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**Stakeholder Perceptions of a Novel Maturity Corrected Reporting
System for Performance Data within Professional Academy Football**

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Submitted in accordance with the requirements for the degree of
Master in Science by Research

York St John University

Science, Technology and Health

October 2025

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Acknowledgements

The author kindly thanks Jamie Salter, Dale Forsdyke, Chris Howe and Ross Mizen for their continuous support, advice and guidance throughout the course of this research project. Thanks are also due to the clubs for their cooperation and to all participants who generously gave their time to take part in the study.

A final acknowledgement is reserved for Theo, whose patience, understanding and unwavering support have been greatly appreciated throughout this journey.

Abstract

Player development lies at the heart of academy football, with clubs investing heavily in the identification and nurturing of talent (Reeves & Roberts, 2018; Sarmento et al., 2018). Selection decisions often rely on performance testing, yet athletes are grouped by chronological age despite large differences in biological maturation. Variations in growth affect physical performance, producing advantages for earlier maturing players (Hannon et al., 2020; Towlson et al., 2021).

These disparities contribute to maturity related biases in talent pathways, with later matures vulnerable to exclusion during key developmental stages (Güllich, 2014; Hill et al., 2023; Sweeney & Lundberg, 2024). Such effects challenge the inclusivity of academy systems and may reduce the diversity of athletes progressing into senior football. Subjective biases also shape how practitioners interpret and act on performance data, reinforcing structural inequalities (Golik & Blanco, 2021). While maturity correction models can adjust raw data to better reflect underlying ability, little is known about how stakeholders understand and apply such corrected outputs.

This study investigates stakeholder comprehension, perceptions and training prescription recommendations when presented with maturity corrected reporting of performance data. A mixed methods design was used, combining novel dashboards with semi structured interviews involving academy coaches, sport scientists and support staff.

Stakeholders perceived dashboards that combined maturity correction with clear, simple design as most effective. Quantitative findings showed Dashboard C (*Appendix 4*) received the highest ratings for visual appeal, content quality and role relevance, while Dashboard A (*Appendix 2*) was rated lowest. Thematic analysis revealed two overarching themes: enhancing clarity of data and enhancing decision making. Stakeholders noted that maturity correction improved interpretability, while straightforward visuals aided comprehension.

This study offers insights into the benefits and challenges of implementing maturity adjusted reporting systems, informing the design of tools that support equitable training prescription and reduce maturity bias in talent development.



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Introduction

Youth sport occupies a central role in modern societies, providing children and adolescents with opportunities for physical activity, social interaction and personal development. Participation rates remain high across Europe, with governments and sporting bodies promoting sport as a tool for both health and social inclusion (Emmonds et al., 2024). Parents and communities often view youth sport as a pathway for instilling values such as discipline, teamwork, and resilience, even in contexts where competitive achievement is not the primary focus (Eriksen and Stefansen, 2022). At the same time, research highlights the importance of social and environmental factors in shaping developmental opportunities, with supportive ecosystems enabling young people to progress within sport more effectively (Henriksen and Stambulova, 2023). Beyond participation, debates continue over how youth sport should be structured and whether it is always organised in a way that is just and inclusive, particularly given growing concerns over inequality and access (Torres and López Frías, 2023).

While many young people engage in sport for enjoyment, health or social reasons, for others it serves as the entry point into pathways designed to identify and nurture talent. This search for talent is prevalent across sports spanning athletics, swimming, football, gymnastics, cricket and beyond. However, participation patterns reveal complex trajectories rather than straightforward progressions to elite levels (Güllich et al., 2023). In many cases, athletes experience sampling across multiple sports before specialisation, which can benefit long term development. The Long-Term Athlete Development (LTAD) model, for instance, promotes early sampling as a foundation for later performance (Ford et al., 2011). Yet counter arguments emphasise that early specialisation, particularly in sports such as football can increase risks of burnout, dropout and overuse injuries (Carvalho and Gonçalves, 2023). Parents and families play a crucial role in this process, shaping expectations and providing support, but not all families can invest equally in the financial and emotional demands of sport (Eriksen and Stefansen, 2022). Moreover, existential challenges shape the athlete experience: identity formation, life skills development and the need to negotiate the uncertainties of pursuing elite performance (Ronkainen et al., 2023). These complexities highlight the difficulty of constructing fair and effective systems of talent development.

Identifying sporting talent has long been recognised as an inexact science, complicated by multiple biological, psychological and environmental variables. In particular, variation in biological maturation presents a fundamental challenge, with differences in the timing and tempo of growth shaping selection decisions during adolescence (Massa et al., 2022). Young athletes' progression is rarely linear, and the challenges they face can vary widely depending on personal perception and context (Williams and MacNamara, 2022). The experiences of failure and resilience form part of the developmental journey, but these can also contribute to attrition if environments fail to provide adequate support. Experienced sport psychologists emphasise that the design of youth pathways must balance performance goals with well-being and long-term athlete development (Thrower et al., 2024). Research into talent development environments highlights that while some contexts promote progression and holistic growth, others are dysfunctional, producing inequality or exclusion (Hauser et al., 2024). These challenges are amplified by the multidisciplinary nature of talent development, where physiological, psychological, and sociocultural factors must all be considered (Xiang et al., 2022). Consequently, accurately predicting future elite performance remains complex for practitioners and researchers alike.

Alongside these challenges, the professionalisation of sport has further shaped the structures of youth development. The governance of sporting organisations increasingly reflects professional standards, with policies designed to align youth development with elite success (Stieger et al., 2025). In the UK, the introduction of the Elite Player Performance Plan (EPPP) in 2012 reflects how policy reform has sought to professionalise youth football development, though this has raised debates about balancing elite goals with broader participation (Roe and Parker, 2022). From an athlete's perspective, professionalisation has influenced the expectations placed on coaches, with players reporting that professionalised environments demand not only technical skill but also relational expertise from coaching staff (Schubring et al., 2024). Systems level approaches suggest that youth sport and physical education must be viewed holistically, recognising the interconnection between grassroots participation and pathways towards elite competition (Bjørndal and Rudd, 2024). At the same time, growing specialisation in youth sport brings both benefits and risks, including higher injury rates and shorter careers (McLellan et al., 2022). Professionalisation therefore

presents both opportunities and challenges, particularly when applied to youth contexts where athlete welfare must be prioritised.

Amid these shifts, technology is increasingly viewed as a potential tool to support decision making in youth sport. Innovations in artificial intelligence (AI) and data analytics have transformed how athletes' training loads, physical outputs and even psychological indicators are tracked (Zhang et al., 2024). In the context of talent development, AI systems are being trialled to reduce human biases and analyse large datasets more effectively, offering new perspectives on long term potential (McAuley et al., 2024). Machine learning approaches may support talent scouting by integrating diverse performance indicators, revealing patterns not visible through traditional methods (Mittal and Rohit, 2025). These technological shifts are not only reshaping youth sport structures but also influencing the labour market within sport, as coaches, analysts and scouts adapt to more data driven practices (Glebova et al., 2024). The promise of such systems lies in their ability to complement, rather than replace, human expertise, helping to manage the inherent uncertainty of predicting future success.

Within this broader landscape, football has often been seen as a frontrunner in developing structured, professionalised talent pathways. While some critics argue this represents premature professionalisation, others suggest that it offers young players access to higher quality resources and coaching (Sweeney et al., 2021). Comparisons with other sports, such as cricket, highlight the relative advancement of football. Whereas, women's professional cricket pathways are still emerging, football academies have already established comprehensive developmental programmes (Runswick et al., 2024). Internationally, football's influence is also apparent, with Nordic systems emphasising equality of access alongside structured player development (Szerovay et al., 2023). However, even within football, challenges remain, such as the persistence of relative age effects within EPPP academies, where players born earlier in the selection year are overrepresented (Doncaster et al., 2024). These challenges highlight that despite football's progress, biases and inequalities remain embedded within systems designed to professionalise youth sport.

Taken together, these findings point towards a central challenge. How do we design youth sport systems that are both fair and effective in nurturing potential? Football provides a compelling case study because of its established professionalised structures and the extensive use of performance data within academy settings. Yet even here,

concerns persist around the interpretation of data, the impact of constructs such as biological maturation on performance and the ways in which reporting systems may influence stakeholder decision making. Addressing these challenges requires new approaches that both acknowledge developmental differences and present information in ways that are accessible to stakeholders. This study therefore focuses on “Stakeholder Perceptions of a Novel Maturity Corrected Reporting System for Performance Data within Professional Academy Football,” situating the research within the wider debates around youth sport and the professionalisation of development pathways.



Literature Review

Context of Football Academies

Structure and Demands

Elite football academies represent structured and resource intensive environments that aim to identify, develop and transition talented young players into the professional game. Under the EPPP, English academies are tiered into four categories based on their infrastructure, staffing, and support provision (Premier League, 2011). These systems cater to thousands of young players each year, yet only a small fraction progress to earn professional contracts. Longitudinal tracking has shown that less than 1% of players entering elite academy systems at a young age ultimately secure a career in senior professional football (Reeves and Roberts, 2018; Güllich, 2014). This high attrition rate places considerable emphasis on early selection decisions, raising concerns about whether the 'right' players are being retained and developed.

The academy journey typically begins at a young age, with some players recruited as early as age six (Williams et al., 2023). From that point, players engage in intensive training and competition schedules that can involve upwards of 8-12 hours per week, depending on age group and academy category (Mitchell et al., 2021). Salter et al. (2021) note that managing this training load is critical, particularly given the physiological demands of growth and maturation during adolescence. Biological maturity can vary significantly between players of the same chronological age, leading to discrepancies in physical capability, fatigue tolerance and injury susceptibility. Without careful monitoring, the combination of high training volumes and uneven maturity trajectories increases the risk of overuse injuries and delayed recovery.

Injury Risk and Developmental Pressure

Injury risk is a particular concern in academy environments, where early-stage physical development intersects with performance pressures. Common issues include growth related conditions such as Osgood-Schlatter disease, apophyseal injuries and joint pain. These conditions are often exacerbated by mismatches between physical maturity and training load. As players progress through the academy ranks, the cumulative training demands and competitive exposure can elevate injury incidence (Wik., 2021). This not only affects physical health but may also influence retention outcomes, with academy staff occasionally citing long term injuries in release decisions.

Beyond the physiological risks, the pressure to perform can skew developmental priorities. Despite the EPPP's emphasis on long-term development, many academies are inherently results driven, with short term performance often influencing selection and retention (Mitchell et al., 2021). This tension forces staff to balance recognising potential with rewarding immediate outcomes. Kite et al. (2024) found that earlier recruitment age and favourable anthropometric profiles, such as greater height or body mass, were associated with more successful progression through the system. However, these advantages often reflect early maturation rather than long term potential.

Selection Decisions and Stakeholder Dynamics

The retention and release processes are therefore not only frequent but also complex. Patel et al. (2020) identified that retention decisions in one elite academy were influenced by a mix of physical, maturational and performance factors, with relatively older and more physically mature players more likely to be retained. Yet, as Güllich (2014) highlighted in the German context, early de-selection does not necessarily indicate a lack of potential; some players may simply require more time or a different environment to realise their capabilities. This raises critical concerns about the timing and criteria used in selection, as releasing players too early risks overlooking those with high developmental potential.

The interplay between stakeholders within the multi-disciplinary teams that support player development further complicates the picture. Coaches, sport scientists, and medical staff all contribute to athlete management, but their perspectives can differ. Salter et al. (2021) observed variation in the use of maturity and training load data across academies, indicating inconsistency in how decisions are informed and communicated. Stakeholders face the challenge of balancing a range of quantitative and qualitative inputs, within a system that demands both performance and progression.

Taken together, these contextual factors highlight the high stakes nature of academy football. Young players operate in an environment marked by physical demands, developmental uncertainty and intense competition. While the structure and ambition of academy systems aim to foster elite performance, they also risk excluding players based on transient characteristics such as maturation timing or injury history. These realities present significant challenges for those responsible for identifying and developing talent within such complex and pressurised settings.

Challenges in Talent Development

Within youth football, talent identification and talent development are distinct yet interlinked processes. Talent identification refers to the recognition of individuals with the potential for future excellence, often involving early recruitment based on perceived ability (Vaeyens et al., 2008; Sarmento et al., 2018). Talent development, by contrast, focuses on the ongoing support, refinement, and progression of players already within the system. It includes decisions about training, playing time, and crucially, retention or release. As Till and Baker (2020) argue, the developmental environment plays a critical role in whether identified talent is ultimately realised. This study is concerned with talent development. Because the players included are already part of club structures, having passed the initial identification phase, this study focuses on supporting their continued progression and ensuring selection decisions are evidence informed. The dashboards in question serve as a tool within this developmental phase, aiming to assist staff in managing the ongoing evaluation and support of these young athletes.

Talent development within youth sport often involves a combination of objective data and subjective assessments. While objective data is essential in assessing physical capabilities and performance, subjective biases are inevitable in decision making processes. Coaches may, consciously or unconsciously, favour certain players based on personal preferences, past experiences, or even unacknowledged stereotypes (Golik & Blanco, 2021). This preference for specific traits or playing styles can significantly affect the selection process, with coaches potentially overlooking players who do not match their idealised vision of a talented athlete.

The long-term impact of excluding late developers, often driven by subconscious rather than deliberate bias, remains a persistent concern. Towlson et al. (2021) argue that decisions based on static physical benchmarks fail to accommodate the nonlinear nature of development, increasing the likelihood of premature deselection. Players may disengage from sport due to reduced confidence and limited opportunity, which is a frequent consequence. Morganti et al. (2023) add that early maturers may not sustain their performance edge as biological differences diminish with age. However, their study does not fully address the broader social and economic repercussions of excluding late developers from elite pathways. These findings raise questions about whether current systems inadvertently reinforce societal inequalities by privileging early maturers.

Talent development systems in youth sport are increasingly scrutinised for the biases they perpetuate. Among these, environmental biases such as disparities in access to coaching, facilities, and support can significantly shape an athlete's developmental opportunities. Stakeholders often fail to acknowledge these structural inequities, yet they can profoundly influence which players are identified and selected. For instance, athletes from more privileged backgrounds may benefit from higher quality training environments and greater exposure to scouts, regardless of their true potential (Golik & Blanco, 2021).

There has also been a growing interest in refining talent development systems, driven by recognition of the shortcomings in traditional, subjective methods. With increased awareness of how biases affect selection, the field has seen a shift towards more objective, data driven approaches. González-Rodenas et al. (2022) underline the value of understanding how tactical behaviours develop with age, illustrating the influence of biological maturity on decision making. This has prompted a rise in technologies and tracking systems designed to mitigate selection bias and support more accurate evaluation.

Despite advances in sports science, implementation within academy settings remains inconsistent (Hill et al., 2023). Studies offer valuable insights into maturity adjusted assessments, but without practical frameworks, their influence on policy and coaching practice is limited. Bartlett and Drust (2021) emphasise the importance of integrating research into applied environments, yet translation into coaching behaviour continues to fall short. The issue is not the lack of evidence, but the challenge of how it is communicated, understood, and operationalised by key decision makers.

Technological innovations, such as AI driven tools and interactive dashboards, have been promoted as potential solutions to this translation gap (Buchheit & Laursen, 2024). While these platforms improve access to data, they do not automatically lead to more informed decisions. Without appropriate training and stakeholder buy in, staff may underuse or misinterpreted complex systems, thus limiting their potential impact.

For meaningful change to occur, a multifaceted strategy is essential. One that goes beyond technology to include education, policy reform, and long-term collaboration among researchers, coaches, and academy leaders. Without these structural supports, the disconnection between science and practice is likely to persist, constraining the usefulness of maturity adjusted data in real world settings. Bartlett and Drust (2021)

highlight that effective knowledge translation is vital to ensuring research has practical impact. Yet, as Charbonnet et al. (2022) and Hill et al. (2020) argue, current reporting systems often fail to present actionable insights. Without user friendly reporting tools, staff may overlook or misapply maturity corrected data. Therefore, diluting its potential to improve talent development and training practices, especially when maturity itself remains inconsistently assessed and reported across the youth sport landscape.

Classifying Maturity Status in Youth Sport

In order to understand the implications of biological development on talent development, it is first essential to define what is meant by maturity status. Maturity status refers to the stage of biological development an individual has reached relative to their peers. Within youth sport, athletes are commonly grouped into one of three categories: early, on time or late maturers. These classifications are typically made by comparing an individual's biological maturation to population norms for their chronological age (Malina, 2011).

Early maturers are those who show advanced skeletal, hormonal, or physical development for their age. They are often taller, stronger, and faster during key adolescent years, which can lead to favourable treatment in selection decisions and increased playing opportunities (Cumming et al., 2006). In contrast, late maturers tend to lag behind their peers in terms of physical development, which can disadvantage them in performance-based evaluations, despite the possibility of catching up or even surpassing their peers in later adolescence. On time maturers fall close to the average developmental benchmarks for their age group and are often considered to represent the 'norm' in comparative assessments (Monasterio et al., 2024).

These categories are not simply descriptive, they carry significant weight in how young athletes are perceived, coached and selected. Physiological advantages associated with early maturation can lead to over selection, while late maturers may be unjustly overlooked, despite evidence suggesting that physical advantages tend to level out in adulthood (Perkins et al., 2022). Additionally, maturity status affects training responses and perceived exertion, with younger biological age often correlating with higher subjective fatigue even at similar workloads (Teixeira et al., 2022). Coaches and

practitioners must understand these differences to create equitable training environments and accurate performance assessments.

Importantly, maturity status is not only a physical marker but also influences psychosocial development. Research suggests that perceived support from coaches and adults can vary depending on an athlete's maturation stage (Cumming et al., 2006), which may influence motivation, confidence and long-term engagement in sport. Moreover, Kelly et al. (2019) highlight the 'underdog hypothesis'—the idea that late maturers, due to their early disadvantages, may develop compensatory skills such as resilience, tactical intelligence or technical finesse. While compelling, this remains a theoretical proposition that requires further empirical testing to determine whether such attributes translate into long-term performance benefits.

Some studies have called for more holistic classification systems that go beyond biological age. For instance, Sedeaud et al. (2025) argue for a more comprehensive approach to talent development that incorporates 'life pathways', including relative age, biological maturity and training age. This holistic view offers a deeper understanding of development but raises questions about practicality. Longitudinal tracking of these variables may be difficult to implement consistently across sporting environments, especially in resource constrained settings.

A clear and consistent understanding of maturity status is therefore a vital foundation for the use of maturity adjusted metrics in youth sport. How this status is estimated, however, varies widely and the accuracy, feasibility, and implications of current assessment methods remain a topic of ongoing debate.

Current Methods for Maturity Estimation

Estimating maturity itself is a methodological challenge. Buchheit and Laursen (2024) promote AI driven systems to increase objectivity in assessments, recognising their potential to transform practice. However, these systems often rely on large datasets and complex algorithms, making them difficult to implement in smaller or grassroots settings. Moreover, they may lack sensitivity to context and sport specific nuances, risking misapplication or overreliance.

More traditional anthropometric methods remain popular due to their accessibility. Malina et al. (2015), for example, endorse the use of basic measures like height and

weight, which are widely used in environments with limited resources. Researchers have criticised these methods for their imprecision and inability to capture individual variation in development (Abbott et al., 2020). The trade-off between accuracy and accessibility remains central to this debate. AI based approaches offer precision but may not be feasible in all settings, whereas anthropometric methods are broadly applicable but less reliable.

Another issue lies between generalised and sport specific maturity models. Abbott et al. (2021) and Ruf et al. (2024) advocate for discipline specific frameworks, such as those tailored to swimming or football. While these are valuable for single sport environments, their utility across multi-sport academies is uncertain. Conversely, Towlson et al. (2021) call for flexible systems that can accommodate individual differences across sports. This tension illustrates the difficulty of balancing contextual relevance with broad applicability, a topic in need of further research.

The central challenge in this area is estimating biological maturity reliably in academy environments. While skeletal age assessment remains the clinical 'gold standard' (Fransen et al., 2018), its invasiveness and cost make it impractical for regular use. Non-invasive anthropometric techniques, such as the Khamis and Roche (1994), Malina and Koziel (2014), and Moore et al. (2015) methods, have become more widespread. Among these, the maturity offset method by Mirwald et al. (2002), which calculates 'Years from Peak Height Velocity' (YPHV), remains common in academy football. For instance, a 13.5-year-old with an estimated APHV of 15 years would have a YPHV of 1.5. However, this approach tends to overestimate maturity in early developers and underestimate it in late maturers.

Despite growing interest in improving how maturity is measured, the tools currently available each carry limitations, whether in precision, practicality or contextual fit. As a result, inconsistencies in estimating biological development can contribute to selection biases, particularly when used alongside or in place of chronological age. These biases, rooted in both relative age and biological maturity, remain among the most persistent challenges in youth sport.

The Challenge of Relative Age and Maturity Bias

One significant and persistent bias in youth football is the Relative Age Effect (RAE), the tendency for players born earlier in the selection year to be overrepresented in elite pathways. As Pérez-González et al. (2021) highlight, this is particularly evident in competitive football, where relatively older players benefit from early physical and cognitive advantages. Coaches sometimes mistake these temporary differences with innate ability, resulting in skewed selection practices that favour athletes from the first quarter of the year (Arede et al., 2021; Baxter-Jones et al., 2020; Hill et al., 2020).

Closely related, but conceptually distinct, is maturity bias. This is the tendency to favour early biologically maturing athletes over their later maturing peers. While relative age relates to birth date, maturity bias stems from variation in biological growth and pubertal timing. Even within the same birth cohort, players may differ substantially in height, strength and speed due to their individual maturity status. These physical differences can lead coaches to overestimate ability in early maturers, despite these advantages often being temporary (Malina et al., 2015).

