-L.; Yick, K.-L.; Yu, A. Cushioning Performance of Specialized Running Socks for Enhanced Shock Absorption and Reduced Plantar Pressure. *Materials* 2025, 18, 2941. https://doi.org/10.3390/ma18132941

PolyU RISports Delegation Visits General Administration of Sport of China Training Bureau and Institute of Sport Science



A delegation of ten representatives from the Research Institute for Sports Science and Technology (RISports) at PolyU, led by Prof. Ming ZHANG, Director of RISports and Head of the Department of Biomedical Engineering at the University, visited the General Administration of Sport of China Training Bureau and the China Institute of Sport Science in Beijing on 16 June 2026.

The delegation held discussions with representatives from both institutions on topics including scientific training for elite athletes, performance enhancement, injury prevention and rehabilitation. Both sides also explored potential collaboration in sports science talent development, joint research project applications and the commercialisation of research outcomes. The delegation also toured the training facilities and research laboratories to gain insights into the national team training system and current sports technology applications.

This visit further strengthened the ties between PolyU and national sports research institutions, laying a solid foundation for future collaboration in sports science and elite sports.



PolyU School of Optometry and China Hong Kong Paralympic Committee Sign MoU to Advance Para Sports Development and Support Vision Impairment Classification for Athletes



The School of Optometry at PolyU and the China Hong Kong Paralympic Committee (HKPC) signed a Memorandum of Understanding (MoU) on 5 June 2026. The two parties will leverage their respective strengths, combining academic research expertise with sports resources to foster the long-term development of Hong Kong's Para sports ecosystem, while providing comprehensive and professional support for Para athletes, coaches and practitioners.

Witnessed by Prof. David SHUM, Dean of the PolyU Faculty of Health and Social Sciences, and Mrs Jenny FUNG, President of China Hong Kong Paralympic Committee, the MoU was signed by Prof. KEE Chea-su, Head and Professor of the PolyU School of Optometry, and Dr Jim LUK, Vice President of China Hong Kong Paralympic Committee.

The PolyU School of Optometry will engage in deep co-operation with HKPC across four key areas:

- **Facilitating vision impairment classification:** Vision classification is essential for ensuring fair competition in Para sports. The PolyU School of Optometry will utilise its professional optometric expertise to assist visually impaired athletes in completing precise vision impairment classifications according to their specific sports.
- **Providing professional training and support:** PolyU will deploy an expert team to provide academic expertise and professional support for seminars, workshops and coaching courses organised by HKPC, while HKPC will facilitate connections with athletes, coaches and Para sports resources, thereby building a practical exchange platform.
- **Promoting joint research and educational initiatives**: Both parties will explore joint research projects, educational initiatives and development programmes, aiming to enhance training effectiveness and the eye health of Para athletes.
- **Fostering international collaboration and exchanges:** Both parties will jointly explore international collaboration opportunities to promote academic and technical exchanges between local and overseas Para sports organisations.

Looking ahead, both parties hope to harness this collaboration to unlock new opportunities for Hong Kong's Para sports community and jointly promote the popularisation and professionalisation of sports locally.

PolyU SFT Teams Up with lululemon in First Academic–Industry Collaboration to Promote Circular Fashion and Nurture Design Talent



The School of Fashion and Textiles (SFT) at PolyU has partnered with lululemon to advance circular fashion in activewear through a structured academic–industry collaboration embedded within the relaunch of lululemon's *Like New* programme in Hong Kong.

Like New is lululemon's circular take-back and resale initiative aimed at extending product lifecycles and promoting responsible consumption. Building on this foundation, the renewed partnership integrates education, design innovation and community engagement to cultivate circular thinking among the next generation of fashion professionals and consumers.

PolyU SFT's academic staff—Prof. KAN Chi-wai, Prof. Chloe KI, Prof. Tsai-chun HUANG, Prof. Magnum LAM and Prof. CHAN Hau-ling—and Miss LAI Chu-yi, an SFT alumna, are involved in this partnership.

The collaboration is implemented through three interconnected programmes that link classroom learning with real-world circular practice:

1. RE:FORM
The "RE:FORM" Circular Design Competition is a hands-on circular design competition in which students redesign end-of-life lululemon garments and surplus materials using circular design principles such as durability, modularity, repairability and material regeneration.

2. Like New Campus Voices
The "Like New Campus Voices" Engagement Programme is a student-led campus initiative that promotes awareness of lululemon's circular initiatives, including garment take-back and responsible consumption practices.

3. Move Like New
The "Move Like New" Circular Experience comprises campus-based experiential activities, including open yoga classes, designed to integrate wellness practices with circular lifestyle education.

All three initiatives are running until November 2026, with the "RE:FORM" competition outcomes to be announced that month. The winning entries will be exhibited in January 2027.

