

Maturation sensitive approaches to examine the re-classification of strength in UK youth ice hockey players



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Accounting for maturation and body size substantially alters strength classification in youth ice hockey players. Mass+height allometry produced the most biologically meaningful centile rankings.

Methods

Participants

A cross-sectional study measured a sample of quasi competitive male UK youth ice hockey players (N = 304, 11 – 16.5 years). Data was collected at the annual England ice hockey showcase event, This poster specifically focuses on peak force from the isometric mid-thigh pull (IMTP). Data was collected using two Hawkins portable force plates, following the guidance from (Comfort, et al., 2019). All participants used lifting strap and the highest value from three trials was used for analysis.

At the point of consent to participate self-reported parental was collected and at the event participant mass, standing and seated height were also collected.

Maturity Assessment

Biological age was calculated in two different ways, first (BA-MIR) using the maturity offset (MO) calculation using the Modified Mirwald equation (Kozielec & Malina, 2018). The second (BA-KR) was calculated using predicted adult height (PAH) based on the Khamis-Roche equation (Khamis & Roche, 1994.) Self-reported parental height was only available for 274 participants.

Centile Modelling

Generalised Additive Models for Location, Scale and Shape (GAMLSS) (Rigby & Stasinopoulos, 2005; Stasinopoulos & Rigby, 2007) were used to generate IMTP-PF centiles (5th, 25th, 50th, 75th, 95th) for chronological age (CA), BA-MIR and BA-KR. Reference data for each centile level was created for every 0.1 years between 11 and 16.5 years. Each participant was assigned a centile ranking and a z-score based on these values.

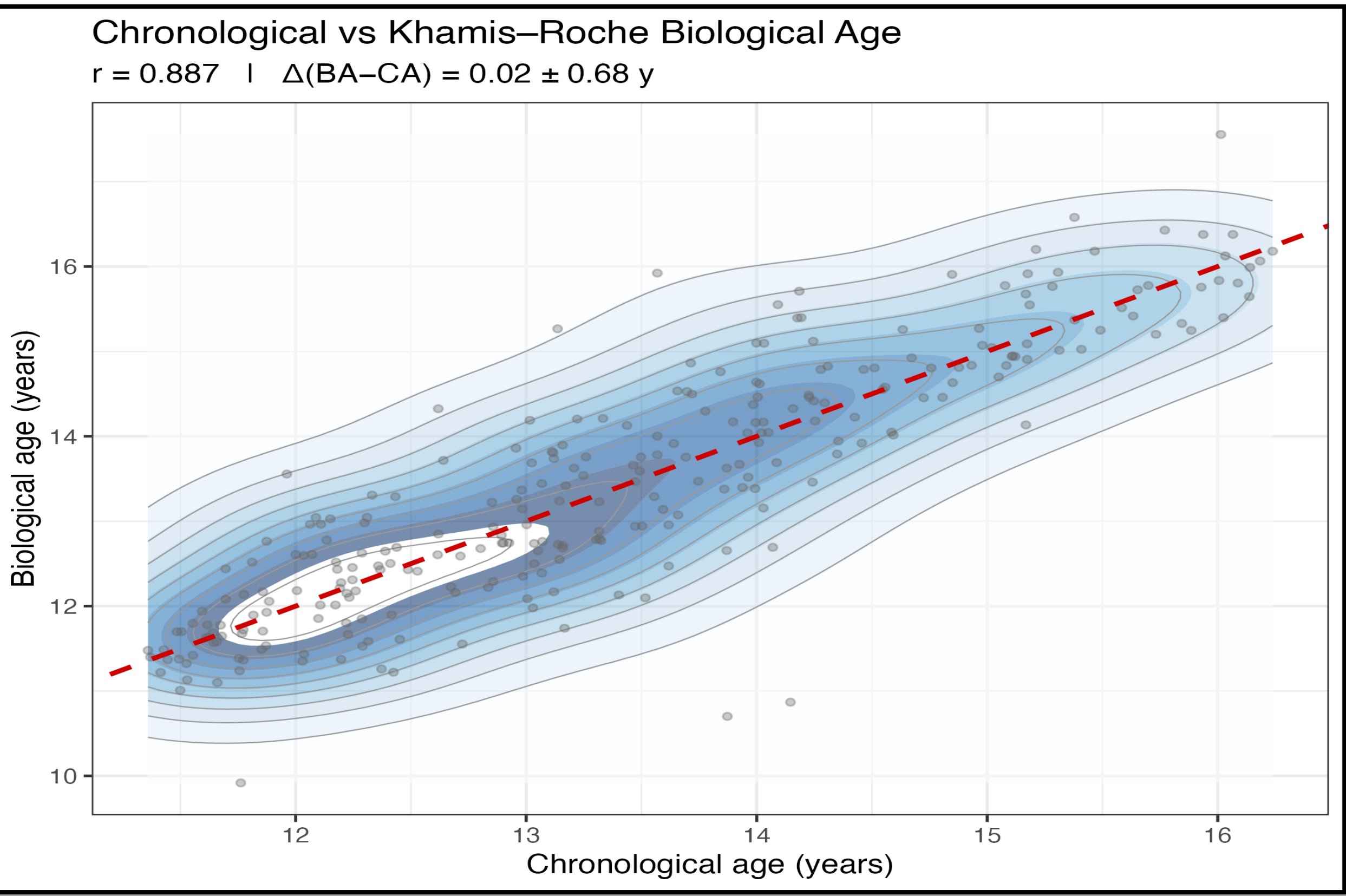
Allometric Scaling: Removing the Influence of Body Size