This bias can significantly influence access to opportunities. Fitzgerald et al. (2024) and Rubia et al. (2023) found that relative age and biological maturity exert independent effects on selection, meaning athletes can be doubly disadvantaged if they are both relatively younger and late maturing. Despite the EPPP's emphasis on long term development, immediate physical performance often carries more weight in selection decisions (Hill et al., 2023), which may exclude players with strong technical potential but delayed physical development.

In response, strategies such as bio-banding have been proposed to create fairer groupings based on biological rather than chronological age (Chimera et al., 2024). While promising in theory, practitioners have often resisted bio-banding in practice. Its success relies on stakeholder understanding, as poorly implemented systems risk introducing new inequities (Charbonnet et al., 2022). Coaches may be uncertain about interpreting maturity data, and parents may view regrouping as a demotion, limiting uptake and consistency.

Without a clear framework for recognising and adjusting for biological maturity, development systems often prioritise those with early physical advantage over those with long-term potential. As Sweeney and Lundberg (2024) note, traditional assessment practices often fail to account for these biases, reinforcing systemic barriers.

Understanding how maturity influences physical performance is therefore essential for designing more equitable and effective talent development systems, a focus of the following section.

Effect of Maturation on Performance and Its Impact

Ruf et al. (2024) advocates for maturity informed assessment protocols, acknowledging that growth related changes during adolescence can distort the evaluation of physical capabilities. However, these assessments are challenged by the nonlinear and highly individualised nature of biological development. While some athletes experience early rapid growth followed by a plateau, others continue progressing physically into late adolescence (Albaladejo-Saura et al., 2021; Lloyd & Oliver, 2013).

The scale of maturity related variation is significant. Athletes of the same chronological age may differ in skeletal age by up to six years (Johnson et al., 2015), leading to pronounced disparities in anthropometric and performance profiles. For example, male youth footballers can differ by 50% in body mass, 17% in stature, and 21% in fat free mass (Hannon et al., 2020). Differences of 10–15% in predicted adult height have also been reported within age groups. In elite academy settings, skeletal age spans range from 10.7 to 14.9 years in U13s, 11.8 to 18.0 years in U14s, and 13.7 to 17.8 years in U15s (Wik et al., 2023). These physical discrepancies help explain why early maturers tend to outperform peers in physical tests and are more frequently selected into older or higher-level groups (Bradley et al., 2019; Johnson et al., 2017).

To address this imbalance, recent studies have adjusted performance data to account for maturity effects. Hogan et al. (2022) proposed the Mat-CAP model in youth swimming, which corrects outcomes retrospectively for biological variation. Similar trends are emerging in football, where maturity has been shown to influence agility test outcomes (Sellami et al., 2024) and the strength of associations between body size and physical performance (Nedeljkovic et al., 2007; Robles-Palazón et al., 2024).

However, without a clear understanding of how maturation influences performance, coaches and decision makers may misinterpret raw data, reinforcing existing biases in selection and development. This misinterpretation can undervalue late developing players and contributing to premature drop out. Particularly if performance metrics are assumed to reflect potential rather than current biological advantage. Enhancing

stakeholder comprehension is therefore critical to ensuring more equitable and informed talent pathways.

Challenge of inclusive data reporting

Communicating Maturity Adjusted Data

In youth sport, well designed dashboards tailored to maturity adjusted data can promote more objective comparisons between athletes at different stages of development, encouraging a longer-term perspective over short term physical advantage. However, the effectiveness of such tools depends on both user-friendly design and adequate stakeholder education. Poorly structured dashboards risk overwhelming users with unnecessary complexity, reducing engagement and trust (Kandel et al., 2011).

Beyond simply improving comprehension, good data reporting practices can support broader cultural shifts in talent development. Till et al. (2023) argue for integrated talent development environments in which maturity informed frameworks replace rigid, static selection models. However, ensuring stakeholders engage meaningfully with such data remains a challenge. Misuse of visual tools, such as overemphasis on a single metric, can reinforce existing biases rather than reduce them. This highlights the need for targeted education and training to help coaches, scouts, and decision makers apply maturity adjusted insights appropriately.

Recent developments in data visualisation (Du & Yuan, 2021) suggest that tools like Power BI, AI driven analytics, and interactive dashboards can significantly improve accessibility and utility. These platforms allow stakeholders to filter and analyse key metrics, enhancing transparency and enabling more evidence informed decision making. Yet adoption depends on institutional buy in. Without demonstrable benefits, there may be reluctance to move away from familiar selection practices. The success of such tools relies on their intuitive design, contextual relevance, and alignment with the informational needs of the end user.

To ensure comprehension, visualisation tools must be grounded in principles from cognitive science and design. Cognitive Load Theory (Sweller, 2022, 2024; Ouwehand et al., 2025) offers a useful framework, suggesting dashboards should minimise extraneous load and direct attention toward essential insights. Dual Coding Theory (Bi, 2021) further supports the combination of visual and verbal elements to improve

memory and understanding. Since coaches and other stakeholders often work under time constraints and may lack high levels of data literacy, dashboard design should aim to clarify, not complicate, the information being conveyed.

Design Principles and Evaluation of Comprehension

Common visual features in maturity adjusted dashboards include radar plots, colour coded thresholds and standardised scoring systems like Z scores or T scores (Schober et al., 2021). These formats allow quick performance comparisons relative to a reference group. The Total Score of Athleticism (TSA; Turner et al., 2014) is one such example of a composite metric that enables cross domain comparison of athletic traits. User centred design approaches have been widely adopted in dashboard development (Ansari, 2022; Teasley et al., 2021), emphasising the importance of iterative testing with real users. Features like customisability, intuitive navigation, and consistent visual hierarchies help ensure dashboards can be adapted to specific stakeholder requirements (Murphy et al., 2021; Exel & Dabnichki, 2024). Research on data storytelling further suggests that embedding narrative elements or contextual cues within dashboards improves uptake, particularly among users with lower levels of visualisation literacy (Pozdniakov et al., 2023).

Still, visual clarity alone does not guarantee understanding. True stakeholder comprehension involves not only interpreting the data accurately but also contextualising it within decision making processes. Recent studies in visualisation research show that comprehension varies depending on prior experience, visual literacy and interface design (Rodrigues et al., 2021; Quadri et al., 2024). This suggests that researchers should evaluate comprehension empirically, rather than assume it.

Several methods have been used to assess user understanding. Think aloud protocols, task-based accuracy tests and post interaction interviews are common tools for examining how users interpret dashboards and where confusion arises (Cui & Liu, 2021; Almasi et al., 2023). In elite sport contexts, formative usability studies have explored whether dashboards meet the cognitive and practical needs of performance staff. For instance, Mezzzone et al. (2025) observed how stakeholders interacted with basketball specific dashboards, analysing navigation patterns, task success rates and verbalised reasoning.

Increasingly, practitioners are adopting iterative design processes with feedback loops to refine dashboard interfaces. Pilot testing within football and basketball clubs has informed improvements in layout, metric selection and guidance materials (Zhang, 2022; Bodelon Ruibal, 2021). Embedding this kind of feedback driven development helps ensure that dashboards not only present maturity data but also support real world application and better decision quality.

Applications of Power BI in Performance Contexts

Compared to static tools like Excel, Power BI offers a more dynamic platform for visualising and interacting with athlete data. It enables real time filtering, such as by maturity status or training group and the creation of custom views suited to different roles. These features make it particularly effective in high performance settings where fast, context sensitive insights are critical.

Sport science literature increasingly supports the use of business intelligence platforms like Power BI to improve communication between data professionals and practitioners. For example, Plakias et al. (2023) describe how football coaches used Power BI dashboards to better interpret player performance metrics. Mezzzone et al. (2025) applied a similar approach in basketball, using stakeholder feedback to enhance dashboard usability and practical relevance. Even within smaller organisations, practitioners have used Power BI to streamline reporting processes and support evidence informed planning (Santos, 2024).

The applications of Power BI extend beyond performance tracking. Rebouj and Lotfi (2024) combined it with regression models to predict athlete performance trajectories, while Manescu (2025) described its integration into broader decision making frameworks. However, effective implementation is not guaranteed by software access alone. While platforms like Power BI offer new possibilities for tailoring and communicating performance data, their success ultimately depends on thoughtful design, user engagement and organisational commitment to inclusive practices.

The present study

This study aims to develop and compare different dashboard reporting methods, to assess which formats best support coaches' understanding and interpretation of maturity adjusted performance data. While maturity correction models can help address

bias in youth sport, their impact ultimately depends on how clearly and effectively the adjusted data is communicated to end users. By exploring how coaches engage with various reporting styles, this research seeks to identify the most effective ways of presenting maturity adjusted data to inform fairer and more accurate decision making. Data alone cannot drive change. Its value lies in how it is understood and applied. Without clear and usable reporting systems, even the most sophisticated adjustments for maturity risk being overlooked or misinterpreted. By focusing on the interface between data and decision making, this study aims to support more equitable talent development practices and help reduce the risk of late maturing players being undervalued or deselected too soon.



Methodology

General Method

This study investigates how a novel maturity corrected reporting system influences training prescription and stakeholder perceptions within elite youth football academies. The central research question guiding this work is, how does the maturity corrected system impact training prescription recommendations and stakeholder perceptions? In pursuit of this, the study explores stakeholder preferences, assess the usability of the reporting system and evaluate the clarity and interpretability of the data presented.

A pragmatic research paradigm underpins the study, aligning with the applied, problem-solving nature of the research and supporting a flexible methodological approach tailored to real world contexts (Tashakkori & Teddlie, 2010; Taherdoost, 2022). Pragmatism prioritises research outcomes that are actionable and relevant to end users, enabling the integration of multiple data sources and methods to address complex questions effectively. In this study, pragmatism guided the decision to use a mixed methods, sequential design that could accommodate iterative refinement of the system based on stakeholder feedback. For example, initial insights from the pilot study directly informed revisions to the dashboard interface, ensuring that stakeholder needs shaped the development process in real time. Similarly, the use of both quantitative survey data and qualitative focus groups provided breadth and depth, by quantifying general trends while analysing the rationale behind them (Taguchi, 2018; Shan, 2022).

The study adopted a mixed methods approach to enhance the robustness and richness of findings by drawing on the complementary strengths of qualitative and quantitative research. Integration occurs across design, data collection and interpretation stages, allowing for triangulation and a more nuanced understanding of stakeholder experiences (Fetters, Curry & Creswell, 2013). The study follows a sequential design that unfolds in three distinct phases, an initial pilot study, followed by stakeholder surveys, culminating in focus groups. This order deliberately supports iterative system development and cumulative insight building. The pilot phase allowed for early feedback and refinement of data visualisations before broader implementation. The survey phase captured quantifiable trends in system usability and stakeholder satisfaction across a wider sample. Finally, the focus groups enabled deeper exploration of the reasons behind stakeholder preferences, drawing out themes that would not have emerged through surveys alone. This sequencing aligns with recommendations for integration in

mixed methods research, ensuring that each phase meaningfully informs the next and supports outcome driven inquiry (Sweetman, Badiee & Creswell, 2010; Perez Bentancur & Tiscornia, 2024).

The research was conducted in collaboration with ai.io, a UK based technology company specialising in the application of artificial intelligence to performance data within elite sport. Their proprietary system adjusts performance metrics based on biological maturity rather than chronological age, with the aim of offering a more equitable representation of player development. The reporting system was deployed in two professional football academies in England. While not named for confidentiality purposes, these academies can be understood to represent high performance environments that routinely use performance data to guide training prescription, load monitoring and talent development.

The study focused on male academy players aged 12 to 16 (U13 to U16 age groups) across pre-season and in-season phases during 2024/2025. The academies involved already conducted regular physical performance testing, meaning the introduction of the maturity corrected reporting system did not alter existing procedures or place additional demands on participants. Instead, the study utilised a convenience sample of players already linked to the partner clubs. In addition, seven stakeholders participated in the study, representing York City FC (n=1), Chelsea FC (n=2), Burnley FC (n=3) and ai.io Scout (n=1). Their roles included, Lead Talent ID Executive and Coach, Performance Insight Analyst, Head of Academy Sports Science and Medicine, Lead Academy Strength and Conditioning Coach, Head of Youth Development, Lead Academy Sport Scientist and Athletic Development Coach.

Ethical approval was granted by the York St John's University ethics panel (ETH2425-0178) prior to the commencement of any data collection. No direct interventions were introduced into the testing process; all players were deemed injury free and fit to participate by club medical staff and were warmed up appropriately by club coaches. In line with standard safeguarding and data protection protocols, all player data was fully anonymised prior to analysis using a unique ID system. While individual parental consent was not required for data collection, given the pre-existing consent structures at each club, partner clubs provided formal approval for the use of testing data via a signed data processing agreement (*see Appendix 1.*). Participants were informed of their right to withdraw at any time without consequence.

Data Collection, Co-Researcher Analysis and Dashboard Creation

Data Collection

The age groups were selected due to the heightened influence of biological maturation on physical performance during early to mid-adolescence. Ai.io staff carried out the testing within the academies' existing monitoring schedules, ensuring ecological validity and minimising disruption to training programmes.

The testing battery comprised countermovement jump (CMJ) height, hip adduction and abduction strength at 45° (measured at percentage of maximal effort) and sprint performance over 5m, 10m, 20m and 30m distances. The study selected these measures for their established relevance in youth football and their association with key aspects of athlete development, injury risk mitigation and positional demands. Despite their frequent use in academy environments, there remains a lack of maturity adjusted interpretation in the literature. For example, CMJ and sprint performance are known to progress non-linearly through adolescence (Radnor et al., 2022), yet normative guidelines that incorporate maturity status remain scarce. Similarly, while hip adduction and abduction strength testing is associated with groin injury risk and physical development in adolescent footballers (Light et al., 2022; O'Brien et al., 2025), questions remain regarding optimal testing positions and standardisation methods for players undergoing rapid growth. By including these metrics, this study aims to address gaps in understanding while generating outputs with direct application to training prescription and talent development.

Co-Researcher Analysis and Maturity Correction

Following data collection, the collaborating performance analyst prepared and processed the raw dataset for the project. Responsibilities included data cleaning, verification of integrity and the application of maturity corrections to relevant performance variables. The maturity correction process was based on the Mirwald et al. (2002) prediction equation for estimating years from PHV, in combination with the MAT-CAPS adjustment model, which accounts for differences in anthropometric scaling relative to biological age. This hybrid method provides a more precise standardisation of performance scores by adjusting for maturity related variation rather than relying solely on chronological age.

Maturity status was first estimated using anthropometric measures; standing height, sitting height and body mass, collected during the testing sessions. The MAT-CAPS procedure was then applied to adjust raw performance scores to a biologically comparable baseline, enabling fairer comparison of players' metrics regardless of maturity timing. This adjustment ensured that the reporting system reflected developmental potential rather than temporary advantages or disadvantages associated with early or late maturation.

Dashboard Creation in Power BI

Once the dataset was processed and maturity corrections applied, the researcher imported the information into Microsoft Power BI to create a visual reporting system. The dashboard was designed to present key performance indicators in a format accessible to academy stakeholders each with varying levels of data literacy. Development prioritised clarity, comparability and actionability. Dashboard A (*Appendix. 2*) displays the existing a.io reporting system, included as a benchmark given its familiarity to participants. In contrast, the subsequent dashboards were created by the researcher and refined iteratively in response to feedback collected in later phases of the study. This approach ensured that the tool evolved in alignment with the requirements of its intended users.

Pilot Testing of the System

The pilot testing phase served as a design iteration stage, allowing early stakeholder feedback from a.i.o personnel to inform the refinement of the maturity corrected reporting system before its use in the survey and focus groups. Participants included the company's Head of Sports Science and a senior lecturer in performance analysis at York St John University, both of whom had extensive experience interpreting athlete performance data and advising on reporting systems. The researcher gathered feedback through a semi structured, open ended interview that explored usability, clarity and overall effectiveness of the prototype dashboards. The researcher refined the original dashboard versions, following pilot feedback during the development process and are no longer available in their original form. The final adapted versions can be seen in *Appendix 3.*, and *4.*, representing the outcome of this iterative refinement rather than the initial prototypes.

The researcher transcribed the interviews and analysed feedback using rapid thematic analysis, an approach that enables timely yet rigorous identification of key themes while maintaining a focus on decision relevant findings (Hamel et al., 2021; Nevedal et al., 2021). This approach was well suited to incorporating feedback within the project's operational timeframe. Analysis of the pilot feedback resulted in several substantive changes to the reporting system. The researcher modified Dashboards B and C so that all visuals displayed the same athlete's data, ensuring that stakeholders' judgements of dashboard clarity were based on consistent information rather than differences between individual athletes. The multi-page layout was condensed into a single-page format to provide an 'at-a-glance' overview of key metrics. The researcher removed one cluster bar chart after determining that it added little interpretive value; it was replaced with a group comparison visual enabling contextualisation of an athlete's performance within their peer group. The research team agreed to retain the company's existing reporting format as Dashboard A in the survey and focus groups to act as a baseline familiar to stakeholders, providing a meaningful point of reference for comparison. These refinements ensured that the dashboards entering the survey and focus groups were recognisable to end users while being optimised for clarity, allowing for a fair and informed comparison between the established reporting method and the novel maturity corrected system.

Main evaluation of the Study

The final and most substantial phase of this project involved a mixed methods evaluation study, combining survey data with follow up interviews. This stage directly addressed the central research question, how the maturity corrected system impacts training prescription recommendations and stakeholder perceptions. It also explored three sub-questions: (1) how stakeholders interpret the maturity corrected outputs compared to existing reporting formats, (2) what preferences emerge regarding data presentation and usability, and (3) what implications do these preferences hold for the practical application of maturity corrected reporting within academy settings.

Participants and Sampling

Seven stakeholders took part in this phase, comprising one joint interview (N = 2) and five individual interviews (N = 5). All seven participants also completed the survey,

ensuring alignment between qualitative and quantitative components. While the original intention was to conduct larger focus groups, scheduling constraints within elite academy environments required a pragmatic adjustment, resulting in the use of smaller scale interviews. This approach retained the benefits of interactive discussion in the joint interview while allowing for in depth exploration of individual perspectives.

The study used purposive sampling, with the aim of capturing diverse viewpoints across talent identification, coaching, sports science and performance analysis roles. This spread ensured that the perspectives of those both generating and using performance data were included. The number of participants reflects the pragmatic constraints of research in high performance settings, where staff availability is limited, but was sufficient to identify common themes and meaningful divergences across roles.

Survey Design

The researcher administered the survey via Qualtrics, drawing on established best practice for online survey research (Goodfellow, 2023; Weber, 2021). To mitigate known challenges of online surveys, such as variable response rates (Wu, Zhao & Fils-Aime, 2022), the survey was integrated directly into the study process and required prior to interviews, ensuring full completion.

Items focused on usability, clarity and preference between the maturity corrected and baseline dashboards. Question formats included multiple choice items and Likert scale ratings, which were selected for their reliability in capturing attitudinal data (Kusmaryono, Wijayanti & Maharani, 2022). The study adopted a five-point response format to balance sensitivity with interpretability, in line with guidance from the literature on scale construction and validity. In addition, Likert responses were used not only for quantifying stakeholder views but also for interpreting emotional reactions to data presentation, a dimension shown to provide insight into user preferences (Magalhães et al., 2023). As highlighted in *Appendix 5*, items were structured to avoid leading phrasing and were refined in consultation with the researcher's academic advisor. The survey's overall structure followed recommendations for effective Likert scale design and use in evaluation research (South et al., 2022).

Interviews

Following survey completion, the researcher conducted interviews to explore themes in greater depth. As noted, one joint interview and five individual interviews were

undertaken. The semi-structured guide (*Appendix 6*) was iteratively refined with input from the academic advisors, ensuring a focus on clarity, accessibility and practical application of the dashboards while avoiding overly directive questions. Changes from the initial draft included reducing leading questions and broadening discussion prompts around visual appeal and data interpretability.

Topics included the usability of the maturity corrected system, clarity of dashboard design, perceived impact on training prescription and implications for talent identification processes. The dual structure of individual and joint formats enabled triangulation of perspectives, while the alignment with prior survey items ensured continuity between the two methods.

During the interviews, the researcher implemented several procedures to support the quality, rigour and trustworthiness of the data collected. The semi-structured interview guide was developed and refined with academic advisors, in line with recommendations for ensuring conceptual clarity and methodological robustness in interview design (Kallio et al., 2016). Across both in person and online formats, reflective probing, clarification questions and paraphrasing were used where appropriate to check researcher understanding and reduce the risk of misinterpretation, consistent with guidance on good probing practice in qualitative interviewing (Robinson, 2023).

The researcher recorded interviews with consent, using Microsoft Teams for online interviews and the Otter Ai application for in person interviews. The duration of each interview was recorded, and all transcripts were carefully checked against the original audio to ensure accuracy. Where any uncertainty remained, participants were contacted via email to confirm meaning or clarify statements. This process contributed to the development of a systematic audit trail and strengthened the procedural credibility of the data (Carcary, 2020). All files and logs were stored securely on the researcher's password protected laptop, anonymised prior to analysis, and deleted following completion of the project in line with university ethical procedures. Collectively, these steps enhanced the transparency, dependability and overall trustworthiness of the interview dataset.

Quantitative Data Analysis Procedure

The quantitative strand of the study examined stakeholders' evaluations of the three dashboards (A, B, C). Each survey question included a brief definition to ensure consistency in interpretation (see *Appendix 5*). The researcher exported responses into Jamovi (Version 2.6; The jamovi project, 2024) for analysis. Prior to conducting inferential tests, the researcher screened data for normality. Visual inspection of Q–Q plots indicated that scores were approximately normally distributed, with data points closely aligned around the reference line and no systematic S shaped deviation. This justified the use of parametric tests.