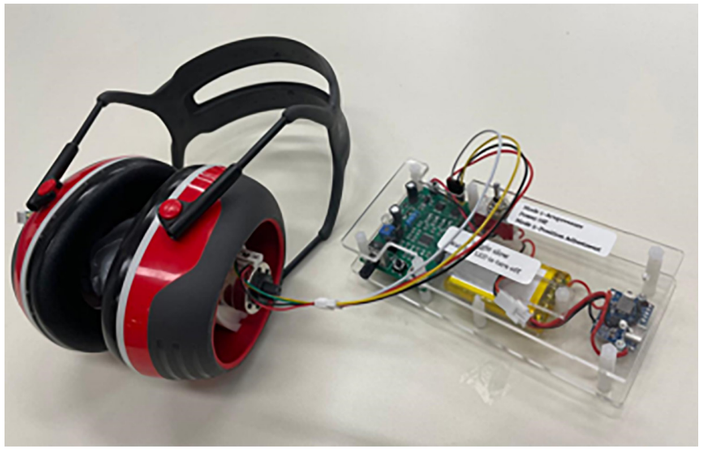
This collaboration represents PolyU SFT's first structured partnership with a globally renowned activewear brand in advancing circular fashion education in Hong Kong. By integrating lululemon's *Like New* relaunch with academic programming, the partnership establishes a meaningful model for translating industry-led circular initiatives into educational practice.

The initiative moves beyond conventional sponsorship or brand engagement. Instead, it embeds circularity within design experimentation, peer-driven engagement and experiential campus activities. Through the three programmes, students are not only exposed to circular concepts but are actively involved in applying them across design, communication and lifestyle contexts.

Upon completion in November 2026, this partnership is expected to strengthen students' circular fashion literacy, enhance their professional readiness for sustainability-oriented roles and cultivate sustained engagement with responsible consumption practices. At the institutional level, it demonstrates how academic–industry collaboration can serve as a catalyst for knowledge transfer, innovation and ecosystem development within the circular activewear sector.

More broadly, the partnership positions PolyU SFT as a key contributor to shaping future talent and advancing circular transformation within the global activewear sector.

PolyU RS Partners Globally to Advance Sports Science and Launch Innovative Recovery and Rehabilitation Technologies



Contract research with HKSI and evaluation of the device's effects at the GD Sports Training Centre: An auriculoacupressure device for sleep problems and chronic pain



Collaborative research with the Wuhan Sports Institute: A patellar mobilisation device for enhancing knee motion

The PolyU Department of Rehabilitation Sciences (RS) sports team, led by Prof. Amy Siu Ngor FU, Associate Head of the RS and Peter Hung Professor in Pain Management, has been partnering with national, provincial and local sports bureaus, institutes and hospitals, as well as global researchers. Together, they conduct research and knowledge transfer in sports rehabilitation, aiming to enhance sports performance, minimise injury incidence and facilitate injury recovery.

This partnership began in 2008 with the General Administration of Sport of China, where the team provided sports rehabilitation for national teams preparing for the Beijing Olympics, as well as planning and delivering sports physiotherapy services at the Olympic Village. In preparation for the 2024 Paris Olympics, this partnership has expanded to include a research project on sleep recovery for national athletes.

At the provincial level, the team has been providing research and services for the Guangdong Sports Training Centre since 2014, identifying injury profiles and risk factors in elite athletes to develop preventive guidelines. The team's most recent research project, funded by the Guangdong Sports Bureau, focuses on identifying sport-specific recovery strategies for elite athletes.

Locally, the team receives funding support from the Hong Kong Sports Science and Research Funding Scheme to design and test an auriculotherapy device for sleep problems in local athletes preparing for the All-China Games. Furthermore, it is partnering with the Wuhan Sports Institute to reveal the mechanism and effectiveness of another self-invented device: a patellar mobilisation device for anterior knee pain.

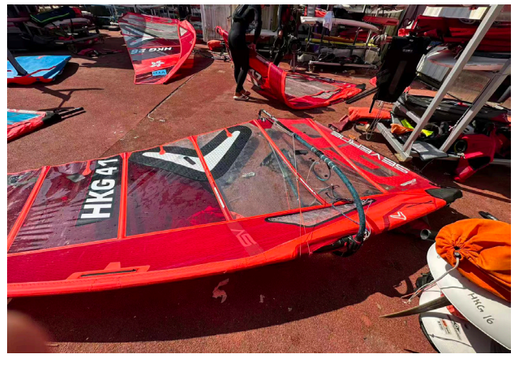
PolyU AAE and HKSI Partner on Research to Advance Elite Windsurfing Technologies



On-water pre-system research and testing

The Department of Aeronautical and Aviation Engineering (AAE) at PolyU and the Hong Kong Sports Institute (HKSI) are collaborating under the Sports Science and Research Funding Scheme on a research initiative focused on the application of innovative technologies in elite windsurfing starting from 2026. The project, titled "Smart Sports Monitoring System for Elite Windsurfing", runs from 1 May 2026 to 30 April 2028. Prof. Li-Ta HSU, Associate Professor of PolyU's AAE, serves as the project supervisor.

