CASES EXPERT STATEMENT

THE CASES EXPERT STATEMENT ON GROWTH AND MATURATION IN YOUTH SPORT, AND THE IMPLICATIONS FOR HEALTH, PERFORMANCE AND DEVELOPMENT

Produced on behalf of the Chartered Association of Sport and Exercise Science
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Youth sport systems remain predominantly organised according to chronological age, despite longstanding recognition that biological development during adolescence is highly variable within and between individuals. Within a single age group, differences in growth and maturation can equate to significant biological diversity (Malina *et al.*, 2004), influencing physical performance, injury risk, selection, and developmental outcomes. While concepts such as, maturity estimation, adjusted benchmarking and bio-banding are increasingly used, we are still learning about their wider benefits and applications. Growth, maturation and associated maturity strategies influence how athletes experience and respond to their youth sport environments in ways that influence their health, performance and development (e.g., Han *et al.*, 2026; Lindholm *et al.*, 2025). Thus, they present the potential to inform talent systems and policy with multi-faceted benefits for youth athletes.

This Expert Statement aims to discuss growth and maturation as a dynamic process embedded within complex sport systems, that influences how young athletes experience, interpret and respond to those environments in the contexts of both health and performance. Within this, it critically evaluates current approaches to injury risk, performance interpretation, and bio-banding, discussing integrated, context-sensitive models of practice. Accordingly, this statement reflects established and emerging perspectives on growth, maturation and associated maturity strategies to inform applied recommendations.

MATURITY ASSESSMENTS: EMBRACING UNCERTAINTY

Biological maturation has three constructs: the status, timing, and tempo of progress towards achieving a mature adult state (Malina *et al.*, 2004). A central feature of applied youth sport science is the categorisation of athletes relative to key maturational events (i.e., peak height velocity [PHV]; the period during adolescence when the rate of growth in height is at its maximum), typically using groupings such as pre-, circa-, and post-PHV. While these categories provide practical structure, they are based on predictive equations with inherent errors and a degree of uncertainty (Towlson *et al.*, 2021). However, it is widely accepted that early risk stratification is essential and indicators such as growth tempo (>7.2cm per year), being circa-PHV, atypical maturity timing (1 year), and heightened leg length velocity (>3.5cm per year), altered movement patterns, and symptoms like discomfort or fatigue, are important warning signals for practitioners (e.g., Towlson *et al.*, 2021).

Methods used to estimate somatic maturity, such as anthropometric prediction equations for maturity offset or percentage of predicted adult height, can vary significantly (Salter *et al.*, 2022) in accuracy and applicability (for example, because of self-report estimates of parental height; variation related

Article View

to ethnicity; or the use of reference values to calculate biological age and timing). Technologies such as hand and wrist ultrasound (e.g., SonicBone) have been developed and are emerging, but their long-term application and reliability require further investigation. As such and in the absence of direct measures of biological development, applied decisions are often necessarily informed by estimates. Best practice reflects an understanding of assessment limitations and how these assessments are fundamental to designing systems that are responsive to the needs of youth athletes.

GROWTH, MATURATION AND INJURY: A SYSTEMS PERSPECTIVE

Injury incidence and burden often increase during periods of rapid growth and in those with a higher growth tempo (Parry *et al.*, 2024). Growth-related changes, such as increased limb length, altered joint mechanics, and reduced neuromuscular control, may contribute to periods of increased vulnerability, but they do not operate in isolation. Injury risk emerges from the interaction between biological development and the surrounding environment. Key moderating factors include training load magnitude and progression, exposure to high-risk activities, movement competency and relative strength levels, adequate recovery, and psychosocial stressors. For example, an athlete may experience higher physical load and struggle to create the same quality of performance whilst also finding themselves confused about why this is the case, leading to the athlete also experiencing greater psychosocial stress. Simultaneously, coaches may view this decrease in performance negatively, which further increases the psychosocial stress on the athlete. Periods of maturation also often coincide with broader developmental challenges, including academic, social and identity-related considerations. Collectively, these interacting factors can create a crescendo of stress that further increases injury risk and influence broader athlete health and performance. Practitioners understand this relationship as multifactorial rather than directly causal between growth and maturation and injury risk. Accordingly, best practice reflects the need to consider growth and maturation within the wider training and performance environment, with practitioners adapting load distribution, movement quality, performance expectations, recovery strategies, and psychosocial support.