As each participant rated all three dashboards, a series of one-way repeated measures ANOVAs were conducted to compare responses across conditions. Where a significant main effect was observed, Bonferroni adjusted post hoc tests were applied to explore specific pairwise differences. Both statistical significance ($p < .05$) and effect sizes were reported. Effect sizes were expressed as Cohen's d , alongside their 95% confidence intervals, to capture the likely range of the true population effect. Effect size magnitudes were interpreted following established conventions (0.2 = small, 0.5 = moderate, 0.8+ = large; Cohen, 2005).

The researcher tabulated descriptive statistics (means and standard deviations) for each dashboard and question, providing an overview of trends in stakeholder perceptions. Inferential results (ANOVA, post hoc comparisons, and effect sizes) were also presented, allowing both the statistical and practical significance of differences to be considered. For example, large effect sizes (e.g., $d = 2.3$) were interpreted as reflecting substantial differences in how participants evaluated specific features, even where the small sample size ($n = 7$) limited the likelihood of achieving significance in some comparisons.

To ensure methodological rigour and transparency, the researcher followed APA's Journal Article Reporting Standards for Quantitative Research (Appelbaum et al., 2018; APA, 2018). This included presenting descriptive data, assumption checks, inferential outcomes, effect sizes, and confidence intervals in line with established statistical reporting guidance.

Qualitative Data Analysis Procedure

Before data analysis commenced, the automatically generated transcripts from Microsoft Teams were checked carefully by the researcher against the audio recordings to ensure accuracy. The qualitative exploration centred on semi-structured interviews, which provided rich insights into stakeholder experiences and perceptions of the maturity corrected reporting system. An example extract from a transcript is included in *Appendix 7*.

The analysis followed a systematic reflexive thematic analysis approach, guided by Naeem et al.'s (2023) six step framework. First, transcripts were read multiple times to achieve familiarisation with the data. Second, initial codes were generated inductively to capture recurring ideas and patterns, with attention given to both explicit statements and underlying meanings. Third, the researcher collated these codes into preliminary themes that reflected key aspects of participants' narratives, such as clarity of dashboard visuals, usability for decision making and implications for training prescription. Fourth, the researcher reviewed and refined the themes against both the coded extracts and the full dataset to ensure coherence and alignment with the research objectives. Fifth, each theme was defined and named to highlight its interpretive significance. Finally, findings were synthesised into a cohesive report, with illustrative quotes used to ground interpretations in participants' own words. A thematic diagram was also generated (*Table 2*) to depict the relationships between themes, offering a visual representation of how different elements of stakeholder experience intersected. A single researcher conducted the coding process, adopting an inductive approach that allowed themes to emerge directly from the data rather than being constrained by pre-defined categories. While multiple coders can enhance inter-rater reliability, in this instance the decision to use one coder was a pragmatic choice, consistent with recommendations for smaller scale qualitative case studies where depth of engagement is prioritised over coder comparison (Cole, 2024). Reflexive thematic analysis places emphasis on the interpretive role of the researcher, meaning that transparency and reflexivity were foregrounded in place of statistical reliability testing.

To further strengthen the trustworthiness and analytic rigour of the qualitative findings, several strategies were employed throughout the reflexive thematic analysis process. Credibility was supported by grounding theme development in multiple, diverse data

excerpts across participants and by presenting rich, illustrative quotations to demonstrate how interpretations were situated within the dataset, consistent with contemporary criteria for high quality qualitative research (Megheirkouni and Moir, 2023; Ahmed, 2024). The analysis was iterative; earlier codes were revisited following subsequent interviews, allowing themes to be refined as the researcher's understanding of the data deepened.

Theme development was reviewed with the research supervisor as part of an interpretive sense checking process. Through this collaborative discussion, the original four preliminary themes were refined and condensed into two stronger, conceptually coherent themes. This process aligned with the reflexive positioning of thematic analysis, in which meaning is co-constructed rather than assessed through inter-rater reliability (Braun et al., 2022). The researcher maintained an audit trail through coding notes and analytic memos documenting how interpretations and theme structures evolved, supporting transparency and dependability in line with guidance on audit trail practice (Carcary, 2020).

These procedures were informed by contemporary qualitative quality frameworks, including Tracy's "Big Tent" criteria and subsequent extensions emphasising sincerity, resonance, coherence and meaningful contribution (Tracy, 2025; Leach et al., 2025). Taken together, these strategies enhanced the credibility, confirmability and overall trustworthiness of the qualitative analysis.

Results

Table 1. Descriptive statistics (Means and Standard Deviations) and Bonferroni pairwise comparisons (p-values and Cohen's d) for dashboard ratings across groups (n = 7)

Question	Mean ± SD (A)	A-B (p, d)	Mean ± SD (B)	A-C (p, d)	Mean ± SD (C)	B-C (p, d)
Visual appeal	2.43 ± 0.787	0.001 -2.300	4.41 ± 0.690	0.014 -1.725	3.71 ± 0.756	0.889 0.575
Quantity of content	2.14 ± 1.07	0.042 -1.453	3.29 ± 0.488	0.086 -1.271	3.14 ± 0.690	1.000 0.182
Quality of content	3.00 ± 1.15	0.132 -1.158	4.00 ± 0.816	0.418 -0.827	3.71 ± 0.488	1.000 0.331
Ease of understanding	2.86 ± 1.21	1.000 -0.429	3.29 ± 1.11	0.594 -0.714	3.57 ± 0.535	1.000 -0.286
Value for role	2.00 ± 0.816	<.001 -2.901	3.71 ± 0.488	<.001 -3.143	3.86 ± 0.378	1.000 -0.242

Table 2. Thematic analysis of interview transcripts

Example raw data	Sub-themes	Themes
“Adjusted T Scores based on maturation is great and provides usable actionable data for practitioners” “Data makes a lot more sense for me when adjusted to the Z or T score” “T scores are better... especially when explaining to a coach comparing players across ages” “I understand Z scores, but using 50 out of 100 or 75 out of 100... coaches will understand that better”	Standardisation helps translate data into practice T scores perceived as more intuitive than Z scores	Enhancing clarity of data
“Doughnut chart on dashboard C and cluster bar chart on dashboard B and the best parts for me” “The radar chart was too difficult to understand but when it was the same data in a cluster chart for some reason it was much clearer” “I liked the fact dashboard B was easy to use and on a single page” “Presentation of dashboard C was the clearest” “Dashboard A... too much info to digest” “Layout was hard to read and pick data from due to the busy background on dashboard B”	Visuals that simplify complex data valued Clean design and layout aid interpretation Overly complex visuals create confusion	
“I would want to see longitudinal data” “Longitudinal percentiles charts could definitely help here”	Desire to see development over time	Enhancing decision making

“Maturation forward planning to where and at what point will players be fully developed”	Forward planning for player progression
“Historical comparisons would be a good insight”	
“The cluster bar chart in Dashboard B made comparisons much easier to understand.”	Strong preference for simple, comparative visuals
“The doughnut chart in Dashboard C was very clear for showing group maturity status.”	
“The radar chart was confusing – simpler visuals like bar charts are better for coaches.”	Filters and contextual detail needed for practical use
“Dashboards would be more useful with filters, for example by player position or development stage.”	

Themes

The six interviews (including one joint interview) varied in duration, ranging from 31.02 to 47.53 minutes, with a mean length of 38.34 minutes. Together, these interviews generated approximately 122 pages of single-spaced raw transcript data. From the interview transcripts, two overarching themes were identified: *enhancing clarity of data* and *enhancing decision making*. The following sections provide a narrative account of each theme, supported by illustrative quotes taken from *Table 2*.

Enhancing clarity of data

This theme reflects stakeholders' need for performance data to be presented in ways that are immediately understandable and interpretable. Participants emphasised that clarity was achieved when the dashboards translated complex information into simple, standardised outputs that could be easily communicated to others. For example, several coaches described the adjusted T-scores as "great" for providing "usable actionable data for practitioners", with one participant noting that "T-scores are better... especially when explaining to a coach comparing players across ages". Another explained that although they understood Z-scores, "using 50 out of 100 or 75 out of 100... coaches will understand that better", suggesting that familiarity and intuitive scale formats supported comprehension.

Visual presentation was also central to clarity. Participants highlighted that certain charts, such as the doughnut and cluster bar charts, "made comparisons much easier to understand" and were very clear for showing group maturity status". By contrast, more complex visuals were described as "too much info to digest", "confusing", or "hard to read and pick data from due to the busy background". These reflections indicate that stakeholders valued simple, clean layouts that enabled them to interpret information quickly, without the risk of misinterpretation. Further interpretation of this theme is explored in the Discussion.

Enhancing decision making

This theme captures how stakeholders perceived the dashboards as supporting practical decision making around player development and progression, particularly when information was presented in a way that felt meaningful and applicable to their roles. Participants expressed a desire to use the dashboards to inform "forward planning to where and what point will players be fully developed", as well as to review "historical

comparisons” and development trends over time. Several also noted that longitudinal percentile charts could definitely help here”, reflecting an interest in monitoring progression rather than viewing data at a single time point.

Clear, comparative visuals were viewed as especially valuable for these decisions. One participant explained that the cluster bar chart “made comparisons much easier to understand”, while another felt that simpler visuals such as bar charts were “better for coaches” than more complex radar charts. Practical filters and contextual detail were also seen as important for applied use, with one stakeholder suggesting that “dashboards would be more useful with filters, for example by player position or development stage”. Collectively, these comments indicate that when data was presented in a clear, interpretable format, stakeholders felt more confident using it to guide evidence-informed decisions. Further interpretation of this theme is explored in the Discussion.

Discussion

Overview of Key Findings

The present study explored stakeholder comprehension, perceptions and training prescription recommendations when using maturity corrected reporting of performance data. This section outlines the central findings before examining their implications in depth. Overall, the results demonstrate that stakeholders recognised maturity adjustment as enhancing the clarity and fairness of performance information, while also identifying areas for improvement in visualisation design and functionality.

Quantitative ratings of the three dashboards (A-C) provide further insight into these perceptions. Dashboard A consistently received lower evaluations across most criteria, particularly for *visual appeal* ($M = 2.43 \pm 0.79$), *ease of understanding* ($M = 2.86 \pm 1.21$) and *value for role* ($M = 2.00 \pm 0.82$). In contrast, Dashboard B was rated significantly higher for *quality of content* ($M = 4.00 \pm 0.82$) and *ease of understanding* ($M = 3.29 \pm 1.11$), while Dashboard C attracted the strongest overall scores, especially for *value for role* ($M = 3.86 \pm 0.38$) and *visual appeal* ($M = 3.71 \pm 0.76$). Pairwise comparisons showed that several differences were statistically significant. For instance, Dashboard C was rated as providing greater value than A ($p < .001$, $d = -3.143$), while B outperformed A on quality of content ($p = .132$, $d = -1.158$). Taken together, these results suggest that while all dashboards conveyed maturity correction to some degree, their design features shaped stakeholder comprehension and perceived utility in distinct ways.

A key outcome of the study was the perceived value of correcting for biological maturity when interpreting physical performance. This aligns with long standing evidence that variation in maturity status introduces considerable disparities in growth, strength, speed, and functional capacity among youth players of the same chronological age (Malina et al., 2004). Coaches and support staff acknowledged that such differences often distort comparisons, reinforcing concerns raised in the literature around the relative age effect and maturation biases in selection and development pathways (Towlson et al., 2017). Stakeholders reported that maturity correction offered a fairer baseline from which to evaluate players, supporting more equitable training prescription. This finding echoes Malina et al. (2015), who highlight the importance of accounting for biological age in the interpretation of youth athletes' performance and progression.

Another important insight concerns how performance data are presented. Stakeholders demonstrated varying levels of statistical literacy, with some readily interpreting standardised scores while others expressed uncertainty. This observation supports previous critiques that maturity estimation methods, such as the maturity offset, are complex and prone to misinterpretation if not translated into accessible formats (Malina and Koziel, 2014). The use of dashboards provided a novel mechanism for communicating maturity adjusted data, but differences in comprehension emphasise the need for thoughtful visual design. As Cleveland and McGill (1985) demonstrated, the form of graphical representation directly influences accuracy of interpretation. Stakeholders in the current study gravitated towards simpler formats, such as bar and doughnut charts, while identifying more complex visuals as potentially confusing.

The findings also highlight the practical challenges of translating performance analytics into applied settings. Variability in comprehension across roles, reflects wider tensions noted in sport science regarding the research practice gap. Similar issues have been observed in the feedback of GPS data, where staff groups often interpret the same information differently, leading to divergent training decisions (Nosek et al., 2021). In this study, perceptions of maturity correction differed according to professional background, with scientifically trained staff demonstrating greater confidence in statistical interpretation, and coaching staff emphasising the importance of clarity and actionable insights. This resonates with Callinan et al. (2023), who reported comparable differences in rugby coaches' and analysts' approaches to performance analytics.

A consistent theme across stakeholder groups was the identification of additional features that could increase the utility of maturity corrected dashboards. These included longitudinal tracking of player progression, comparative options to benchmark within and across squads and filtering functions to tailor outputs to specific contexts. Such requests suggest that while stakeholders valued the adjustment itself, the perceived usefulness of the system is closely tied to its ability to support ongoing decision making. The desire for longitudinal information also reflects the developmental focus of academy sport, where changes over time are often more informative than single timepoints (Ford et al., 2011; Williams et al., 2023). These perspectives highlight the tension between providing simple, comprehensible outputs and delivering richer, more detailed information required for planning.

Taken together, these findings reinforce the dual importance of maturity adjustment and effective data communication in supporting equitable talent development. Stakeholders valued the correction of performance data for biological age, consistent with evidence that such practices mitigate the influence of growth and maturation on player evaluation (Malina et al., 2015). However, the degree to which dashboards successfully conveyed this information depended on their design, echoing broader work on data visualisation and comprehension (Bach et al., 2024). These results underline the need to balance statistical rigour with accessibility, ensuring that performance information is interpretable by a multidisciplinary audience.

This overview establishes two central themes for the following discussion: first, the role of maturity correction in enhancing clarity and fairness in the interpretation of performance data; and second, the influence of dashboard design on stakeholder comprehension and the practical application of information. These themes provide a framework through which to evaluate the broader implications of the study for talent development environments, data communication and applied sport science practice.

Enhancing Clarity of Data

A central theme that emerged from stakeholder interviews was the extent to which maturity adjustment improved the clarity of performance data. Clarity in this context refers to both the interpretability of the information presented and the perceived fairness of the comparisons being made between athletes at different stages of growth and maturation. Stakeholders consistently described the adjusted reports as easier to make sense of and more reflective of underlying ability than unadjusted metrics. This finding aligns with long standing concerns in youth sport regarding the distortive effect of biological variation on the assessment of talent (Malina et al., 2004; Malina et al., 2015). The significance of clarity here cannot be overstated. In youth football academies, athletes of the same chronological age can vary by several years in biological maturity, which in turn influences body size, strength, speed and endurance capacities (Malina & Koziel, 2014). Without adjustment, raw performance data risk overstating the ability of early maturing players and understating that of later maturing peers. Stakeholders in this study identified the maturity corrected dashboards as offering a more equitable representation of athletes' capabilities, suggesting that clarity was enhanced not only in terms of data legibility but also in terms of fairness. This reflects Towlson et al.'s (2017)

argument that accounting for relative age and maturation biases is necessary if evaluation is to be equitable across cohorts.

This enhanced clarity was not simply a technical matter of numbers being corrected but carried practical implications for how stakeholders understood developmental trajectories. Coaches and support staff reported that the adjusted outputs helped to contextualise performance results, reducing the likelihood that players would be unfairly categorised as underperforming simply due to late maturation. This represents a move toward the “inclusive data reporting” advocated by Williams, Ford, and Drust (2023), in which systems of evaluation take greater account of the diversity of developmental pathways rather than privileging early physical advantage.

However, while stakeholders saw maturity adjustment as strengthening interpretive clarity of the data, stakeholders were clear that clarity could be further enhanced through additional features not yet implemented in the dashboards. Longitudinal tracking, for example, was frequently cited as a desirable function. Stakeholders expressed that clarity is not limited to a snapshot of performance at a single time point but is also dependent on being able to follow developmental trajectories over time. This resonates with the logic of the Long-Term Athlete Development (LTAD) model (Ford et al., 2011), which frames progression as a multi-year process requiring systematic monitoring of growth and adaptation. Without longitudinal perspective, clarity remains partial, as stakeholders are unable to see whether adjustments and training prescriptions are influencing development in the intended direction.

Stakeholders also highlighted that comparative functions could enhance interpretability further. The ability to filter, contrast, or benchmark data within positional groups, across age bands, or relative to maturity status was viewed as essential for making sense of the adjusted outputs in applied decision making contexts. These requests are consistent with principles of effective data visualisation, where clarity depends on reducing cognitive load and providing options for meaningful comparison (Cleveland & McGill, 1985). While the current dashboards reduced one major source of noise (biological variability), participants stressed that decision clarity could be reinforced by tools that facilitate relational understanding. Notably, seeing not only what a player has achieved but also in comparison to whom and in what context.

These findings collectively suggest that clarity in performance reporting is multifaceted. Maturity adjustment was perceived as an essential first step in counteracting the

distortions caused by developmental variation, aligning the reporting system more closely with fairness and inclusivity. Yet clarity is not absolute; stakeholders sought additional functionality to contextualise adjusted scores over time and against relevant reference groups. In other words, maturity correction improved the accuracy of the representation, but stakeholders conceptualised clarity as also requiring tools that situate data within broader developmental narratives.

Supporting Decision Making in Applied Contexts

Decision making in sport is increasingly shaped by the integration of performance data, yet the capacity of practitioners to use such information effectively depends on more than access to metrics. A central challenge lies in translating complex datasets into actionable insights that align with the practical realities of coaching and performance environments (Bartlett and Drust, 2021). While data collection and analysis are well established in elite football, the question remains whether dashboards and reporting systems truly support applied decision making, or whether they risk creating a gap between the generation of knowledge and its application.

One of the key issues is the research practice gap. In sport, as in education and other applied fields, the production of complex analyses often outpaces practitioners' ability to integrate them into decision making processes (Rycroft-Smith, 2022). Coaches, for instance, may lack the time, resources, or technical expertise to interpret statistical outputs in ways that inform immediate practice. Lasarov et al. (2026) note that even emerging tools such as generative AI, which promise to streamline data translation, must still be embedded within systems that acknowledge practitioner needs. This underscores that decision support tools are not neutral: they must be designed with a clear understanding of user contexts, otherwise they risk amplifying complexity rather than reducing it.

Visualisation plays an important role in bridging this gap. Decision making models in data visualisation research demonstrate that the structure of graphs, dashboards, and reports can shape user interpretation and subsequent action (Bancilhon, Padilla and Ottley, 2023). For coaches and sport scientists, this means that visualisations are not only descriptive but also prescriptive in guiding the focus of attention and highlighting trade-offs. In many objective contexts, such as balancing player workload, tactical

priorities, and long-term development, visual tools can make competing demands explicit, enabling practitioners to weigh alternatives systematically (Hakanen et al., 2023). However, achieving this requires careful design, as poorly constructed dashboards risk overwhelming users or obscuring the variables most relevant to applied decisions.

Co-operative approaches to design provide one pathway to improving effectiveness. Goudsmit et al. (2022) emphasise that dashboards developed in collaboration with coaches are more likely to be adopted in practice, as they reflect the lived realities of training environments. By involving end users in the design process, data systems can avoid the pitfall of being technically robust yet practically irrelevant. Boeker and Midoglu (2023) similarly demonstrate how interactive dashboards in football contexts can allow practitioners to explore athlete data in ways tailored to their immediate questions, rather than relying on static reports that may not capture situational nuances.

Knowledge brokering offers another mechanism for supporting decision making. Bartlett and Drust (2021) argue that sport scientists can act as intermediaries, translating complex research and performance data into formats that resonate with practitioners. This aligns with findings from broader fields such as education, where knowledge brokers help navigate the tension between evidence generation and practice (Rycroft-Smith, 2022). Effective brokering requires not only technical expertise but also communication skills and trust within applied settings. Without these, the potential of data informed decision making is constrained, regardless of the sophistication of the underlying analytics.

The use of provenance within visualisation further supports decision making by enabling transparency in how metrics and outputs are derived. Chakhchoukh, Boukhelifa and Bezerianos (2023) show that in visualisation provenance allows users to trace the origins of data and explore how different analytical choices shape outcomes. In sport, this transparency may foster greater confidence among coaches and athletes, who are more likely to act upon information when its derivation is clear. Moreover, provenance tools can assist in trade off analysis, ensuring that decisions are grounded not only in data outputs but also in an understanding of their limitations and assumptions.

Ultimately, supporting decision making in applied contexts requires recognising that data does not exist in isolation from practice. Dashboards and reporting systems must be evaluated not only on technical accuracy but also on their capacity to integrate with

workflows, align with user priorities and facilitate trust in the decision making process. This points towards a model of performance analytics that is iterative, collaborative, and user centred, where knowledge translation is embedded as a continuous process rather than a final step. By addressing these dimensions, systems for performance data can evolve from being storage for information to becoming active tools in shaping decisions on the pitch and in training environments.

Integration with Existing Literature

The findings of this study align with, and extend upon, several strands of existing literature across talent development, data visualisation, decision making and applied sport analytics. In particular, the results support the need for reporting systems that balance clarity with functionality, bridging the gap between technical complexity and practitioner usability. By situating the present work within these domains, we can better understand both its theoretical grounding and practical contribution.