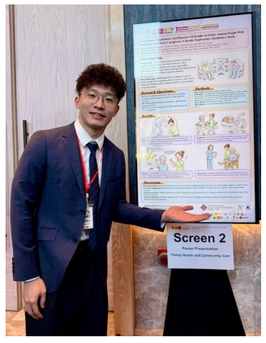
By integrating expertise in engineering, sensing technologies and sports science, the collaboration seeks to advance data-informed approaches to athlete monitoring and performance support. The partnership also fosters knowledge exchange between academia and the high-performance sports sector, contributing to the continued development of sports technology and sports science in Hong Kong.



Planned equipment mounting position on the sail

Presentation Award

PolyU SN PhD Student Secures Distinguished Poster Presentation Award at 2nd ICPC & FHN in 2026



Mr XIONG Jiaming, a PhD student from the School of Nursing (SN) at PolyU, won a Distinguished Poster Presentation Award at The 2nd International Conference on Palliative Care and Family Health Nursing, 2026, held in Thailand.

Mr XIONG received the award in Group 1 of the Family Health and Community Care category, for his research titled "Perceptions, Facilitators, and Barriers of Dyadic Activities Among People with Dementia and Their Caregivers: A Dyadic Exploratory Qualitative Study". He was supervised by Prof. WANG Shanshan, Assistant Professor of the SN at PolyU.

Mr XIONG's research presented the perceptions of dyadic physical activities of people with dementia and their caregivers, as well as their perceived facilitators, barriers and expectations for such activities.

The 2nd International Conference on Palliative Care and Family Health Nursing, 2026, was held at the Faculty of Nursing of Thammasat University Rangsit Campus in Thailand from 22 to 23 June. The conference's objectives were (1) "to exchange knowledge and research evidence among health professionals towards palliative care and family health nursing" and (2) "to initiate and build up networking and mutual collaboration among nursing professionals at an international level".

The conference covered topics on palliative care and family health nursing. The programme included a plenary session and major symposiums, as well as research and innovation presentation sessions featuring both oral and poster presentations.

References:

Xiong, J. (22–23 June 2026). *Perceptions, Facilitators, and Barriers of Dyadic Activities Among People with Dementia and Their Caregivers: A Dyadic Exploratory Qualitative Study* [Poster presentation]. 2nd International Conference on Palliative Care and Family Health Nursing, Thammasat University Rangsit Campus, Khlong Luang, Thailand.

Research Attachment

Three PolyU RS Undergraduates Chosen for RS Global Undergraduate Research Studentship Scheme

Three undergraduate students from PolyU's Department of Rehabilitation Sciences (RS) were successfully selected for the RS Global Undergraduate Research Studentship Scheme (GURSS), a six-week overseas research attachment.

The selected students are undertaking research training and academic exchange activities at the University of Sydney and the George Institute for Global Health, UNSW Sydney, Australia, from 27 July to 29 August 2026. This research attachment will provide them with valuable opportunities to gain international research exposure and broaden their academic horizons.

The selected students are as follows:

Name	Programme	Year
Mr Ray CHEUNG Wai-yip	BSc (Hons) in Occupational Therapy	3
Miss Hannah HUI Winglam	BSc (Hons) in Physiotherapy	2
Mr Sunny TSANG Chun-ho	BSc (Hons) in Physiotherapy	2



The attachment programme aims to foster students' research capabilities, strengthen global engagement and promote interdisciplinary collaboration with leading international institutions. Through direct involvement in ongoing research projects and mentorship from internationally renowned scholars, students will gain first-hand experience in academic research and evidence-based practice.

This international attachment reflects RS's commitment to nurturing research talent among undergraduate students and providing opportunities for global academic engagement.

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

Research Newsletter

INNOVATION DIGEST

Editorial Committee

Chairman Prof. Cheng DONG
Associate Vice President (Knowledge Transfer)

Members Prof. Zuankai WANG, Dean of Graduate School
Prof. Qingyan CHEN, Director of PolyU Academy for Interdisciplinary Research
Ms Priscilla HUNG, Director of Communications and Public Affairs
Ms Karen JIANG, Director of Institutional Planning and Analytics
Prof. Christina WONG, Director of Research and Innovation

Editorial and Design Research and Innovation Office
Communications and Public Affairs Office

Innovation Digest is published to showcase the groundbreaking research work undertaken by PolyU's academics, serving as a platform to induce inspiration and facilitate collaboration, as well as sparking new ideas and partnerships, to drive innovation in society. For contributions and enquiries, please contact the Research and Innovation Office at rio.general@polyu.edu.hk.

©The Hong Kong Polytechnic University

Published August 2026

If you would like to subscribe to *Innovation Digest*, please scan the QR code.

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

www.polyu.edu.hk

@HongKongPolyU

@The Hong Kong Polytechnic University

@香港理工大学

@香港理工大学 PolyU

Online Version

MIX
Paper | Supporting responsible forestry
FSC® C221015