MATURATION, PERFORMANCE AND THE INTERPRETATION PROBLEM

Early-maturing male athletes tend to demonstrate superior strength, speed, and power, which contributes to their over-representation in youth sport when interpreted as them being more 'talented'. However, this interpretation is problematic when used blindly. Stakeholders (e.g., coaches, academy directors) may face pragmatic internal and external pressures to produce performance results for, for example, individual or organisational reputation, performance, or even business-related reasons, or may be unconsciously biased toward earlier maturing athletes. However, physical advantages linked to maturation are often transient, likely influence short-term performance more than long-term advantage; yet they disproportionately influence early selection decisions (Han *et al.*, 2026). Practitioner perspectives suggest that maturation can obscure the evaluation of technical and tactical ability, leading to over-selection of early maturers and under-recognition of late developers. These perspectives highlight a key challenge in that performance is context-dependent, and different environments value and demonstrate different aspects of ability. As such, practitioners should interpret performance within the context in which it is produced, by adopting a maturity-conscious approach rather than assuming transient performance reflects stable underlying talent.

Importantly, the implications of growth and maturation are not uniform across sexes. For example, while early maturation is often associated with performance advantages in boys' sport, maturation-related changes in body composition and physical performance characteristics may present different performance, developmental and psychosocial challenges for girls. These changes include a slower or plateauing accumulation of muscle mass relative to boys, alongside hormonal shifts (e.g., rising oestrogen) that influence strength, power and body composition trajectories differently than the testosterone-driven gains seen in male adolescents. While athletes, coaches and parents may interpret these changes negatively (e.g., "They've got slower", "They don't seem as fit as they used to be"), these are expected developmental processes. Stakeholder education on these changes can support realistic expectations and healthy adaptations to adolescence. This is especially important given that early maturing girls are at increased risk of sport dropout (Gallant et al., 2023).

BIO-BANDING: REFINING ITS ROLE IN PRACTICE

Bio-banding is one prominent strategy to address biological diversities, by grouping athletes according to maturity rather than chronological age. Typically, athletes are grouped based on their current maturity status, depending on the method used (i.e., maturity offset or percentage of predicted adult height). Bands are often <88% = pre-PHV, 88-95% = circa-PHV and >95% = post_PHV. While practitioner evidence indicates that bio-banding is perceived positively (Lindholm *et al.*, 2025), its application can be constrained by logistical and organisational factors (Towlson *et al.*, 2023) including staff resources, training scheduling and pathway preferences.

Evidence suggests that bio-banding holds physical, technical, and psychological benefits for youth athletes (e.g., Han *et al.*, 2026). In practice, however, applications have tended to focus primarily on biological maturity, while other sources of variation, such as skill level, cognition, and psychosocial domains, may be less explicitly considered.

Bio-banding may alter athletes' behaviours and performance expressions (e.g., Lindholm *et al.*, 2025), while also shaping their psychosocial and cognitive experiences, such as perceived competence, emotional responses, and cognitive load (e.g., Han *et al.*, 2026). In chronologically grouped competition, large maturity-related differences may promote maladaptive comparison standards for less mature athletes, contributing to reduced perceived confidence and greater evaluative stress. In contrast, bio-banded environments may provide more developmentally appropriate comparison contexts, whilst simultaneously increasing cognitive engagement through more balanced competition. Collectively, this suggests that maturation influences not only what athletes can do, but also how they experience and respond to developmental environments. Accordingly, psychological readiness, perceived competence, and external stressors (e.g., academic demands, social pressures, bodily changes) represent important considerations in maturation-informed practice.

In practice, emphasis is often placed on the benefits of bio-banding for late maturing athletes (e.g., Towlson *et al.*,

2023). For example, less mature athletes may experience greater physical engagement and technical involvement when grouped with peers of similar biological status, and may stand out more easily (Towlson *et al.*, 2023). However, consideration of bio-banding benefits for early maturers and how their potential can be maximised is equally important, especially given the large volume of early-selected, early-maturing athletes who do not make it to an elite level in their sport and the potential health implications associated with this.