Linking to Talent Development and Bio-Banding Research

One of the key themes in talent development literature is the challenge of accounting for biological variation among youth athletes. Traditional evaluation systems have often overlooked the influence of maturation on performance data, contributing to biases in talent development (Cumming et al., 2006). More recently, bio-banding has been proposed as a structured response, grouping players by biological rather than chronological age (Towlson & Cumming, 2022). The present study does not directly employ bio-banding, but it shares the same intent of mitigating maturity related bias in assessment.

By embedding maturity corrected reporting into dashboards, the system developed here complements bio-banding by providing coaches with an accessible representation of where athletes stand relative to their maturity status. This is consistent with Towlson and Cumming's (2022) call for future interventions that make biological differences visible and actionable. The contribution lies not in replacing existing methods, but in providing an additional interpretive layer that can be seamlessly integrated into ongoing practice, enhancing fairness in player evaluation.

Theoretical Grounding in Cognitive Load and Visualisation

The emphasis on clarity in this project resonates strongly with broader theories of cognitive processing and information design. Cognitive load theory (Sweller, 1988) highlights the importance of minimising unnecessary complexity in learning and decision environments. When dashboards are cluttered or overly technical, they increase extraneous load, reducing comprehension and limiting their practical value.

Similarly, Tufte's (1990) principles of graphical excellence stress that data should be presented with minimal distortion and maximum clarity, enabling users to draw accurate insights at a glance. The positive feedback from stakeholders in this study suggests that the maturity corrected dashboards succeeded in applying such principles. This strengthens the argument that visualisation is not merely an aesthetic concern, but a central determinant of whether performance information can effectively inform coaching practice.

User Centred Design and Human Factors

The findings also align with established research on user centred system design. Few (2013) argues that dashboards must be designed around the needs of their end users, providing actionable information in intuitive formats rather than overwhelming detail. This perspective is reinforced by human factors research in health informatics, where usability engineering methods have been applied to ensure that complex data systems enhance rather than hinder decision making (Kushniruk & Borycki, 2025).

In the present context, the system was not evaluated on aesthetic appeal alone, but on its ability to support comprehension and decision making among coaches and support staff. The similarity with these broader literatures highlights that sports dashboards are best understood not simply as technological tools, but as human data interfaces. Their success depends on principles of usability and ergonomics as much as statistical rigour.

Insights from Decision Making in Football

Coaching decision making is a cognitive process that requires rapid integration of multiple streams of information (Roca et al., 2022). Previous work has shown that coaches often rely on intuition-based judgements, which can introduce bias and inconsistency. By contrast, the maturity corrected dashboards developed here were

perceived as supporting more systematic evaluation, reducing reliance on subjective impressions.

This aligns with Roca et al.'s (2022) observations that effective decision making requires external supports that organise and structure information in ways that reduce cognitive burden. Importantly, the study also highlights that coaches valued dashboards as tools for communication, supporting dialogue between staff and players. This finding extends existing work by showing that dashboards can serve as both decision aids and relational tools in high performance environments.

Big Data, Football Analytics and Tactical Performance

Another strand of integration comes from the broader literature on big data and analytics in sport. Watanabe et al. (2021) highlight how data driven systems are reshaping sport management, offering unprecedented opportunities for evidence based decision making but also raising challenges of accessibility and interpretation. Similarly, Goes et al. (2021), in their systematic review of tactical performance analysis, emphasise the growing reliance on positional and performance data to inform practice, but caution that such information must be translated into forms that are usable in real time.

The present findings speak directly to this tension. While dashboards can integrate large and complex data streams, their value depends on reducing informational noise and presenting insights that coaches can readily apply. This is also consistent with Thakkar and Shah's (2021) argument that data science applications in football require effective interpretive layers to bridge the gap between raw metrics and tactical or developmental insights. In this sense, the current system represents a practical step towards operationalising big data in a way that prioritises clarity and user trust.

Functional Integration Across Domains

Taken together, the findings position the maturity corrected dashboard as a contribution that bridges multiple domains: sport science, visualisation theory, decision making, and big data analytics. Each of these literatures has acknowledged gaps; be it the underrepresentation of biological variation, the need to manage cognitive load, or the challenge of translating data into practice. The present study shows how these threads can be woven together into a functional reporting system.

The integration also underlines the importance of adaptability. Just as Towlson and Cumming (2022) argue that bio banding must evolve in response to practical feedback, so too must dashboards be refined iteratively, with end user engagement at their core. The system trialled here does not claim to solve all issues of talent identification or performance reporting, but it provides a scaffold that aligns with, and extends, existing research across disciplines.

Practical Implications

The findings of this study have a range of practical implications for academy environments, particularly in relation to the design and application of maturity corrected dashboards. These implications span training load management, talent identification and development, evidence based practice and the integration of new technologies such as machine learning into decision making processes. By reflecting on stakeholder responses and situating them alongside applied sport science literature, several actionable directions emerge.

Training Prescription and Load Management

A consistent theme was that maturity corrected reporting could support coaches and sport scientists in tailoring training loads more equitably. The consideration of biological maturation is crucial when prescribing volume and intensity, as players of the same chronological age may differ substantially in their physical readiness. Gabbett et al. (2021) emphasise that both healthy and injured athletes require careful progression of training loads, balancing development with injury risk reduction. By presenting maturity adjusted metrics, dashboards may help practitioners identify players who might be more vulnerable to overuse injuries or under stimulation, enabling the calibration of training to optimise development while minimising risk. This aligns with existing load management frameworks, where clarity and precision in athlete monitoring directly support long term performance and health.

Talent Identification and Development

From a talent identification perspective, the findings suggest that stakeholders value systems which enhance fairness and reduce maturity bias. Kelly (2023) highlights that effective talent identification and development frameworks must account not only for

technical and tactical ability, but also for biological and developmental factors. Incorporating maturity adjustment into performance dashboards responds directly to this challenge, offering staff a more equitable basis for evaluating potential. Importantly, this reduces the over selection of early maturing players, a trend well documented in academy sport, and creates opportunities for later developers to be recognised on their own trajectory. Beyond immediate selection decisions, such tools can embed long term athlete development principles into everyday practice, ensuring that growth and maturation are not overlooked in pursuit of short term performance outcomes.

Conditioning and Performance Support

Beyond fairness, the integration of corrected data can strengthen conditioning and performance planning. Kreider (2020) stresses that high level performers require an integrated approach combining strength, conditioning and nutritional strategies, underpinned by objective data. Dashboards that account for maturity offer a practical means of aligning these programmes with athletes' developmental status. For instance, practitioners can better judge when players are physically ready for increased resistance training or high intensity conditioning, thereby optimising both safety and effectiveness. This has implications not only for physical development, but also for psychological wellbeing, as players who receive age and maturity appropriate programming may experience higher engagement and reduced frustration.

In a real-world scenario, consider an under 15 player undergoing strength training. A dashboard could indicate that although chronologically similar to peers, this player remains in an earlier stage of maturation. Coaches might then delay the introduction of heavier loads, instead focusing on mobility, movement quality, and progressive conditioning. Conversely, a more advanced peer could progress sooner to structured resistance work. These adjustments, supported by maturity data, allow practitioners to deliver the right stimulus at the right time.

Adoption of Emerging Technologies

Another implication relates to the integration of emerging technologies, such as machine learning, in conjunction with maturity correction. Nassis et al. (2023) review applications of machine learning in soccer, particularly for injury risk prediction. When combined with maturity adjusted data, predictive models may become more robust, accounting for

biological variation that influences susceptibility to injury. While stakeholders in this study emphasised the need for clarity and usability in dashboards, these systems may also provide a foundation for the gradual introduction of advanced predictive tools. The key challenge lies in balancing innovation with accessibility. Practitioners must be able to interpret the outputs without specialist data science expertise, otherwise the practical value will be undermined.

Embedding Evidence Based Practice

The degree to which dashboards influence practice will depend on their alignment with evidence based approaches and the willingness of practitioners to adopt them. Schwarz et al. (2021) found that while coaches and athletes value evidence based practice, barriers remain in terms of trust, relevance and time constraints. The findings of this study reinforce the importance of designing maturity corrected systems that are not only scientifically valid but also intuitive and actionable. Practical implementation strategies, such as co-design with end users, training for staff and iterative feedback loops, may strengthen adoption and mitigate the risk of dashboards being seen as disconnected from the realities of academy environments.

A case example can be seen in communication with parents. In many academies, parents challenge selection or training decisions, questioning whether their child is being given fair opportunity. A dashboard that presents clear, maturity adjusted visuals could support coaches in explaining decisions transparently. For instance, showing that a player's reduced running metrics are relative to biological status, not effort. This links research evidence and everyday practice, improving trust in the academy system.

Addressing Fairness and Inclusion

A final implication relates to fairness and inclusion in youth sport. Stakeholders highlighted the potential of maturity corrected reporting to enhance perceived fairness in selection and training allocation. Grondin (2024) illustrates that timing of birth and maturity status can shape long term opportunities in sport, reinforcing structural inequalities. By mitigating these biases, dashboards may contribute not only to more balanced development pathways but also to broader ethical goals of inclusivity. The ability to demonstrate to parents, players and staff that evaluations are adjusted for

maturity could also build trust in academy processes, reducing scepticism around selection and retention decisions.

Limitations

Although this study provides novel insights into the application of a maturity corrected reporting system within elite football academies, readers should consider several limitations when interpreting findings. Acknowledging these constraints aligns with current calls for transparency and reflexivity in sport science research, which emphasise that identifying boundaries of inference enhances credibility rather than diminishes it (Caldwell et al., 2020; Hansford et al., 2021).

A primary limitation is the restricted scope of the sample. The study took place in three professional football academies in England and focused solely on male players aged 12–16. While these age groups are particularly relevant for examining maturation effects on performance, the findings may not generalise to female players, other age groups or less resourced environments (Gould, 2019; Williams, 2018). Similarly, the small number of stakeholder participants (n=7) provides rich, detailed perspectives but limits the breadth of experiences captured. Nonetheless, the participants selected were directly relevant to the research questions, including coaches, sport scientists, talent ID executives and performance insight staff. This careful selection ensured that the data were highly applicable to the context of elite youth football, supporting the validity of the study despite the limited sample size (Gould, 2019).

The mixed methods, sequential design enhanced the depth and contextual relevance of the findings but introduces some methodological constraints. Each phase was informed by the preceding one, meaning insights from the pilot study shaped subsequent surveys and focus groups. While this iterative approach reflects the pragmatic development of applied systems, it also highlights that early-stage feedback could influence later responses (Gobo, 2023; Mulatu & Negash, 2024).

Surveys and focus groups provide complementary strengths, yet each carries potential biases. Small focus groups are susceptible to social desirability effects, particularly in elite settings where participants may align responses with perceived expectations (Sevilmiş & Yildiz, 2022; Abeza et al., 2022). Similarly, survey responses reflect subjective perceptions, and the small sample precluded inferential statistical testing. However, combining qualitative and quantitative data allowed for triangulation, increasing the robustness of the findings by providing multiple lenses on stakeholder experiences (Almalki, 2016; Bazeley, 2016).

The maturity corrected reporting system itself carries inherent limitations. It relies on biological maturity estimation models, such as the maturity offset, which are known to include assumptions and estimation errors (Malina & Koziel, 2014). The study design accounted for these limitations, and the researcher interpreted the results within these recognised model boundaries, preserving the validity of the findings (Charbonnet et al., 2022).

The researcher developed the dashboards as a prototype and refined them iteratively based on stakeholder feedback. While design choices may have influenced perceptions of usability and clarity, the process ensured that system development was stakeholder-led, enhancing practical relevance and applied validity (Clegg et al., 2020; Clegg et al., 2023). Furthermore, some outputs, such as corrected sprint times appearing slower than raw measures, may seem counterintuitive (Doty et al., 2019). The researcher addressed this by contextualising the findings and highlighting the importance of interpreting corrected metrics within a maturity adjusted framework, ensuring that these outputs were informative rather than misleading (Charbonnet et al., 2022; Baker et al., 2024).

Qualitative data were analysed using reflexive thematic analysis, which is interpretive and relies on the judgement of the researcher (Braun & Clarke, 2021). While this introduces subjectivity, reflexive practice and systematic coding procedures were applied to enhance transparency and ensure credible interpretation of stakeholder perspectives. Quantitative analyses were primarily descriptive due to sample size constraints, but this approach provided reliable insights into trends in usability and stakeholder perceptions within the studied context (Almalki, 2016).

The research was conducted in collaboration with ai.io, a technology company specialising in AI driven performance data. While partnerships of this type offer access to novel tools and high ecological validity, they may also introduce perceived bias. The researcher mitigated this through careful anonymisation of data, independent analysis, and transparent reporting procedures (Zaharia & Kaburakis, 2016).

Finally, the study was situated in high performance football academies with existing data infrastructures. While this strengthens the ecological validity for elite contexts, the findings may not fully translate to environments with fewer resources or less established performance data practices (Crawley, 2021; Martindale et al., 2013). Nonetheless, the study provides valuable, contextually grounded insights into stakeholder comprehension

and practical application of maturity corrected reporting systems, maintaining both relevance and credibility within elite youth football.



Future Research

Future research should aim to expand the understanding of stakeholder perceptions of maturity corrected performance reporting systems across professional football academies. While the current study focused on three English Premier League academies and male players from U13 to U16 during pre-season and in-season phases of the 2024/25 season, extending this work to a broader range of clubs, leagues, or age groups could help determine whether perceptions differ across organisational contexts or developmental stages. This would also enable researchers to compare between different academy philosophies, player management approaches, and technological infrastructures, providing a more comprehensive picture of how reporting systems are received and applied.

In addition, future studies could investigate the adoption of reporting systems over time, examining how stakeholders' comprehension, trust, and usage evolve across a season or multiple seasons. Exploring how coaches and performance staff integrate corrected metrics into training planning, match analysis and talent development decisions would further support the refinement of reporting practices and improve actionable outcomes for player development.

Methodologically, mixed methods approaches should continue to be employed, combining quantitative measures of comprehension or engagement with qualitative insights from interviews or focus groups. Building on the current study, future research could also examine how the dashboards and scoring approaches (TSA, Z scores, and T scores with the novel maturity correction) are interpreted and applied in different contexts. Researchers could test these systems across additional leagues or age groups may reveal whether particular scoring methods or visualisations are more effective in specific settings. Further work could explore new visualisation strategies or interactive features beyond those already tested, while also considering whether different stakeholder groups interpret and act on the data differently. Importantly, future research should also capture parents' perceptions, as they are key stakeholders in the academy environment but may require information to be presented differently to support their understanding and engagement. Together, these approaches would help refine reporting systems to enhance clarity, reduce misinterpretation and increase practical adoption across professional academy environments.

Finally, future research should examine potential barriers and facilitators to system adoption, including technological constraints, organisational culture, and individual stakeholder attitudes. Understanding these factors would support the development of guidelines for implementing maturity corrected reporting systems in ways that maximise acceptance, usability, and ultimately, positive outcomes for player development.

References

- Abbott, S., Moulds, K., Salter, J., Romann, M., Edwards, L. and Cobley, S. (2020) Testing the application of corrective adjustment procedures for removal of relative age effects in female youth swimming. *Journal of Sports Sciences* [Post-print], 38 (10), pp. 1077–1084. Available from <https://www.tandfonline.com/doi/full/10.1080/02640414.2020.1741956>. [Accessed 24th June 2025].
- Abbott, Shaun, et al. 'Maturity-Related Developmental Inequalities in Age-Group Swimming: The Testing of "Mat-CAPs" for Their Removal'. *Journal of Science and Medicine in Sport*, vol. 24, no. 4, Apr. 2021, pp. 397–404. *DOI.org (Crossref)*, <https://doi.org/10.1016/j.jsams.2020.10.003>.
- Abeza, G., O'Reilly, N. and Séguin, B. (2022) The Sequential-Funnel-Based Focus Group Design: Adapting the Focus Group for Research in Sport Management. *Journal of Global Sport Management* [Post-print], 7 (1), pp. 43–70. Available from <https://www.tandfonline.com/doi/full/10.1080/24704067.2018.1550621>. [Accessed 29th August 2025].
- Ahmed, S. K. (2024) 'The pillars of trustworthiness in qualitative research', *Journal of Medicine, Surgery, and Public Health*, vol. 2, p. 100051 [Online]. DOI: 10.1016/j.glmedi.2024.100051 (Accessed 6 January 2026).
- Alamar, B. (2024) 9 Analytics in the Organization: A Blueprint for Analytic Success. In: *Sports Analytics*. Columbia University Press, pp. 133–156.
- Albaladejo-Saura, M., Vaquero-Cristóbal, R., González-Gálvez, N. and Esparza-Ros, F. (2021) Relationship between Biological Maturation, Physical Fitness, and Kinanthropometric Variables of Young Athletes: A Systematic Review and Meta-

Analysis. *International Journal of Environmental Research and Public Health*, 18 (1), p. 328.

Almalki, S. (2016) Integrating Quantitative and Qualitative Data in Mixed Methods Research--Challenges and Benefits. *Journal of Education and Learning* [Post-print], 5 (3), pp. 288–296. Available from <https://eric.ed.gov/?id=EJ1110464>. [Accessed 29th August 2025].

Almasi, S., Bahaadinbeigy, K., Ahmadi, H., Sohrabei, S. and Rabiei, R. (2023) Usability Evaluation of Dashboards: A Systematic Literature Review of Tools. *BioMed Research International* [Post-print], 2023 (1), p. 9990933. Available from <https://onlinelibrary.wiley.com/doi/10.1155/2023/9990933>. [Accessed 24th June 2025].

Ansari, B., 2022. *Taking a User-Centered Design Approach to Develop a Data Dashboard for New York State Department of Health and Implications for Improving the Usability of Public Data Dashboards*. State University of New York at Albany.

Arede, Jorge, et al. 'Maturity Timing and Performance in a Youth National Basketball Team: Do Early-Maturing Players Dominate?' *International Journal of Sports Science & Coaching*, vol. 16, no. 3, June 2021, pp. 722–30. *DOI.org (Crossref)*, <https://doi.org/10.1177/1747954120980712>.

Ashford, M., Taylor, J., Newcombe, D., MacNamara, Á., Behan, S., Phelan, S. and McNeill, S. (2024) Coaching adaptive skill and expertise in Premier League football academies—paving a way forward for research and practice. *Frontiers in Sports and Active Living* [Post-print], 6. Available from <https://www.frontiersin.org/journals/sports-and-active-living/articles/10.3389/fspor.2024.1386380/full>. [Accessed 25th September 2025].

Bach, B., Freeman, E., Abdul-Rahman, A., Turkay, C., Khan, S., Fan, Y. and Chen, M.

(2023) Dashboard Design Patterns. *IEEE Transactions on Visualization and Computer Graphics* [Post-print], 29 (1), pp. 342–352. Available from <https://ieeexplore.ieee.org/abstract/document/9903550>. [Accessed 25th September 2025].

Bach, B., Keck, M., Rajabiyazdi, F., Losev, T., Meirelles, I., Dykes, J., Laramée, R.S., AlKadi, M., Stoiber, C., Huron, S., Perin, C., Morais, L., Aigner, W., Kosminsky, D., Boucher, M., Knudsen, S., Manataki, A., Aerts, J., Hinrichs, U., Roberts, J.C. and Carpendale, S. (2024) Challenges and Opportunities in Data Visualization Education: A Call to Action. *IEEE Transactions on Visualization and Computer Graphics* [Post-print], 30 (1), pp. 649–660. Available from <https://ieeexplore.ieee.org/abstract/document/10310184>. [Accessed 28th September 2025].

Bancilhon, M., Padilla, L. and Ottley, A. (2023) Improving Evaluation Using Visualization Decision-Making Models: A Practical Guide. In: Albers Szafir, D., Borgo, R., Chen, M., Edwards, D.J., Fisher, B. and Padilla, L. eds. *Visualization Psychology*. Cham, Springer International Publishing, pp. 85–107.

Bartlett, Jonathan D., and Barry Drust. 'A Framework for Effective Knowledge Translation and Performance Delivery of Sport Scientists in Professional Sport'. *European Journal of Sport Science*, vol. 21, no. 11, Nov. 2021, pp. 1579–87. *DOI.org (Crossref)*, <https://doi.org/10.1080/17461391.2020.1842511>.

Baxter-Jones, Adam D. G., et al. 'The Role of Growth and Maturation during Adolescence on Team-Selection and Short-Term Sports Participation'. *Annals of Human Biology*, vol. 47, no. 4, May 2020, pp. 316–23. *DOI.org (Crossref)*, <https://doi.org/10.1080/03014460.2019.1707870>.

- Bazeley, P. (2016) Mixed or merged? Integration as the real challenge for mixed methods. *Qualitative Research in Organizations and Management: An International Journal* [Post-print], 11 (3), pp. 189–194. Available from <http://www.emerald.com/qrom/article/11/3/189-194/452742>. [Accessed 29th August 2025].
- Bi, Y., 2021. Dual coding of knowledge in the human brain. *Trends in Cognitive Sciences*, 25(10), pp.883-895.
- Bodelon Ruibal, X., 2021. *Redesigning Sport Data Valley's conceptual framework and user interface to improve UX*(Bachelor's thesis, University of Twente).
- Boeker, M. and Midoglu, C. (2023) Soccer Athlete Data Visualization and Analysis with an Interactive Dashboard. In: Dang-Nguyen, D.-T., Gurrin, C., Larson, M., Smeaton, A.F., Rudinac, S., Dao, M.-S., Trattner, C. and Chen, P. eds. *MultiMedia Modeling*. Cham, Springer International Publishing, pp. 565–576.
- Bradley, B., Johnson, D., Hill, M., McGee, D., Kana-Ah, A., Sharpin, C., Sharp, P., Kelly, A., Cumming, S. P., & Malina, R. M. (2019). Bio-banding in academy football: Player's perceptions of a maturity matched tournament. *Annals of Human Biology*, 46(5), 400–408. <https://doi.org/10.1080/03014460.2019.1640284>
- Braun, V. and Clarke, V. (2021) Can I use TA? Should I use TA? Should I *not* use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. *Counselling and Psychotherapy Research* [Post-print], 21 (1), pp. 37–47. Available from <https://onlinelibrary.wiley.com/doi/10.1002/capr.12360>. [Accessed 29th August 2025].
- Buchheit, M. and Laursen, P.B., Sports Science 3.0: Integrating Technology and AI with Foundational Knowledge.
- Burch, M. and Schmid, M. (2023) *Dashboard Design*. 1st ed. New York, River Publishers.

- Caldwell, A.R., Vigotsky, A.D., Tenan, M.S., Radel, R., Mellor, D.T., Kreutzer, A., Lahart, I.M., Mills, J.P., Boisgontier, M.P., Boardley, I., Bouza, B., Cheval, B., Chow, Z.R., Contreras, B., Dieter, B., Halperin, I., Haun, C., Knudson, D., Lahti, J., Miller, M., Morin, J.-B., Naughton, M., Neva, J., Nuckols, G., Peters, S., Roberts, B., Rosa-Caldwell, M., Schmidt, J., Schoenfeld, B.J., Severin, R., Skarabot, J., Steele, J., Twomey, R., Zenko, Z., Lohse, K.R., Nunan, D., and Consortium for Transparency in Exercise Science (COTES) Collaborators (2020) Moving Sport and Exercise Science Forward: A Call for the Adoption of More Transparent Research Practices. *Sports Medicine* [Post-print], 50 (3), pp. 449–459. Available from <https://doi.org/10.1007/s40279-019-01227-1>. [Accessed 29th August 2025].
- Callinan, M.J., Connor, J.D., Sinclair, W.H. and Leicht, A.S. (2023) Exploring rugby coaches perception and implementation of performance analytics. *PLOS ONE* [Post-print], 18 (1), p. e0280799. Available from <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0280799>. [Accessed 28th September 2025].
- Carcary, M. (2020) 'The Research Audit Trail: Methodological Guidance for Application in Practice', *Electronic Journal of Business Research Methods*, vol. 18, no. 2, p. pp166-177-pp166-177 [Online]. DOI: 10.34190/JBRM.18.2.008 (Accessed 6 January 2026).
- Carvalho, H.M. and Gonçalves, C.E. (2023) Mismatches in youth sports talent development. *Frontiers in Sports and Active Living* [Post-print], 5, p. 1189355. Available from <https://www.frontiersin.org/articles/10.3389/fspor.2023.1189355/full>. [Accessed 4th September 2025].
- Chakhchoukh, M., Boukhelifa, N. and Bezerianos, A. (2023) Understanding How In-Visualization Provenance Can Support Trade-Off Analysis. *IEEE Transactions on*

Visualization and Computer Graphics [Post-print], 29 (9), pp. 3758–3774. Available from <https://ieeexplore.ieee.org/abstract/document/9768153>. [Accessed 28th September 2025].

Charbonnet, Bryan, et al. ‘Maturity-Based Correction Mechanism for Talent Identification: When Is It Needed, Does It Work, and Does It Help to Better Predict Who Will Make It to the Pros?’ *Journal of Sports Science & Medicine*, vol. 21, no. 4, Dec. 2022, pp. 640–57. *PubMed Central*, <https://doi.org/10.52082/jssm.2022.639>.

Chimera, N.J., Falk, B., Klentrou, P. and Sullivan, P. (2024) Is Biobanding the Future of Youth Sport Participation? *Pediatric Exercise Science*, 36 (4), pp. 181–191.

Clegg, T., Greene, D.M., Beard, N. and Brunson, J. (2020) Data Everyday: Data Literacy Practices in a Division I College Sports Context. In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. Honolulu HI USA, ACM, pp. 1–13. Available from <https://dl.acm.org/doi/10.1145/3313831.3376153>. [Accessed 29th August 2025].

Clegg, T.L., Cleveland, K., Weight, E., Greene, D. and Elmqvist, N. (2023) Data everyday as community-driven science: Athletes’ critical data literacy practices in collegiate sports contexts. *Journal of Research in Science Teaching* [Post-print], 60 (8), pp. 1786–1816. Available from <https://onlinelibrary.wiley.com/doi/10.1002/tea.21842>. [Accessed 29th August 2025].

Cleveland, W.S. and McGill, R. (1985) Graphical Perception and Graphical Methods for Analyzing Scientific Data. *Science* [Post-print], 229 (4716), pp. 828–833. Available from <https://www.science.org/doi/10.1126/science.229.4716.828>. [Accessed 28th September 2025].

Cole, R. (2024) Inter-Rater Reliability Methods in Qualitative Case Study Research. *Sociological Methods & Research* [Post-print], 53 (4), pp. 1944–1975.

Available from <https://journals.sagepub.com/doi/10.1177/00491241231156971>.

[Accessed 17th September 2025].

Coutinho, P., Mesquita, I. and Fonseca, A.M. (2016) Talent development in sport: A critical review of pathways to expert performance. *International Journal of Sports Science & Coaching* [Post-print], 11 (2), pp. 279–293. Available from <https://journals.sagepub.com/doi/10.1177/1747954116637499>. [Accessed 25th September 2025].

Crawley, N. (2021) *Examining psychosocial development in an elite English football academy: a holistic ecological approach*. Thesis, Brunel University London. Available from <http://bura.brunel.ac.uk/handle/2438/22905>. [Accessed 29th August 2025].

Cui, L. and Liu, Z. (2021) Synergy between research on ensemble perception, data visualization, and statistics education: A tutorial review. *Attention, Perception, & Psychophysics* [Post-print], 83 (3), pp. 1290–1311. Available from <https://doi.org/10.3758/s13414-020-02212-x>. [Accessed 24th June 2025].

Cumming, S.P., Battista, R.A., Standage, M., Ewing, M.E. and Malina, R.M. (2006) Estimated maturity status and perceptions of adult autonomy support in youth soccer players. *Journal of Sports Sciences* [Post-print], 24 (10), pp. 1039–1046. Available from <http://www.tandfonline.com/doi/abs/10.1080/02640410500386142>. [Accessed 7th July 2025].

Dhinu, D.M.R. (2021) *Applied Statistics in Physical Education and Sports*. Friends Publications (India).

Doncaster, G., Kelly, A.L., McAuley, A.B.T., Cain, A., Partington, M., Nelson, L. and O’Gorman, J. (2024) Relative Age Effects and the Premier League’s Elite Player Performance Plan (EPPP): A Comparison of Birthdate Distributions Within and

- Between Age Groups. *Journal of Science in Sport and Exercise* [Internet], Available from <https://doi.org/10.1007/s42978-024-00285-w>. [Accessed 4th September 2025].
- Doty, E., Stone, D.J., McCague, N. and Celi, L.A. (2019) Counterintuitive results from observational data: a case study and discussion. *BMJ Open* [Post-print], 9 (5), p. e026447. Available from <https://bmjopen.bmj.com/content/9/5/e026447>. [Accessed 29th August 2025].
- Du, M. and Yuan, X. (2021) A survey of competitive sports data visualization and visual analysis. *Journal of Visualization* [Post-print], 24 (1), pp. 47–67. Available from <https://doi.org/10.1007/s12650-020-00687-2>. [Accessed 9th July 2025].
- Du, M. and Yuan, X. (2021) A survey of competitive sports data visualization and visual analysis. *Journal of Visualization* [Post-print], 24 (1), pp. 47–67. Available from <https://doi.org/10.1007/s12650-020-00687-2>. [Accessed 25th September 2025].
- Emmonds, S., Till, K., Weaving, D., Burton, A. and Lara-Bercial, S. (2024) Youth Sport Participation Trends Across Europe: Implications for Policy and Practice. *Research Quarterly for Exercise and Sport* [Post-print], 95 (1), pp. 69–80. Available from <https://www.tandfonline.com/doi/full/10.1080/02701367.2022.2148623>. [Accessed 4th September 2025].
- Eriksen, I.M. (2022) Teens' dreams of becoming professional athletes: the gender gap in youths' sports ambitions. *Sport in Society* [Post-print], 25 (10), pp. 1909–1923. Available from <https://www.tandfonline.com/doi/full/10.1080/17430437.2021.1891044>. [Accessed 4th September 2025].
- Eriksen, I.M. and Stefansen, K. (2022) What are youth sports for? Youth sports parenting in working-class communities. *Sport, Education and Society* [Post-print], 27 (5), pp. 592–603. Available from

<https://www.tandfonline.com/doi/full/10.1080/13573322.2021.1894114>. [Accessed 4th September 2025].

Exel, J. and Dabnichki, P. (2024) Precision Sports Science: What Is Next for Data Analytics for Athlete Performance and Well-Being Optimization? *Applied Sciences* [Post-print], 14 (8), p. 3361. Available from <https://www.mdpi.com/2076-3417/14/8/3361>. [Accessed 24th June 2025].

Fetters, M.D., Curry, L.A. and Creswell, J.W. (2013) Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research* [Post-print], 48 (6pt2), pp. 2134–2156. Available from <https://onlinelibrary.wiley.com/doi/10.1111/1475-6773.12117>. [Accessed 31st July 2025].

Fitzgerald, F., Campbell, M., Kearney, P.E. and Cumming, S. (2024) Exploring the existence, strength, and independence of relative age and maturation selection biases: a case study in Gaelic football talent development programmes. *Annals of human biology* [Post-print], 51 (1), p. 2349040. Available from <https://doi.org/10.1080/03014460.2024.2349040>. [Accessed 9th July 2025].

Ford, P., De Ste Croix, M., Lloyd, R., Meyers, R., Moosavi, M., Oliver, J., Till, K. and Williams, C. (2011) The Long-Term Athlete Development model: Physiological evidence and application. *Journal of Sports Sciences* [Post-print], 29 (4), pp. 389–402. Available from <http://www.tandfonline.com/doi/abs/10.1080/02640414.2010.536849>. [Accessed 9th September 2025].

Fox, A.R. (2023) Theories and Models in Graph Comprehension. In: Albers Szafir, D., Borgo, R., Chen, M., Edwards, D.J., Fisher, B. and Padilla, L. eds. *Visualization Psychology*. Cham, Springer International Publishing, pp. 39–64.

- Fransen, J., Baxter-Jones, A. and Woodcock, S. (2018) Responding to the Commentary on the Article: “Improving the Prediction of Maturity From Anthropometric Variables Using a Maturity Ratio”. *Pediatric Exercise Science* [Post-print], 30 (2), pp. 311–313. Available from <https://journals.humankinetics.com/view/journals/pes/30/2/article-p311.xml>. [Accessed 24th June 2025].
- Gabbett, T., Sancho, I., Dingenen, B. and Willy, R.W. (2021) When progressing training loads, what are the considerations for healthy and injured athletes? *British Journal of Sports Medicine* [Post-print], 55 (17), pp. 947–948. Available from <https://bjsm.bmj.com/lookup/doi/10.1136/bjsports-2020-103769>. [Accessed 30th September 2025].
- Glebova, E., Madsen, D.Ø., Mihaľová, P., Géczi, G., Mittelman, A. and Jorgič, B. (2024) Artificial intelligence development and dissemination impact on the sports industry labor market. *Frontiers in Sports and Active Living* [Post-print], 6, p. 1363892. Available from <https://www.frontiersin.org/articles/10.3389/fspor.2024.1363892/full>. [Accessed 4th September 2025].
- Gobo, G. (2023) Mixed Methods and Their Pragmatic Approach: Is There a Risk of Being Entangled in a Positivist Epistemology and Methodology? Limits, Pitfalls and Consequences of a Bricolage Methodology. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research* [Post-print], p. Vol. 24 No. 1 (2023): Mixed Methods and Multimethod Social Research—Current Applications and Future Directions. Available from <https://www.qualitative-research.net/index.php/fqs/article/view/4005>. [Accessed 29th August 2025].
- Goes, F.R., Meerhoff, L.A., Bueno, M.J.O., Rodrigues, D.M., Moura, F.A., Brink, M.S., Elferink-Gemser, M.T., Knobbe, A.J., Cunha, S.A., Torres, R.S. and Lemmink, K.A.P.M. (2021) Unlocking the potential of big data to support tactical performance

analysis in professional soccer: A systematic review. *European Journal of Sport Science* [Post-print], 21 (4), pp. 481–496. Available from <https://onlinelibrary.wiley.com/doi/10.1080/17461391.2020.1747552>. [Accessed 30th September 2025].

Golik, M. and Blanco, M.R. (2021) Homophily: functional bias to the talent identification process? *Personnel Review* [Post-print], 51 (2), pp. 620–643. Available from <https://doi.org/10.1108/PR-05-2019-0230>. [Accessed 19th March 2025].

González-Rodenas, J., Pedrera, G., Dorado, V., Aranda-Malavés, R., Tudela-Desantes, A. and De Matías-Cid, P. (2022) Effects of Age and Playing Tactics on the Individual Tactical Behavior in U10 and U12 Elite Spanish Soccer Players. *Sports* [Post-print], 10 (11), p. 185. Available from <https://www.mdpi.com/2075-4663/10/11/185>. [Accessed 19th March 2025].

Goudsmit, J., Otter, R.T.A., Stoter, I., Van Holland, B., Van Der Zwaard, S., De Jong, J. and Vos, S. (2022) Co-Operative Design of a Coach Dashboard for Training Monitoring and Feedback. *Sensors* [Post-print], 22 (23), p. 9073. Available from <https://www.mdpi.com/1424-8220/22/23/9073>. [Accessed 28th September 2025].

Gould, D. (2019) The Current Youth Sport Landscape: Identifying Critical Research Issues. *Kinesiology Review* [Post-print], 8 (3), pp. 150–161. Available from <https://journals.humankinetics.com/view/journals/krij/8/3/article-p150.xml>. [Accessed 29th August 2025].

Grabinger, L., Hauser, F. and Mottok, J. (2024) On the perception of graph layouts. *Journal of Software: Evolution and Process* [Post-print], 36 (5), p. e2599. Available from <https://onlinelibrary.wiley.com/doi/10.1002/smr.2599>. [Accessed 28th September 2025].

- Grondin, S. (2024) To be or not to be born at the right time: lessons from ice hockey. *Frontiers in Sports and Active Living* [Post-print], 6, p. 1440029. Available from <https://www.frontiersin.org/articles/10.3389/fspor.2024.1440029/full>. [Accessed 30th September 2025].
- Güllich, A. (2014) Selection, de-selection and progression in German football talent promotion. *European Journal of Sport Science* [Post-print], 14 (6), pp. 530–537. Available from <https://onlinelibrary.wiley.com/doi/10.1080/17461391.2013.858371>. [Accessed 7th July 2025].
- Güllich, A., Barth, M., Hambrick, D.Z. and Macnamara, B.N. (2023) Participation patterns in talent development in youth sports. *Frontiers in Sports and Active Living* [Post-print], 5, p. 1175718. Available from <https://www.frontiersin.org/articles/10.3389/fspor.2023.1175718/full>. [Accessed 4th September 2025].
- Hakanen, J., Gold, D., Miettinen, K. and Reed, P.M. (2023) Visualisation for Decision Support in Many-Objective Optimisation: State-of-the-art, Guidance and Future Directions. In: Brockhoff, D., Emmerich, M., Naujoks, B. and Purshouse, R. eds. *Many-Criteria Optimization and Decision Analysis: State-of-the-Art, Present Challenges, and Future Perspectives*. Cham, Springer International Publishing, pp. 181–212.
- Hamel, C., Michaud, A., Thuku, M., Skidmore, B., Stevens, A., Nussbaumer-Streit, B. and Garritty, C. (2021) Defining Rapid Reviews: a systematic scoping review and thematic analysis of definitions and defining characteristics of rapid reviews. *Journal of Clinical Epidemiology* [Post-print], 129, pp. 74–85. Available from <https://linkinghub.elsevier.com/retrieve/pii/S0895435620311276>. [Accessed 14th August 2025].

- Hampson, T. and McKinley, J. (2023) Problems posing as solutions: Criticising pragmatism as a paradigm for mixed research. *Research in Education* [Post-print], 116 (1), pp. 124–138. Available from <https://journals.sagepub.com/doi/10.1177/00345237231160085>. [Accessed 29th August 2025].
- Hannon, M. P., Close, G. L., & Morton, J. P. (2020). Energy and Macronutrient Considerations for Young Athletes. *Strength & Conditioning Journal*, 42(6), 109–119. <https://doi.org/10.1519/SSC.0000000000000570>
- Hansford, H.J., Cashin, A.G., Wewege, M.A., Ferraro, M.C., McAuley, J.H. and Jones, M.D. (2021) Evaluation of Journal Policies to Increase Promotion of Transparency and Openness in Sport Science Research. *Arthroscopy: The Journal of Arthroscopic & Related Surgery* [Post-print], 37 (11), pp. 3223–3225. Available from <https://linkinghub.elsevier.com/retrieve/pii/S0749806321008215>. [Accessed 29th August 2025].
- Hauser, L.-L., Harwood, C.G., Höner, O., O'Connor, D. and Wachsmuth, S. (2024) Talent development environments within sports: a scoping review examining functional and dysfunctional environmental features. *International Review of Sport and Exercise Psychology* [Post-print], 17 (2), pp. 1105–1131. Available from <https://www.tandfonline.com/doi/full/10.1080/1750984X.2022.2129423>. [Accessed 4th September 2025].
- Hauser, L.-L., Harwood, C.G., Höner, O., O'Connor, D. and Wachsmuth, S. (2024) Talent development environments within sports: a scoping review examining functional and dysfunctional environmental features. *International Review of Sport and Exercise Psychology* [Post-print], 17 (2), pp. 1105–1131. Available from

<https://www.tandfonline.com/doi/full/10.1080/1750984X.2022.2129423>. [Accessed 25th September 2025].

Henriksen, K. and Stambulova, N. (2023) The social environment of talent development in youth sport. *Frontiers in Sports and Active Living* [Post-print], 5, p. 1127151. Available from <https://www.frontiersin.org/articles/10.3389/fspor.2023.1127151/full>. [Accessed 4th September 2025].

Henriksen, K. and Stambulova, N. (2023) The social environment of talent development in youth sport. *Frontiers in Sports and Active Living* [Post-print], 5, p. 1127151. Available from <https://www.frontiersin.org/articles/10.3389/fspor.2023.1127151/full>. [Accessed 25th September 2025].

Hill, M., Scott, S., Malina, R. M., McGee, D., & Cumming, S. P. (2020). *Relative age and maturation selection biases in academy football*. 38(11–12), 1359–1367. <https://yorksj.idm.oclc.org/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,shib&db=edsbl&AN=vdc.100111203862.0x000001&site=eds-live&scope=site>

Hill, Megan, Sam Scott, et al. 'Relative Age and Maturation Selection Biases in Academy Football'. *Journal of Sports Sciences*, vol. 38, no. 11–12, June 2020, pp. 1359–67. *DOI.org (Crossref)*, <https://doi.org/10.1080/02640414.2019.1649524>.

Hill, Megan, Thomas John, et al. 'Beyond the Coaches Eye: Understanding the “How” and “Why” of Maturity Selection Biases in Male Academy Soccer'. *International Journal of Sports Science & Coaching*, vol. 18, no. 6, Dec. 2023, pp. 1913–28. *DOI.org (Crossref)*, <https://doi.org/10.1177/17479541231186673>.

Hogan, C., Abbott, S., Halaki, M., Torres Castiglioni, M., Yamauchi, G., Mitchell, L., Salter, J., Romann, M. and Cobley, S. (2022) Maturation-based Corrective Adjustment Procedures (Mat-CAPs) in youth swimming: Evidence for restricted age-group

- application in females. *PLOS ONE* [Post-print], 17 (10), p. e0275797. Available from <https://dx.plos.org/10.1371/journal.pone.0275797>. [Accessed 24th June 2025].
- Johnson, A., Doherty, P. J., & Freemont, A. (2009). Investigation of growth, development, and factors associated with injury in elite schoolboy footballers: Prospective study. *BMJ (Clinical Research Ed.)*, 338, b490. <https://doi.org/10.1136/bmj.b490>
- Johnson, A., Farooq, A., & Whiteley, R. (2017). Skeletal maturation status is more strongly associated with academy selection than birth quarter. *Science and Medicine in Football*, 1(2), 157–163. <https://doi.org/10.1080/24733938.2017.1283434>
- Jones, B., Eather, N., Miller, A. and Morgan, P.J. (2024) Evaluating the impact of a coach development intervention for improving coaching practices and player outcomes in football: the MASTER Coaching randomised control trial. *Physical Education and Sport Pedagogy* [Post-print], 29 (6), pp. 652–669. Available from <https://www.tandfonline.com/doi/full/10.1080/17408989.2022.2153817>. [Accessed 25th September 2025].
- Kandel, Sean, et al. 'Wrangler: Interactive Visual Specification of Data Transformation Scripts'. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 2011, pp. 3363–72. *DOI.org (Crossref)*, <https://doi.org/10.1145/1978942.1979444>.
- Kallio, H., Pietilä, A., Johnson, M. and Kangasniemi, M. (2016) 'Systematic methodological review: developing a framework for a qualitative semi-structured interview guide', *Journal of Advanced Nursing*, vol. 72, no. 12, pp. 2954–2965 [Online]. DOI: 10.1111/jan.13031 (Accessed 6 January 2026).
- Kelly, A. (2023) *Talent Identification and Development in Youth Soccer: A Guide for Researchers and Practitioners*. Taylor & Francis.