FROM BIOLOGICAL VARIABLE TO SYSTEM AND POLICY-LEVEL CONSIDERATION

A common feature of current approaches is the tendency to somewhat understand growth and maturation as isolated athlete characteristics. However, their effects are shaped by the systems within which athletes develop. Training design, competition formats, and selection processes all interact with biological development to influence outcomes. Fixed, chronologically driven training structures may not accommodate individual developmental variability, selection policies may reinforce short-term performance advantages linked to advanced development, and competition systems may limit opportunities. Addressing these challenges requires continuing the shift incorporating individual-level adjustments into system-level thinking that strategically plans for growth and maturation variation, then into implementation into larger talent pathway policy (e.g., the Elite Player Performance Plan in football). A policy shift reflecting knowledge advances in this area from last decade may well increase the chances of potential being maximised from both late and early maturing athletes.

SUMMARY RECOMMENDATIONS FOR PRACTICE

We offer the following evidence- and practice-informed recommendations for considering growth and maturation, and its impact on health and performance in youth sports environments:

- Treat maturity estimates as probabilistic indicators and interpret injury risk within the interaction of growth, load, and environmental demands
- Use maturity-specific strategies proactively and intermittently, to expose both early and late maturing athletes to varied and developmentally appropriate challenges
- When using maturity strategies, deliberately plan for and integrate psychosocial, cognitive, technical and tactical benefits for both late and early maturers
- Integrate regular (i.e., quarterly, or more regularly when circa PHV) growth and maturation data with longitudinal athlete monitoring systems
- Update talent development systems and policies in a way that accommodates variability and negates the influence of maturation-related selection and progression bias

CONCLUSION

Growth and maturation considerations remain fundamental to youth athlete development, and their application in youth sport continue to be refined. Recent research and practice valuably highlight the complexity and uncertainty inherent in this area. Bio-banding offers a useful approach to managing maturity-related differences, but its existing application may not fully account for all maturity-related considerations (e.g., psychosocial or cognitive aspects). Embedding maturation awareness across multidisciplinary staff, sport organisations and governing bodies may complement ongoing efforts to create youth sport environments where youth athletes can healthily maximise their potential. ■

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REFERENCES

Gallant, F. *et al.* (2023). Puberty timing and relative age as predictors of physical activity discontinuation during adolescence. Scientific Reports, 13, 13740. https://doi.org/10.1038/s41598-023-40882-3

Han, C., *et al.* (2026). The Effect of Bio-Banding On Talent Identification in Youth Soccer: A Systematic Review. Journal of sports science & medicine, 25(2), 446–458. https://doi.org/10.52082/jssm.2026.446

Malina, R. M. *et al.* (2004). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. European Journal of Applied Physiology, 91(5-6), 555–562. https://doi.org/10.1007/s00421-003-0995-z

Lindholm, O. *et al.* (2025). Bio-banding in male under-15 and -16 ice hockey teams: A pilot study on players' and coaches' experiences. Journal of sports sciences, 1–15. Advance online publication. https://doi.org/10.1080/02640414.2025.2590942

Parry, G. *et al.* (2024). Associations between growth, maturation and injury in youth athletes engaged in elite pathways: a scoping review. British Journal of Sports Medicine, 58, 1001 – 1010. https://doi.org/10.1136/bjsports-2024-108233

Salter, J. *et al.* (2022). Estimating somatic maturity in adolescent soccer players: Methodological comparisons. International Journal of Sports Science & Coaching, 17(1), 11-17. https://doi.org/10.1177/17479541211020418

Towlson, C. *et al.* (2021). Maturity-associated considerations for training load, injury risk, and physical performance in youth soccer: One size does not fit all. Journal of sport and health science, 10(4), 403–412. https://doi.org/10.1016/j.jshs.2020.09.003

Towlson, C., *et al.* (2023). Soccer academy practitioners' perceptions and application of bio-banding. PLOS ONE, 18(1), e0274079.