- Kelly, Adam L., et al. 'A Longitudinal Investigation into the Relative Age Effect in an English Professional Football Club: Exploring the "Underdog Hypothesis"'. *Science and Medicine in Football*, vol. 4, no. 2, Apr. 2020, pp. 111–18. DOI.org (Crossref), <https://doi.org/10.1080/24733938.2019.1694169>.
- Kite, R.J., Noon, M.R., Morris, R., Mundy, P. and Clarke, N.D. (2024) Observations of Player (de)Selection Within a Professional UK Soccer Academy. *Journal of Science in Sport and Exercise* [Post-print], 6 (1), pp. 71–80. Available from <https://doi.org/10.1007/s42978-023-00222-3>. [Accessed 9th July 2025].
- Kreider, R.B. (2020) Strength, Conditioning, and Nutritional Considerations for High-Level Performers. *Kinesiology Review* [Post-print], 9 (1), pp. 31–40. Available from <https://journals.humankinetics.com/view/journals/krij/9/1/article-p31.xml>. [Accessed 30th September 2025].
- Kushniruk, A.W. and Borycki, E.M. (2025) Human factors and usability engineering research methods in health informatics. In: Gray, K. and Lederman, R. eds. *Research Handbook on Health Information Systems*. Edward Elgar Publishing, pp. 172–190.
- Kusmaryono, I., Wijayanti, D. and Maharani, H.R. (2022) Number of Response Options, Reliability, Validity, and Potential Bias in the Use of the Likert Scale Education and Social Science Research: A Literature Review. *International Journal of Educational Methodology* [Post-print], 8 (4), pp. 625–637. Available from <https://eric.ed.gov/?id=EJ1369114>. [Accessed 17th September 2025].
- Lasarov, W., Trabandt, M., Hoffmann, S. and Viglia, G. (2026) How practitioners can leverage GenAI to bridge the research-practice gap. *Tourism Management* [Post-print], 113, p. 105309. Available from

<https://www.sciencedirect.com/science/article/pii/S0261517725001797>. [Accessed 28th September 2025].

Leach, R. B., Dehnert, M., Reutlinger, C., Marr, C. and Tracy, S. J. (2025) 'Setting Up the Tent Poles: Revisiting and Extending the Big-Tent Model for Qualitative Quality', in Flick, U. (ed), *The Sage Handbook of Qualitative Research Quality*, 1 Oliver's Yard, 55 City Road London EC1Y 1SP, Sage Publications Ltd, pp. 469–483 [Online]. DOI: 10.4135/9781529674354.n31 (Accessed 6 January 2026).

Light, N., Thorborg, K., Krommes, K., Nielsen, M.F., Thornton, K.B., Hölmich, P., Penalver, J.J.J. and Ishøi, L. (2022) Rapid Spike in Hip Adduction Strength in Early Adolescent Footballers: A Study of 125 Elite Male Players From Youth to Senior. *International Journal of Sports Physiology and Performance* [Post-print], 17 (9), pp. 1407–1414. Available from <https://journals.humankinetics.com/view/journals/ijsp/17/9/article-p1407.xml>. [Accessed 14th August 2025].

Lloyd, R.S. and Oliver, J., 2013. *Strength and conditioning for young athletes*. Abingdon: Taylor & Francis.

Magalhães, R., Marcondes, F.S., Durães, D. and Novais, P. (2023) Emotion Extraction from Likert-Scale Questionnaires. In: Quaresma, P., Camacho, D., Yin, H., Gonçalves, T., Julian, V. and Tallón-Ballesteros, A.J. eds. *Intelligent Data Engineering and Automated Learning – IDEAL 2023*. Cham, Springer Nature Switzerland, pp. 166–176.

Malina, R.M. (2011) Skeletal Age and Age Verification in Youth Sport. *Sports Medicine* [Post-print], 41 (11), pp. 925–947. Available from <https://doi.org/10.2165/11590300-000000000-00000>. [Accessed 7th July 2025].

Malina, R.M. and Koziel, S.M. (2014) Validation of maturity offset in a longitudinal sample of Polish boys. *Journal of Sports Sciences* [Post-print], 32 (5), pp. 424–437. Available

from <http://www.tandfonline.com/doi/abs/10.1080/02640414.2013.828850>.

[Accessed 24th June 2025].

Malina, R.M., Eisenmann, J.C., Cumming, S.P., Ribeiro, B. and Aroso, J. (2004) Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13–15 years. *European Journal of Applied Physiology* [Post-print], 91 (5), pp. 555–562. Available from <https://doi.org/10.1007/s00421-003-0995-z>. [Accessed 24th June 2025].

Malina, Robert M., et al. 'Biological Maturation of Youth Athletes: Assessment and Implications'. *British Journal of Sports Medicine*, vol. 49, no. 13, July 2015, pp. 852–59. *DOI.org (Crossref)*, <https://doi.org/10.1136/bjsports-2015-094623>.

Manescu, D.C. (2025). Big Data Analytics Framework for Decision-Making in Sports Performance Optimization.

Martindale, R.J.J., Collins, D., Douglas, C. and Whike, A. (2013) Examining the ecological validity of the Talent Development Environment Questionnaire. *Journal of Sports Sciences* [Post-print], 31 (1), pp. 41–47. Available from <http://www.tandfonline.com/doi/abs/10.1080/02640414.2012.718443>. [Accessed 29th August 2025].

Massa, M., Moreira, A., A. Costa, R., R. Lima, M., R. Thiengo, C., Q. Marquez, W., J. Coutts, A. and S. Aoki, M. (2022) Biological maturation influences selection process in youth elite soccer players. *Biology of Sport* [Post-print], 39 (2), pp. 435–441. Available from <https://www.termedia.pl/doi/10.5114/biolSport.2022.106152>. [Accessed 9th September 2025].

Maturity, and Age as Injury Risk Factors in High-Level Youth Football. *Sports Medicine* <https://journals.humankinetics.com/view/journals/iscj/8/3/article-p362.xml>. [Accessed 7th July 2025].

- Megheirkouni, M. and Moir, J. (2023) 'Simple but Effective Criteria: Rethinking Excellent Qualitative Research', *The Qualitative Report* [Online]. DOI: 10.46743/2160-3715/2023.5845 (Accessed 6 January 2026).
- McAuley, A.B.T., Baker, J., Johnston, K. and Kelly, A.L. (2024) Artificial Intelligence in Talent Identification and Development in Sport. In: Dindorf, C., Bartaguiz, E., Gassmann, F. and Fröhlich, M. eds. *Artificial Intelligence in Sports, Movement, and Health*. Cham, Springer Nature Switzerland, pp. 255–270.
- McLellan, M., Allahabadi, S. and Pandya, N.K. (2022) Youth Sports Specialization and Its Effect on Professional, Elite, and Olympic Athlete Performance, Career Longevity, and Injury Rates: A Systematic Review. *Orthopaedic Journal of Sports Medicine* [Post-print], 10 (11), p. 23259671221129594. Available from <https://journals.sagepub.com/doi/10.1177/23259671221129594>. [Accessed 4th September 2025].
- Memmert, D. and Raabe, D. (2023) *Data Analytics in Football: Positional Data Collection, Modelling and Analysis*. 2nd ed. London, Routledge.
- Mezzzone, A., Oxenham, P. and Ranaweera, J. (2025a) Formative usability assessment of a digital dashboard designed in a British Basketball League club. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology* [Post-print], p. 17543371251324816. Available from <https://journals.sagepub.com/doi/10.1177/17543371251324816>. [Accessed 24th June 2025].
- Mirwald, R.L., Baxter-Jones, A.D., Bailey, D.A. and Beunen, G.P., 2002. An assessment of maturity from anthropometric measurements. *Medicine & science in sports & exercise*, 34(4), pp.689-694.

- Mitchell, T.O., Gledhill, A., Shand, R., Littlewood, M.A., Charnock, L. and Till, K. (2021) Players' Perceptions of the Talent Development Environment Within the English Premier League and Football League. *International Sport Coaching Journal* [Post-print], 8 (3), pp. 362–370. Available from
- Mittal, S. and Rohit (2025) AI in Talent Scouting and Player Development: Role of AI and Machine Learning in Identifying and Nurturing Talent in Sports Organizations. In: Choudhury, T., Arya, P.K., Kotecha, K., Sharma, A. and Um, J.-S. eds. *Advances in Computational Intelligence and Robotics*. IGI Global, pp. 173–196.
- Monasterio, X., Gil, S.M., Bidaurrezaga-Letona, I., Cumming, S.P., Malina, R.M., Williams, S., Lekue, J.A., Santisteban, J.M., Diaz-Beitia, G. and Larruskain, J. (2024) Estimating Maturity Status in Elite Youth Soccer Players: Evaluation of Methods. *Medicine & Science in Sports & Exercise* [Post-print], 56 (6), pp. 1124–1133. Available from <https://journals.lww.com/10.1249/MSS.0000000000003405>. [Accessed 7th July 2025].
- Moore, S.A., McKay, H.A., Macdonald, H., Nettlefold, L., Baxter-Jones, A.D., Cameron, N. and Brasher, P.M., 2015. Enhancing a somatic maturity prediction model. *Med Sci Sports Exerc*, 47(8), pp.1755-64.
- Moraes Bueno Rodrigues, A., Diniz Junqueira Barbosa, G., Côrtes Vieira Lopes, H. and Diniz Junqueira Barbosa, S. (2021) What questions reveal about novices' attempts to make sense of data visualizations: Patterns and misconceptions. *Computers & Graphics* [Post-print], 94, pp. 32–42. Available from
- Morganti, G., Kelly, A.L., Apollaro, G., Pantanella, L., Esposito, M., Grossi, A. and Ruscello, B. (2023) Relative age effects and the youth-to-senior transition in Italian soccer: the underdog hypothesis versus knock-on effects of relative age. *Science & Medicine in Football*, 7 (4), pp. 406–412.

- Murphy, D.R., Savoy, A., Satterly, T., Sittig, D.F. and Singh, H. (2021) Dashboards for visual display of patient safety data: a systematic review. *BMJ Health & Care Informatics* [Post-print], 28 (1), p. e100437. Available from <https://informatics.bmj.com/lookup/doi/10.1136/bmjhci-2021-100437>. [Accessed 24th June 2025].
- Nassis, G., Verhagen, E., Brito, J., Figueiredo, P. and Krstrup, P. (2023) A review of machine learning applications in soccer with an emphasis on injury risk. *Biology of Sport* [Post-print], 40 (1), pp. 233–239. Available from <https://www.termedia.pl/doi/10.5114/biolSport.2023.114283>. [Accessed 30th September 2025].
- Nedeljkovic, A., Mirkov, D.M., Kukolj, M., Ugarkovic, D. and Jaric, S. (2007) Effect of maturation on the relationship between physical performance and body size. *Journal of Strength and Conditioning Research*, 21 (1), pp. 245–250.
- Nevedal, A.L., Reardon, C.M., Opra Widerquist, M.A., Jackson, G.L., Cutrona, S.L., White, B.S. and Damschroder, L.J. (2021) Rapid versus traditional qualitative analysis using the Consolidated Framework for Implementation Research (CFIR). *Implementation Science* [Post-print], 16 (1), p. 67. Available from <https://doi.org/10.1186/s13012-021-01111-5>. [Accessed 14th August 2025].
- Noon, M.R., Eyre, E.L.J., Ellis, M., Myers, T.D., Morris, R.O., Mundy, P.D., Penny, R. and Clarke, N.D. (2021) The Influence of Recruitment Age and Anthropometric and Physical Characteristics on the Development Pathway of English Academy Football Players. *International Journal of Sports Physiology and Performance* [Post-print], 16 (2), pp. 199–207. Available from <https://journals.humankinetics.com/view/journals/ijsp/16/2/article-p199.xml>. [Accessed 7th July 2025].

- Nosek, P., Brownlee, T.E., Drust, B. and Andrew, M. (2021) Feedback of GPS training data within professional English soccer: a comparison of decision making and perceptions between coaches, players and performance staff. *Science and Medicine in Football* [Post-print], 5 (1), pp. 35–47. Available from <https://www.tandfonline.com/doi/full/10.1080/24733938.2020.1770320>. [Accessed 28th September 2025].
- O'Brien, J., Huthöfer, M., Santner, E., Becker, T. and Stöggl, T., 2025. Comparing apples and pears? Evaluating the interchangeability of three different positions for hip abduction and adduction strength testing in academy footballers. *Journal of Athletic Training*.
- Obie, H.O., Chua, C., Avazpour, I., Abdelrazek, M., Grundy, J. and Bednarz, T. (2019) A study of the effects of narration on comprehension and memorability of visualisations. *Journal of Computer Languages* [Post-print], 52, pp. 113–124. Available from <https://linkinghub.elsevier.com/retrieve/pii/S1045926X19300059>. [Accessed 25th September 2025].
- Ouwehand, K., Lespiau, F., Tricot, A. and Paas, F. (2025) Cognitive Load Theory: Emerging Trends and Innovations. *Education Sciences* [Post-print], 15 (4), p. 458. Available from <https://www.mdpi.com/2227-7102/15/4/458>. [Accessed 24th June 2025].
- Parsons, P.C. (2023) Design Cognition in Data Visualization. In: Albers Szafir, D., Borgo, R., Chen, M., Edwards, D.J., Fisher, B. and Padilla, L. eds. *Visualization Psychology*. Cham, Springer International Publishing, pp. 197–215.
- Patel, R., Nevill, A., Smith, T., Cloak, R. and Wyon, M. (2020) The influence of birth quartile, maturation, anthropometry and physical performances on player retention: Observations from an elite football academy. *International Journal of Sports Science & Coaching* [Post-print], 15 (2), pp. 121–134. Available from

<https://journals.sagepub.com/doi/10.1177/1747954120906507>. [Accessed 7th July 2025].

Pedersen, A.M. and Bossen, C. (2024) Data Work Between the Local and the Global: An Ethnography of a Healthcare Business Intelligence Unit. *Proceedings of the ACM on Human-Computer Interaction* [Post-print], 8 (CSCW1), pp. 1–28. Available from <https://dl.acm.org/doi/10.1145/3637317>. [Accessed 29th September 2025].

Pedersen, P.M., Laucella, P.C., Kian, E. and Geurin, A.N. (2021) *Strategic Sport Communication*. Human Kinetics.

Pérez Bentancur, V. and Tiscornia, L. (2024) Iteration in Mixed-Methods Research Designs Combining Experiments and Fieldwork. *Sociological Methods & Research* [Post-print], 53 (2), pp. 729–759. Available from <https://journals.sagepub.com/doi/10.1177/00491241221082595>. [Accessed 31st July 2025].

Pérez-González, B., León-Quismondo, J., Bonal, J., Burillo, P. and Fernández-Luna, Á. (2021) The New Generation of Professional Soccer Talent Is Born under the Bias of the RAE: Relative Age Effect in International Male Youth Soccer Championships. *Children* [Post-print], 8 (12), p. 1117. Available from <https://www.mdpi.com/2227-9067/8/12/1117>. [Accessed 19th March 2025].

Perkins, D.R., Talbot, J.S., Lord, R.N., Dawkins, T.G., Baggish, A.L., Zaidi, A., Uzun, O., Mackintosh, K.A., McNarry, M.A., Cooper, S., Lloyd, R.S., Oliver, J.L., Shave, R.E. and Stembridge, M. (2022) The influence of maturation on exercise-induced cardiac remodelling and haematological adaptation. *The Journal of Physiology* [Post-print], 600 (3), pp. 583–601. Available from <https://physoc.onlinelibrary.wiley.com/doi/10.1113/JP282282>. [Accessed 7th July 2025].

- Plakias, S., Betsios, X. and Kalapotharakos, V. (2023). Bridging the gap: Leveraging Power BI to connect data science and soccer coaches. *Journal of Physical Education and Sport*, 23(10), pp.2543–2550.
- Pozdniakov, S., Martinez-Maldonado, R., Tsai, Y.-S., Echeverria, V., Srivastava, N. and Gasevic, D. (2023) How Do Teachers Use Dashboards Enhanced with Data Storytelling Elements According to their Data Visualisation Literacy Skills? In: *LAK23: 13th International Learning Analytics and Knowledge Conference*. Arlington TX USA, ACM, pp. 89–99. Available from <https://dl.acm.org/doi/10.1145/3576050.3576063>. [Accessed 24th June 2025].
- Proudfoot, K. (2023) Inductive/Deductive Hybrid Thematic Analysis in Mixed Methods Research. *Journal of Mixed Methods Research* [Post-print], 17 (3), pp. 308–326. Available from <https://journals.sagepub.com/doi/10.1177/15586898221126816>. [Accessed 17th September 2025].
- Quadri, G.J., Wang, A.Z., Wang, Z., Adorno, J., Rosen, P. and Szafir, D.A. (2024) Do You See What I See? A Qualitative Study Eliciting High-Level Visualization Comprehension. In: *Proceedings of the CHI Conference on Human Factors in Computing Systems*. Honolulu HI USA, ACM, pp. 1–26. Available from <https://dl.acm.org/doi/10.1145/3613904.3642813>. [Accessed 24th June 2025].
- Radnor, J.M., Oliver, J.L., Waugh, C.M., Myer, G.D. and Lloyd, R.S. (2022) Muscle Architecture and Maturation Influence Sprint and Jump Ability in Young Boys: A Multistudy Approach. *Journal of Strength & Conditioning Research* [Post-print], 36 (10), pp. 2741–2751. Available from <https://journals.lww.com/10.1519/JSC.0000000000003941>. [Accessed 14th August 2025].

- Reeves, M.J. and Roberts, S.J. (2018) Talent identification and talent development in junior-elite football in the UK: an introduction. *Soccer & Society* [Post-print], pp. 1–3. Available from <https://www.tandfonline.com/doi/full/10.1080/14660970.2018.1432382>. [Accessed 7th July 2025].
- Robinson, O. C. (2023) 'Probing in qualitative research interviews: Theory and practice', *Qualitative Research in Psychology*, vol. 20, no. 3, pp. 382–397 [Online]. DOI: 10.1080/14780887.2023.2238625 (Accessed 6 January 2026).
- Roca, A., Gomes, C. and Murphy, C.P. (2022) Cognitive processes underpinning soccer coaches' decision-making during competition. *Journal of Expertise* [Post-print], pp. 1–31. Available from <https://research.stmarys.ac.uk/id/eprint/5664/>. [Accessed 30th September 2025].
- Roe, C. and Parker, A. (2022) Sport, Chaplaincy and Holistic Support: The Elite Player Performance Plan (EPPP) in English Professional Football. In: *Chaplaincy and Practical Theology*. Routledge.
- Ronkainen, N., Aggerholm, K., Allen-Collinson, J. and Ryba, T.V. (2023) Beyond life-skills: talented athletes, existential learning and (Un)learning the life of an athlete. *Qualitative Research in Sport, Exercise and Health* [Post-print], 15 (1), pp. 35–49. Available from <https://www.tandfonline.com/doi/full/10.1080/2159676X.2022.2037694>. [Accessed 4th September 2025].
- Rubia, A. de la, Kelly, A.L., García-González, J., Lorenzo, J., Mon-López, D. and Maroto-Izquierdo, S. (2023) Biological maturity vs. relative age: Independent impact on physical performance in male and female youth handball players. *Biology of Sport* [Post-print], 41 (3), pp. 3–13. Available from <https://www.termedia.pl/Biological->

maturity-vs-relative-age-Independent-impact-on-r-nphysical-performance-in-male-and-female-youth-handball-players,78,51827,0,1.html. [Accessed 9th July 2025].

Ruf, Ludwig, et al. 'Normative Reference Centiles for Sprint Performance in High-Level Youth Soccer Players: The Need to Consider Biological Maturity'. *Pediatric Exercise Science*, vol. 36, no. 4, Nov. 2024, pp. 192–200. *DOI.org (Crossref)*, <https://doi.org/10.1123/pes.2023-0186>.

Runswick, O.R., Ould-Dada, H. and Lewis, D. (2024) The developmental activities of women's professional pathway cricketers. *Journal of Sports Sciences* [Post-print], 42 (6), pp. 547–557. Available from <https://www.tandfonline.com/doi/full/10.1080/02640414.2024.2351290>. [Accessed 4th September 2025].

Rycroft-Smith, L. (2022) Knowledge brokering to bridge the research-practice gap in education: Where are we now? *Review of Education* [Post-print], 10 (1), p. e3341. Available from <https://bera-journals.onlinelibrary.wiley.com/doi/10.1002/rev3.3341>. [Accessed 28th September 2025].

Salter, J., De Ste Croix, M.B.A., Hughes, J.D., Weston, M. and Towlson, C. (2021) Monitoring Practices of Training Load and Biological Maturity in UK Soccer Academies. *International Journal of Sports Physiology and Performance* [Post-print], 16 (3), pp. 395–406. Available from <https://journals.humankinetics.com/view/journals/ijsp/16/3/article-p395.xml>. [Accessed 7th July 2025].

Santos, T.F.R. (2024). Data Driven Sports Organisations: Empowering Small Sports Organizations with Data-driven Training Strategies (Master's thesis, Universidade NOVA de Lisboa (Portugal)).

- Sarmiento, H., Anguera, M.T., Pereira, A. and Araújo, D. (2018) Talent Identification and Development in Male Football: A Systematic Review. *Sports Medicine* [Post-print], 48 (4), pp. 907–931. Available from <https://doi.org/10.1007/s40279-017-0851-7>. [Accessed 7th July 2025].
- Schober, P., Mascha, E.J. and Vetter, T.R. (2021) Statistics From A (Agreement) to Z (z Score): A Guide to Interpreting Common Measures of Association, Agreement, Diagnostic Accuracy, Effect Size, Heterogeneity, and Reliability in Medical Research. *Anesthesia & Analgesia* [Post-print], 133 (6), pp. 1633–1641. Available from <https://journals.lww.com/10.1213/ANE.00000000000005773>. [Accessed 24th June 2025].
- Schubring, A., Lundvall, S. and Rylander, P. (2024) Exploring the professionalisation of sports coaching from the athlete's point of view: a study of professional players from Sweden. *Sport in Society* [Post-print], 27 (12), pp. 1958–1977. Available from <https://www.tandfonline.com/doi/full/10.1080/17430437.2024.2411494>. [Accessed 4th September 2025].
- Schwarz, E., Harper, L.D., Duffield, R., McCunn, R., Govus, A., Skorski, S. and Fullagar, H.H.K. (2021) Practitioner, Coach, and Athlete Perceptions of Evidence-Based Practice in Professional Sport in Australia. *International Journal of Sports Physiology and Performance* [Post-print], 16 (12), pp. 1728–1735. Available from <https://journals.humankinetics.com/view/journals/ijsp/16/12/article-p1728.xml>. [Accessed 30th September 2025].
- Sedeaud, Adrien, et al. 'Talent Identification: Time to Move Forward on Estimation of Potentials? Proposed Explanations and Promising Methods'. *Sports Medicine*, Jan. 2025. *Springer Link*, <https://doi.org/10.1007/s40279-024-02171-5>.

- Sellami, M., Makni, E., Moalla, W., Tarwneh, R. and Elloumi, M. (2024) Effect of maturation level on normative specific-agility performance metrics and their fitness predictors in soccer players aged 11–18 years. *BMC Sports Science, Medicine and Rehabilitation* [Post-print], 16 (1), p. 61. Available from <https://doi.org/10.1186/s13102-024-00855-z>. [Accessed 9th July 2025].
- Sevilmiş, A. and Yildiz, O. (2022) Focus groups: A practical guide for sport education research. *International Journal of Recreation and Sports Science* [Internet], Available from <https://dergipark.org.tr/en/doi/10.46463/ijrss.1161584>. [Accessed 29th August 2025].
- Shan, Y. (2022) Philosophical foundations of mixed methods research. *Philosophy Compass*, 17(1), p. e12804.
<https://doi.org/10.1111/phc3.12804>
- South, L., Saffo, D., Vitek, O., Dunne, C. and Borkin, M.A. (2022) Effective Use of Likert Scales in Visualization Evaluations: A Systematic Review. *Computer Graphics Forum* [Post-print], 41 (3), pp. 43–55. Available from <https://onlinelibrary.wiley.com/doi/10.1111/cgf.14521>. [Accessed 17th September 2025].
- Stieger, R., Nagel, S. and Lang, G. (2025) Professionalisation and governance in sports organisations: towards an integrated understanding. *Current Issues in Sport Science (C/SS)* [Post-print], 10 (2), p. 020. Available from <https://ciss-journal.org/article/view/11993>. [Accessed 4th September 2025].
- Sweeney, L., Horan, D. and MacNamara, Á. (2021) Premature Professionalisation or Early Engagement? Examining Practise in Football Player Pathways. *Frontiers in Sports and Active Living* [Post-print], 3, p. 660167. Available from

<https://www.frontiersin.org/articles/10.3389/fspor.2021.660167/full>. [Accessed 4th September 2025].

Sweeney, Liam, and Tommy R. Lundberg. 'Relative Age and Biological Maturity-Related Selection Biases in Male Youth Soccer across Different Competitive Levels within a National Association'. *Science and Medicine in Football*, June 2024, pp. 1–9. DOI.org (Crossref), <https://doi.org/10.1080/24733938.2024.2369543>.

Sweetman, D., Badiee, M. and Creswell, J.W. (2010) Use of the Transformative Framework in Mixed Methods Studies. *Qualitative Inquiry* [Post-print], 16 (6), pp. 441–454. Available from <https://journals.sagepub.com/doi/10.1177/1077800410364610>. [Accessed 31st July 2025].

Sweller, J. (2022) The Role of Evolutionary Psychology in Our Understanding of Human Cognition: Consequences for Cognitive Load Theory and Instructional Procedures. *Educational Psychology Review* [Post-print], 34 (4), pp. 2229–2241. Available from <https://doi.org/10.1007/s10648-021-09647-0>. [Accessed 24th June 2025].

Sweller, J. (2024) Cognitive load theory and individual differences. *Learning and Individual Differences* [Post-print], 110, p. 102423. Available from <https://linkinghub.elsevier.com/retrieve/pii/S1041608024000165>. [Accessed 24th June 2025].

Szerovay, M., Nevala, A. and Itkonen, H. (2023) *Football in the Nordic Countries: Practices, Equality and Influence*. Taylor & Francis.

Taguchi, H. (2018) *A Diffractive and Deconstructive Methodology for Researching the Production of Subjectivity in Early Childhood*. Routledge.

Taherdoost, H. (2022) What are Different Research Approaches? *Journal of Management Science & Engineering Research**, 5(1), pp. 53–63.

<https://journals.bilpubgroup.com/index.php/jmser/article/view/4538>

Tashakkori, A. & Teddlie, C. (2010) SAGE Handbook of Mixed Methods in Social & Behavioral Research. 2nd ed. Sage.

Teixeira, J.E., Alves, A.R., Ferraz, R., Forte, P., Leal, M., Ribeiro, J., Silva, A.J., Barbosa, T.M. and Monteiro, A.M. (2022) Effects of Chronological Age, Relative Age, and Maturation Status on Accumulated Training Load and Perceived Exertion in Young Sub-Elite Football Players. *Frontiers in Physiology* [Post-print], 13. Available from <https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2022.832202/full>. [Accessed 7th July 2025].

Thakkar, P. and Shah, M. (2021) An Assessment of Football Through the Lens of Data Science. *Annals of Data Science* [Post-print], 8 (4), pp. 823–836. Available from <https://doi.org/10.1007/s40745-021-00323-2>. [Accessed 30th September 2025].

Thrower, S.N., Barker, J.B., Bruton, A.M., Coffee, P., Cumming, J., Harwood, C.G., Howells, K., Knight, C.J., McCarthy, P.J. and Mellalieu, S.D. (2024) Enhancing wellbeing, long-term development, and performance in youth sport: Insights from experienced applied sport psychologists working with young athletes in the United Kingdom. *Journal of Applied Sport Psychology* [Post-print], 36 (3), pp. 519–541. Available from <https://www.tandfonline.com/doi/full/10.1080/10413200.2023.2274464>. [Accessed 4th September 2025].

Till, K. and Baker, J. (2020) Challenges and [Possible] Solutions to Optimizing Talent Identification and Development in Sport. *Frontiers in Psychology* [Post-print], 11, p. 664. Available from <https://www.frontiersin.org/article/10.3389/fpsyg.2020.00664/full>. [Accessed 7th July 2025].

- Torres, C.R. and López Frías, F.J. (2023) A just organized youth sport. *Journal of the Philosophy of Sport* [Post-print], 50 (1), pp. 83–99. Available from <https://www.tandfonline.com/doi/full/10.1080/00948705.2023.2165931>. [Accessed 4th September 2025].
- Towlson, C. and Cumming, S.P. (2022) Bio-banding in soccer: past, present, and future. *Annals of Human Biology* [Post-print], 49 (7–8), pp. 269–273. Available from <https://www.tandfonline.com/doi/full/10.1080/03014460.2022.2129091>. [Accessed 30th September 2025].
- Towlson, C., Cobley, S., Midgley, A., Garrett, A., Parkin, G. and Lovell, R. (2017) Relative Age, Maturation and Physical Biases on Position Allocation in Elite-Youth Soccer. *International Journal of Sports Medicine* [Post-print], 38 (03), pp. 201–209. Available from <http://www.thieme-connect.de/DOI/DOI?10.1055/s-0042-119029>. [Accessed 28th September 2025].
- Towlson, Chris, et al. '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*, vol. 10, no. 4, July 2021, pp. 403–12. *DOI.org (Crossref)*, <https://doi.org/10.1016/j.jshs.2020.09.003>.
- Tracy, S.J. (2025) Practicing Qualitative Research Under the “Big Tent”: Origins, Development, and Continuing Relevance of the Eight Big-Tent Framework for Qualitative Quality. *Qualitative Inquiry* [Post-print], p. 10778004251348167. Available from <https://journals.sagepub.com/doi/10.1177/10778004251348167>. [Accessed 17th September 2025].
- Turner, A., 2014. Total score of athleticism: a strategy for assessing an athlete's athleticism. *Professional Strength and Conditioning*.

- Umek, A. and Kos, A. (2016) The Role of High Performance Computing and Communication for Real-Time Biofeedback in Sport. *Mathematical Problems in Engineering* [Post-print], 2016, pp. 1–11. Available from <http://www.hindawi.com/journals/mpe/2016/4829452/>. [Accessed 25th September 2025].
- Vaeyens, R., Lenoir, M., Williams, A.M. and Philippaerts, R.M. (2008) Talent Identification and Development Programmes in Sport. *Sports Medicine* [Post-print], 38 (9), pp. 703–714. Available from <https://doi.org/10.2165/00007256-200838090-00001>. [Accessed 7th July 2025].
- Watanabe, N.M., Shapiro, S. and Drayer, J. (2021) Big Data and Analytics in Sport Management. *Journal of Sport Management* [Post-print], 35 (3), pp. 197–202. Available from <https://journals.humankinetics.com/view/journals/jsm/35/3/article-p197.xml>. [Accessed 28th September 2025].
- Wik, E. H., Chamari, K., Tabben, M., Di Salvo, V., Gregson, W., & Bahr, R. (2023). Exploring Growth,
- Wik, E.H., Lolli, L., Chamari, K., Materne, O., Salvo, V.D., Gregson, W. and Bahr, R. (2021) Injury patterns differ with age in male youth football: a four-season prospective study of 1111 time-loss injuries in an elite national academy. *British Journal of Sports Medicine* [Post-print], 55 (14), pp. 794–800. Available from <https://bjsm.bmj.com/content/55/14/794>. [Accessed 19th March 2025].
- Williams, A.M., Ford, P.R. and Drust, B. (2023) Talent identification and development in soccer since the millennium. In: *Science and Football*. Routledge.
- Williams, C.A. (2018) Elite Youth Sports—The Year That Was 2017. *Pediatric Exercise Science* [Post-print], 30 (1), pp. 25–27. Available from

<https://journals.humankinetics.com/view/journals/pes/30/1/article-p25.xml>. [Accessed 29th August 2025].

Williams, G.G. and MacNamara, Á. (2022) Challenge is in the eye of the beholder: Exploring young athlete's experience of challenges on the talent pathway. *Journal of Sports Sciences* [Post-print], 40 (10), pp. 1078–1087. Available from <https://www.tandfonline.com/doi/full/10.1080/02640414.2022.2047503>. [Accessed 4th September 2025].

Xiang, C., Tengku Kamalden, T.F., Liu, H. and Ismail, N. (2022) Exploring the Multidisciplinary Factors Affecting Sports Talent Identification. *Frontiers in Psychology* [Post-print], 13, p. 948121. Available from <https://www.frontiersin.org/articles/10.3389/fpsyg.2022.948121/full>. [Accessed 4th September 2025].

Zaharia, N. and Kaburakis, A. (2016) Bridging the Gap: U.S. Sport Managers on Barriers to Industry–Academia Research Collaboration. *Journal of Sport Management* [Post-print], 30 (3), pp. 248–264. Available from <https://journals.humankinetics.com/view/journals/jsm/30/3/article-p248.xml>. [Accessed 29th August 2025].

Zhang, H., Chai, J. and Li, C. (2024) On innovative strategies of youth sports teaching and training based on the internet of things and artificial intelligence technology from the perspective of humanism. *Learning and Motivation* [Post-print], 86, p. 101969. Available from <https://linkinghub.elsevier.com/retrieve/pii/S0023969024000110>. [Accessed 4th September 2025].

Zhang, N., Zhang, J., Jiang, S. and Ge, W. (2024) The Effects of Layout Order on Interface Complexity: An Eye-Tracking Study for Dashboard Design. *Sensors* [Post-print], 24

(18), p. 5966. Available from <https://www.mdpi.com/1424-8220/24/18/5966>.

[Accessed 28th September 2025].



Appendix

Appendix 1. ai.io Data Consent Form

PARTIES

CLUB PARTNER a company registered in England and Wales with registration number XXXXXXXX, and whose registered address is XXXXXXXXXXXXXXXX (the “Club”); and

PROJECT 23RD CENTURY LIMITED a company registered in England and Wales with registration number 10911841, and whose registered address is 60 Wensleydale Road, Hampton, Middlesex, United Kingdom, TW12 2LX (the “Partner”),

each a “Party” and together the “Parties”.

IT IS AGREED THAT:

DEFINITIONS AND INTERPRETATION

“**ai.io Data**” means data as described in clause 7.a. and examples given in clause 11.

“**Applicable Laws**” means all applicable laws, statutes, regulations (including, in respect of the Partner, all national, regional, local or municipal laws, regulations or by-laws of any kind whatsoever and all requirements, regulations or industry practices relating to the provision of the ai.io product suite), government policies, enactments or instruments which may from time to time be in force;

“**Best Industry Practice**” means the exercise of that degree of skill, care, prudence, efficiency, foresight and timeliness as would be expected from a leading company within the relevant industry or business sector;

“**Business Day**” means a day which is not a Saturday or a Sunday or a bank or public holiday in England;

“**Club Data**” means data as described in clause 7.b and 7.c, and examples given in clause 11.

“**Club Team Personnel**” means any Club Team player, manager or head coach, assistant manager, coach, assistant coach, fitness coach, doctor, physiotherapist and/or kit manager;

“**Club Teams**” means all representative teams of the Club from time to time.;

“**Confidential Information**” means all information of a confidential nature in any form whatsoever disclosed (whether directly or indirectly) by or on behalf of a Party to the other Party or an Affiliate of such Party pursuant to or in connection with this Agreement, including: (a) the contents of and negotiations in relation to this Agreement; (b) the identity and business, financial and/or technical affairs of that Party’s business contacts, including customers, agents, distributors and licensees; (c) any information that a Party obtains or receives as a result of discussions leading up to the signature of this Agreement or subsequent performance of this Agreement; (d) any information obtained or observed as result of any site visit; and (e) all financial information of that Party;

“Data Protection Legislation” means the UK GDPR, the Data Protection Act 2018, the EU GDPR and any implementing laws, regulations and secondary legislations, and any applicable successor legislation to the UK GDPR or the Data Protection Act 2018 or the EU GDPR;

“Effective Date” means the date of signature by both Parties;

“Force Majeure Event” means any cause which arises from or is attributable to acts, events, omissions, incidents or accidents beyond the reasonable control of that Party, including any sanctions, extension of sanctions or other governmental action, except that: (a) a default or misconduct by any third party employed or engaged as an agent or independent contractor by the Party claiming a Force Majeure Event shall not constitute a Force Majeure Event unless caused by events or circumstances which are themselves beyond the reasonable control of that third party; (b) mere shortage of materials, equipment or supplies shall not constitute a Force Majeure Event unless caused by events or circumstances which are themselves beyond the reasonable control of that Party; and (c) strikes, lock-outs or other industrial disputes involving only the workforce of that Party or any of its sub-contractors or suppliers, if they are beyond the affected Party’s control and the affected Party has taken reasonable steps to avoid them shall constitute a Force Majeure Event;

“Intellectual Property Rights” means any and all copyrights, designs, trademarks, trade names, insignia, service marks, patents and all other legal and beneficial intellectual and industrial property rights (whether registered or not), no matter what such rights may be known as in any particular country;

“Partner Websites” means the Partner’s primary English language official website for ai.io and any other official website of the Partner using a Partner Mark and relevant to the Brand Sector, including any in a language other than English;

“Performance Lab” means the aiLabs performance labs (Mobile Lab, Fixed Lab and Control Centre) which uses next generation analysis equipment to collect, analyse and benchmark a Player’s performance levels, including physical, technical and cognitive attributes;

“Prohibited Material” means any material that does not comply with Applicable Laws, is offensive or indecent, depicts violence or is otherwise threatening or abusive, is for any organisation whose principal purpose is political or to promote a political cause, whose business includes the sale of tobacco related products or pornographic material or which in the opinion of a reasonable person encourages, in whatever manner, behaviour which promotes disparaging views or behaviour relating to an individual or group’s colour, race, nationality, ethnic or national origins, sex, sexual orientation, marital status, religion, age or disability;

“Regulations” has the meaning given at Clause 2;

“**Season**” means a period of twelve months starting on XX XXX in each year during the Term, save that the first Season shall start on the Effective Date and end on XX XXX;

“**Shared Data**” means data as described in clause 7.a and examples given in clause 11.

“**Support Services**” means maintenance of the ai.io Products, bug fixes, patches, help desk support by email and telephone, including to identify, respond to and resolve Faults;

“**Term**” has the meaning given at Clause 5;

“**VAT**” means value added tax or other applicable sales or turnover taxes or duties in effect from time to time during the Term.

In this Agreement (save where the context requires otherwise):

references to the singular number includes the plural, and vice versa;

references to persons includes bodies corporate, unincorporated associations, partnerships and individuals;

any reference to a Clause is to a clause of this Agreement. In the event (and then only to the extent) of any conflict between any of the Clauses, the relevant Clauses shall prevail;

the headings contained in this Agreement are for the purposes of convenience only and do not form part of and shall not affect the construction of this Agreement;

references to any statutory provisions shall be deemed to include any amendment, replacement or re-enactment from time to time in force; and

any phrase introduced by the term “including”, “include”, “in particular”, “for example” or any similar expression shall be construed as illustrative and shall not limit the sense of the words to which those terms apply.

The performance of this Agreement by the Club shall be subject to:

all Applicable Laws;

the byelaws, rules, regulations, directions, decisions, codes of practice and guidelines, from time to time of:

the Local Authority

FIFA, UEFA, the MLS, the FA, the Premier League and any other football governing bodies to which the Club, the Club Teams or any Club Team matches are subject (together the “**Football Regulations**”),

(the Ground Regulations and Football Regulations being referred to collectively hereafter as the “**Regulations**”).

In the event of any conflict or inconsistency between the provisions of this Agreement and Applicable Laws or the Regulations, the relevant Applicable Laws or Regulations shall prevail, and any failure by the Club

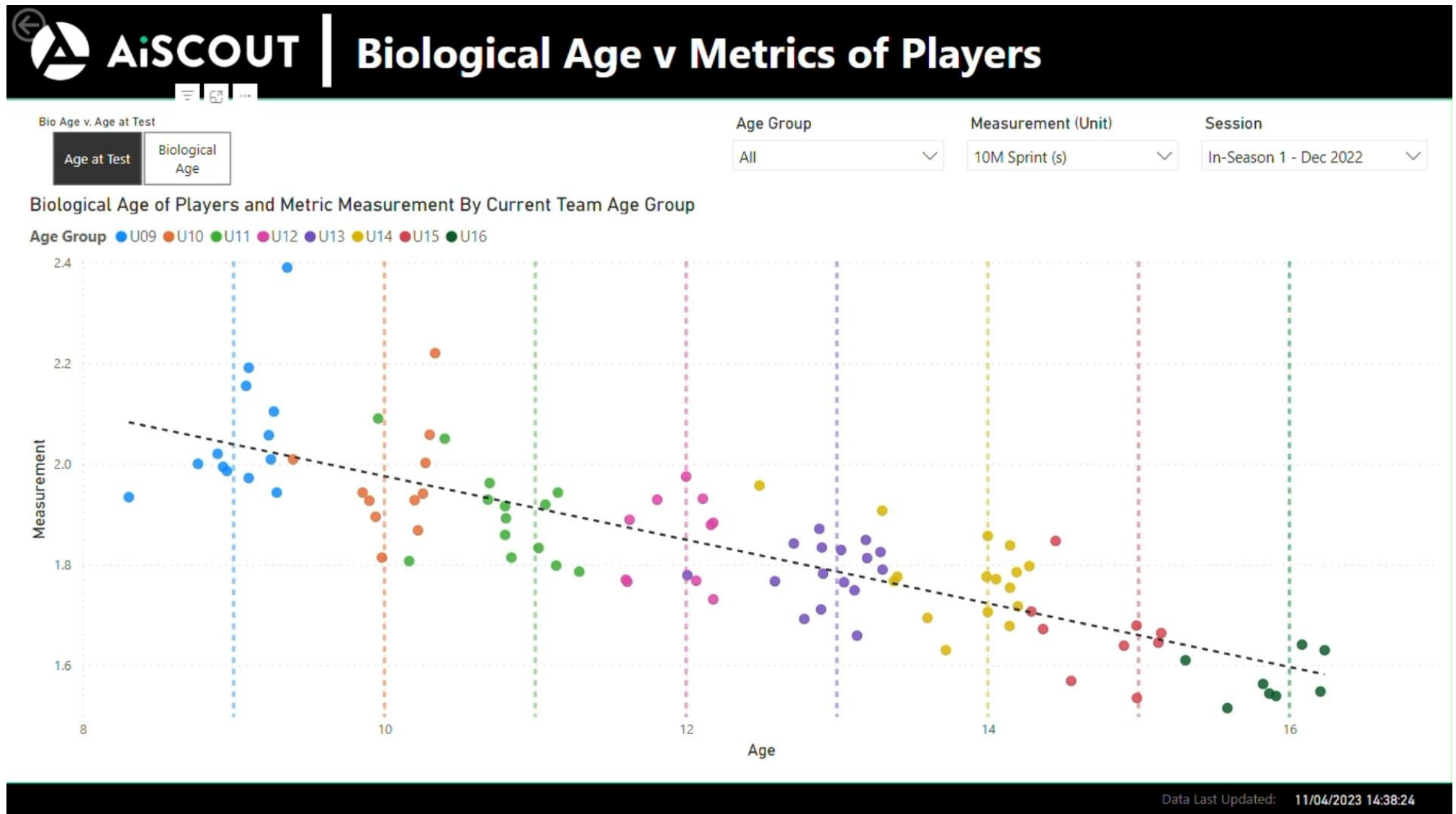
to perform its obligations or grant any of the Marketing Rights as a result or consequence of ensuring compliance with Applicable Laws or the Regulations shall not constitute a breach of this Agreement by the Club.

The Partner further acknowledges and agrees that the Marketing Rights do not apply to any Excluded Event unless expressly set out in this Agreement, and accordingly that the Club is not obliged to deliver any or all Marketing Rights at or in respect of any Excluded Event.

COMMENCEMENT AND DURATION

This Agreement shall commence on the Effective Date and, unless terminated earlier in accordance with its terms, shall continue in full force and effect until the date 5 years after the Effective Date (the “**Term**”).

Appendix 2. Dashboard A



I Player Score Comparison



Select Session:

In-Season 3 Testing



Refine By Age & Position:

U13



Select Metric:

10M Sprint (s)

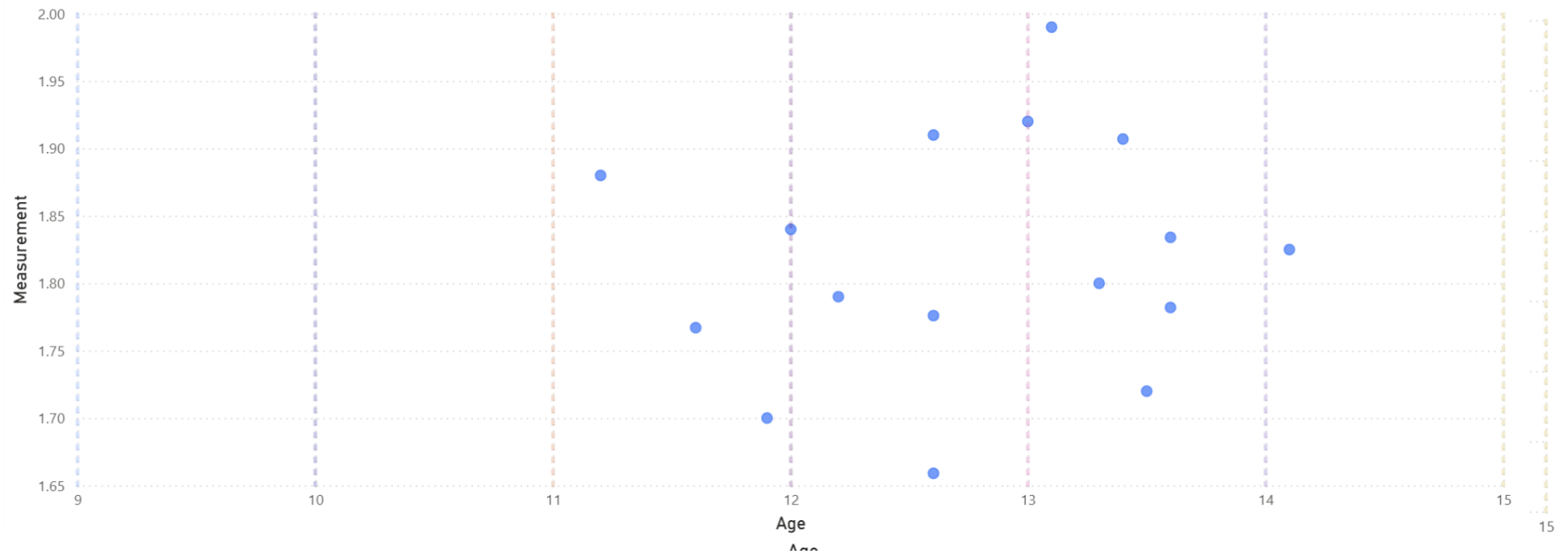


Age at Test

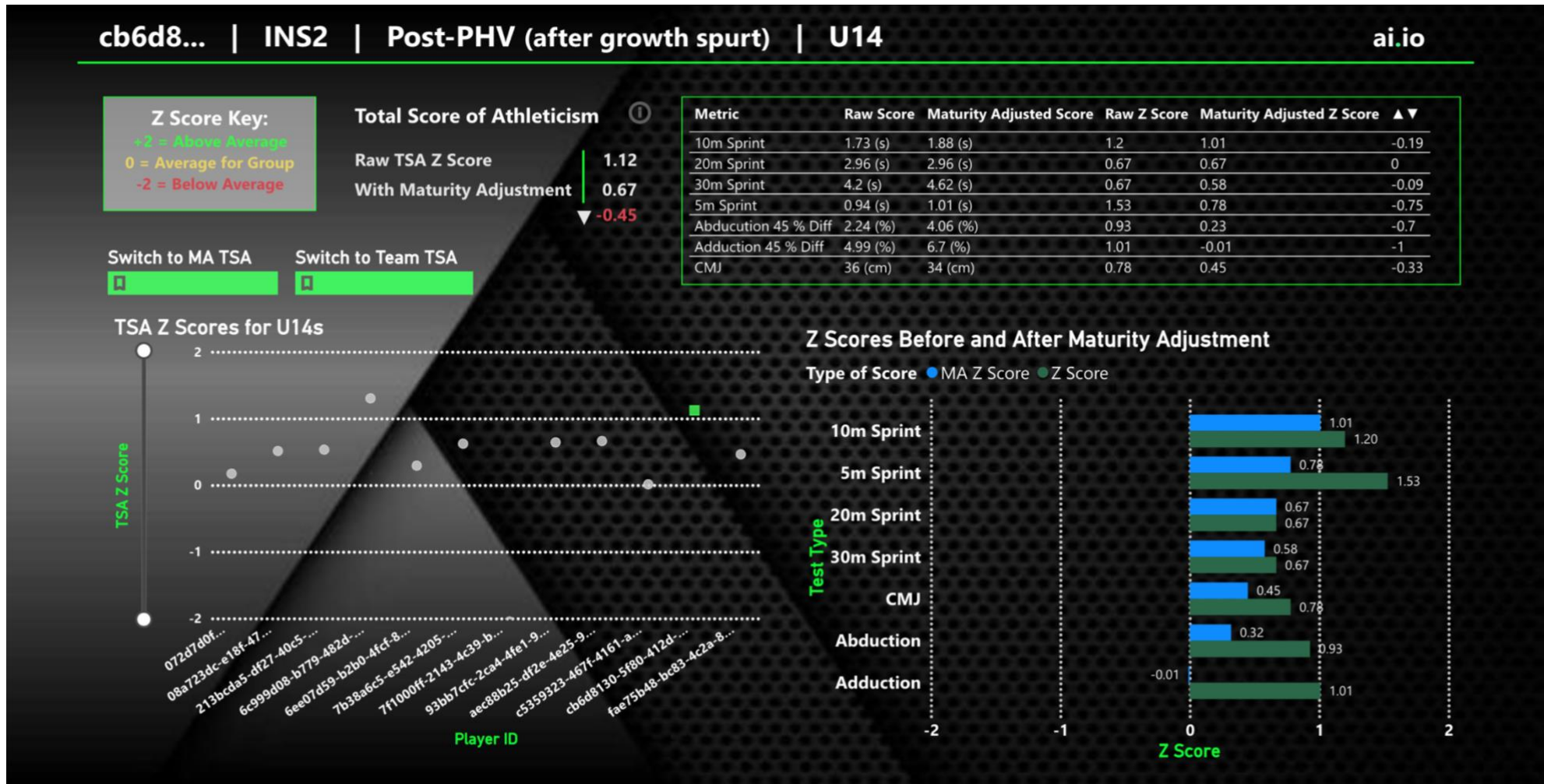
Biological Age

Player Biological Age vs Measurements

Age Group ● U13



Appendix 3. Dashboard B



cb6d8... | INS2 | Post-PHV (after growth spurt) | U14

ai.io

Z Score Key:

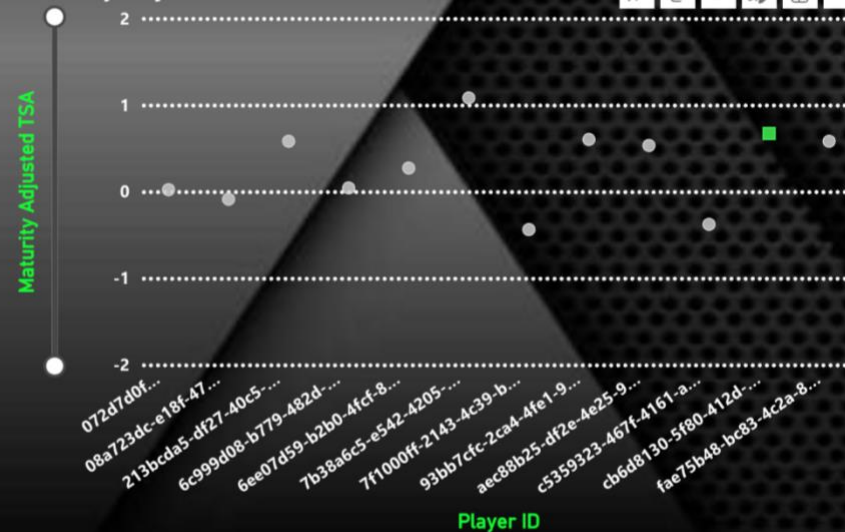
+2 = Above Average
0 = Average for Group
-2 = Below Average

The Total Score of Athleticism (TSA) combines the key performance metrics into a single Z score to summarise overall athletic ability.

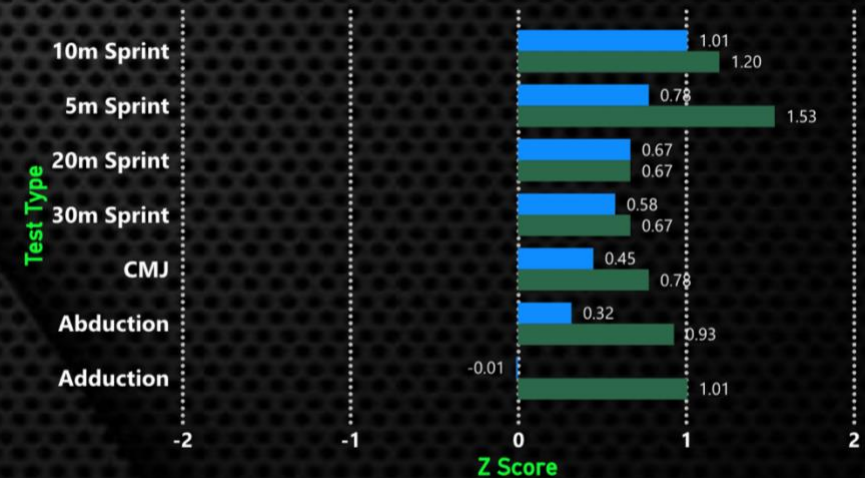
Metric	Raw Score	Maturity Adjusted Score	Raw Z Score	Maturity Adjusted Z Score	▲▼
10m Sprint	1.73 (s)	1.88 (s)	1.2	1.01	-0.19
20m Sprint	2.96 (s)	2.96 (s)	0.67	0.67	0
30m Sprint	4.2 (s)	4.62 (s)	0.67	0.58	-0.09
5m Sprint	0.94 (s)	1.01 (s)	1.53	0.78	-0.75
Abduction 45 % Diff	2.24 (%)	4.06 (%)	0.93	0.23	-0.7
Adduction 45 % Diff	4.99 (%)	6.7 (%)	1.01	-0.01	-1
CMJ	36 (cm)	34 (cm)	0.78	0.45	-0.33

Switch to MA TSA

Switch to Team TSA

Maturity Adjusted TSA Z Scores for U14s**Z Scores Before and After Maturity Adjustment**

Type of Score ● MA Z Score ● Z Score



Appendix 4. Dashboard C

cb6d8... | INS2 | Post-PHV (after growth spurt) | U14

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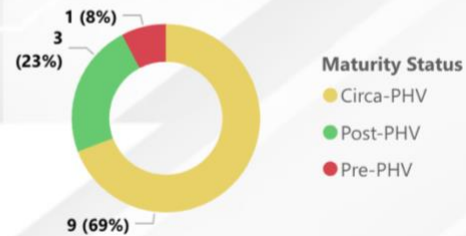
T Scores

Good = 60 and above
Average = Around 50
Bad/Poor = Below 40

TSA

Raw TSA T Score 61
Maturity Adjusted 57
 ▼ -4

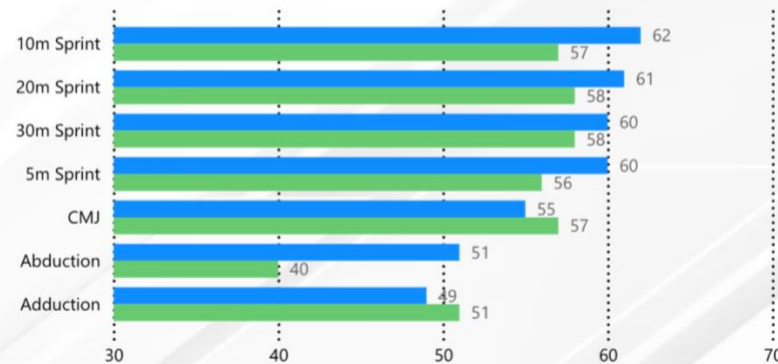
Maturity Status of Age Group



Metric	Raw Score	Maturity Adjusted Score	Raw T Score	Maturity /
5m Sprint	0.94 (s)	1.01 (s)	66	60
10m Sprint	1.73 (s)	1.88 (s)	63	62
Abduction 45 % Diff	2.23 (%)	4.06 (%)	61	51
20m Sprint	2.96 (s)	2.96 (s)	61	61
CMJ	36 (cm)	34 (cm)	60	55
30m Sprint	4.2 (s)	4.62 (s)	61	60
Adduction 45 % Diff	4.99 (%)	6.71 (%)	62	49

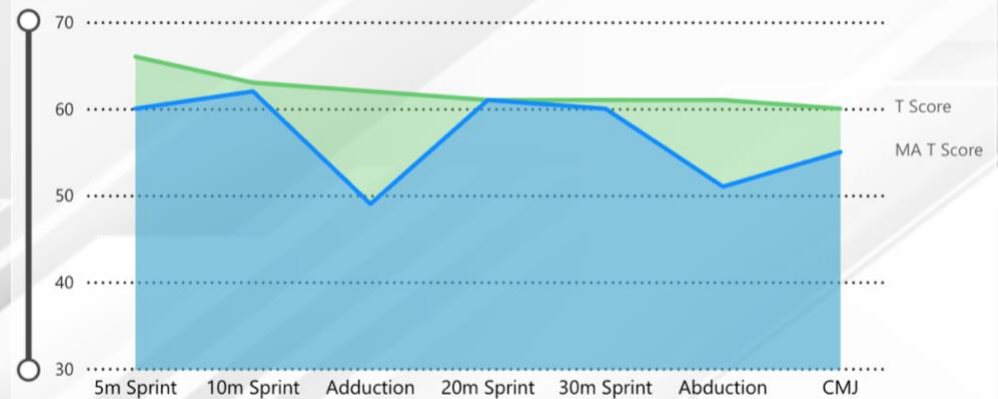
Athlete Scores Compared with Age Group Averages (Maturity-Adjusted)

● Athlete Score ● Group Average Score



T Score and Maturity Adjusted T Scores

● T Score ● MA T Score



Appendix 5. Participant Survey Questions (Qualtrics)

1. What is your role? **Multi choice**

- Coach
- Medical Staff
- S&C
- Sports Scientist
- Other

2. How long have you been in this role? **Text Answer**

3. To what extent is your work impacted by biological maturation of players?

Multiple choice

- Not at all
- Slightly
- Moderately
- Very
- Extremely

4. Which of the following methods do you currently use to assess or account for maturation in players? – **Multiple choice**

- Mirwald (maturity offset) method
- Skeletal age (e.g. X-ray, MRI)
- Parental height prediction
- Maturity bands or bio-banding
- External software/tools (e.g. growth prediction apps)
- I do not currently use any method
- Other (please specify)

5. Based on your overall impression, please rank the three dashboards from most to least effective for your needs. **Ranking**

1-3

6. How visually appealing do you find each dashboard? **Linkert scale for each dashboard**

Not at all - Extremely

7. How would you rate the quantity of content in each dashboard? **Linkert scale for each dashboard**

Much too little - Far too much

8. How would you rate the quality of content in each dashboard? **Linkert scale for each dashboard**

Very poor - Very good

9. How would you rate the ease of understanding of each dashboard? **Linkert scale for each dashboard**

Very difficult to understand - Very easy to understand

10. How valuable is each dashboard within your role? **Linkert scale for each dashboard**

Not valuable at all - Extremely Valuable

11. Which elements of dashboard A lacked value or required improvement? **Text answer**

12. Which elements of dashboard B lacked value or required improvement? **Text answer**

13. Which elements of dashboard C lacked value or required improvement? **Text answer**

14. What did you like most across all three dashboards? **Text answer**

15. Suggested future improvements or features to add. **Text answer**

16. Any other comments or reflections? **Text answer**

Appendix 6. Interview Guide

Introduction

Welcome everyone and explain the purpose: Exploring how three different dashboard designs communicate maturity corrected data and which aspects work best for people in your role.

Emphasise that there are no right or wrong answers.

Reassure participants about confidentiality and their right not to answer any questions.

Discussion Topics

1. First Impressions

- What were your initial thoughts when viewing each of the three dashboards?
- Did any of them stand out immediately as easier to understand or more useful?

2. Usability and Navigation

- How did you find navigating through each dashboard?
- Were any of them more intuitive or more difficult to use?
- Were there any points where you felt unsure about what the data was showing?

3. Clarity and Presentation of Information

- Which dashboard made the data clearest or easiest to interpret?
- Were there any visual elements (e.g., colour, layout, graphs) that helped or hindered understanding?
- How useful were the written summaries or explanations, if included?

4. Practical Use and Decision-Making

- Which dashboard would you be most likely to use in real life situations?
- Did any dashboard change or influence how you thought about an athlete's progress or potential?
- Are there specific features from any dashboard that you would find especially useful?

5. Preferences and Comparisons

- If you had to choose one dashboard to use regularly, which would it be and why?
- Are there features from different dashboards you'd like to combine?

- Do you feel that any of the dashboards misrepresented the information or were open to misinterpretation?
6. Suggestions for Improvement
- What changes would improve the dashboards for people in your position?
 - Would you prefer the data in a different format altogether (e.g., printed, verbal summary, interactive app)?

Closing:

- Is there anything else you'd like to add about your experience with these dashboards?
- Thank everyone for their contributions and explain next steps (e.g., how the findings will be used, any follow up contact if relevant).

Appendix 7. Example Extract from Transcript

ECR: So, when it comes to first impressions, what initial thoughts would do you have when viewing the dashboards and did any of them stand out immediately as easier to understand?

Participant B: For me, I did need the explanation of what the different parts meant. So, part of my first impression was mainly just on aesthetics rather than the content and the way in which you've set up the data.

ECR: Yeah.

Participant B: It's not a very helpful thing, but the aesthetic of the black I thought was a slightly more striking background. But again, the formatting is probably not the biggest thing in the world. That just struck me as a cleaner image.

ECR: No, you'd be surprised. It does play quite a big part in the clarity of a visual.

Participant B: Yeah, that's probably my initial thoughts between template B and template C. The graphic on the bottom left, on the one we're currently on template B is a tidy graphic as a first impression before we understand what it means. Just it's a very tidy, clean, lots of space and clear lines and visual data points.

Obviously with the green highlighted one, it's a nice graphic as a first impression. It gives the impression that this template B is a bit neater, for want of a better word.

ECR: Perfect. Thank you.

So then moving on to usability and sort of the navigation of the system, I know obviously we've had some issues with not being able to get people who don't have Power BI to be able to access the dashboards. But in terms of being able to work your way through the dashboards, were there any parts on either of them that you think would be harder to realise that you needed to use, like in the corner with this, with the TSA, do you think it's good having those buttons to press? Or would it be better just to have everything there at sort of face value?

Participant B: No, when you use that icon to do the pop-up, I thought that was a good feature. You don't want it cluttering the screen. Hopefully a lot of people that will eventually use the tool would know that information, but when it's a first time use like or someone like me on a demo.

It's a good feature to have. Yeah, I thought it was a nice feature.

ECR: Brilliant, great.

ECR: Which of these three dashboards do you think would be you'd be most likely to use in sort of real-life situation when needing to get an overall view of an athlete's ability?

Participant B: There are features, particularly on the last two that I thought were quite useful and I know we're not talking about mixing and matching into a perfect dashboard as we said earlier, but there were some nice features on both that I would use. Again, the graphic in the bottom left that we've got on screen now I thought was great because it has that overall view of the group.

I also liked the one on template C that graphic we had in the bottom left where again you had an overall view of the cohort in green with the athletes measurement in blue. Both of those graphics I know it doesn't speak for a whole dashboard, but both of those graphics I found would be.

Something I would use frequently to make those sorts of informed decisions.

Obviously is if I'm correct, the tables in the top right of both template B&C were showing the same data points and in the same way. So, I thought that was another useful table, but it's the same on both templates.