Relative strength adjusts force for body mass but falsely assumes a linear relationship between strength and body mass. Therefore, using the recommendations Nevill, et al. (2025) allometric modelling was applied allowing strength to be adjusted according to the observed relationship between body size and force production. Four expressions of strength were examined: raw force (N), Relative force (N·Kg⁻¹), Mass-adjusted allometry, Mass + height allometry. The multidimensional model allowed the independent contribution of stature to be evaluated after accounting for body mass.

Results

Biological Age Distributions

Both BA-MIR and BA-KR showed strong associations with chronological age ($r \geq 0.9$). The X-Y plot below shows the distribution densities around the age spectrum, illustrating where there are more data points, greater confidence in centile modelling accuracy (11-14 years), equally lesser dense areas of participants (14-16 years) ↓

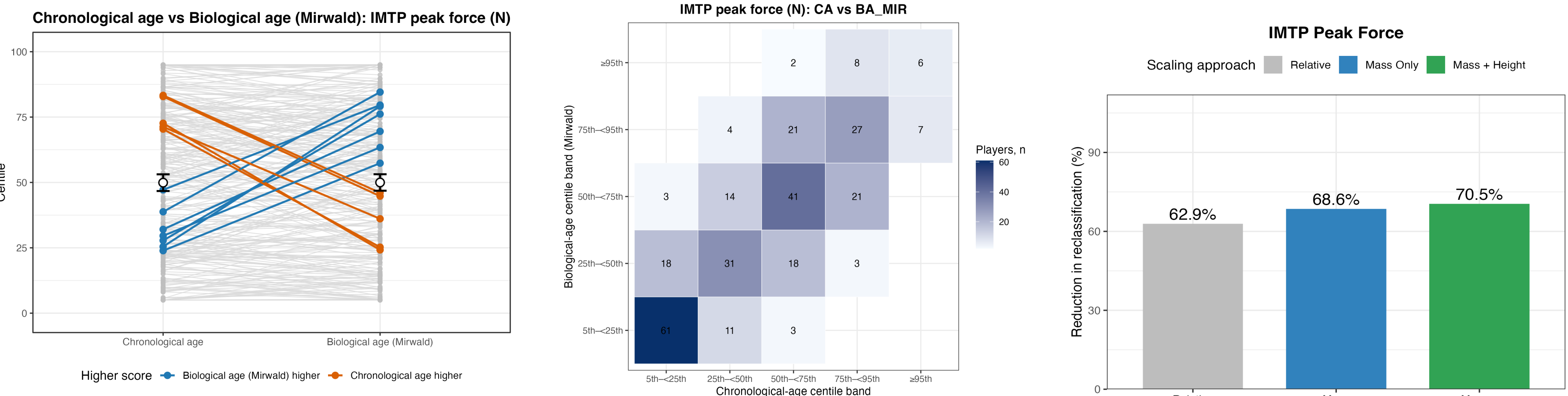
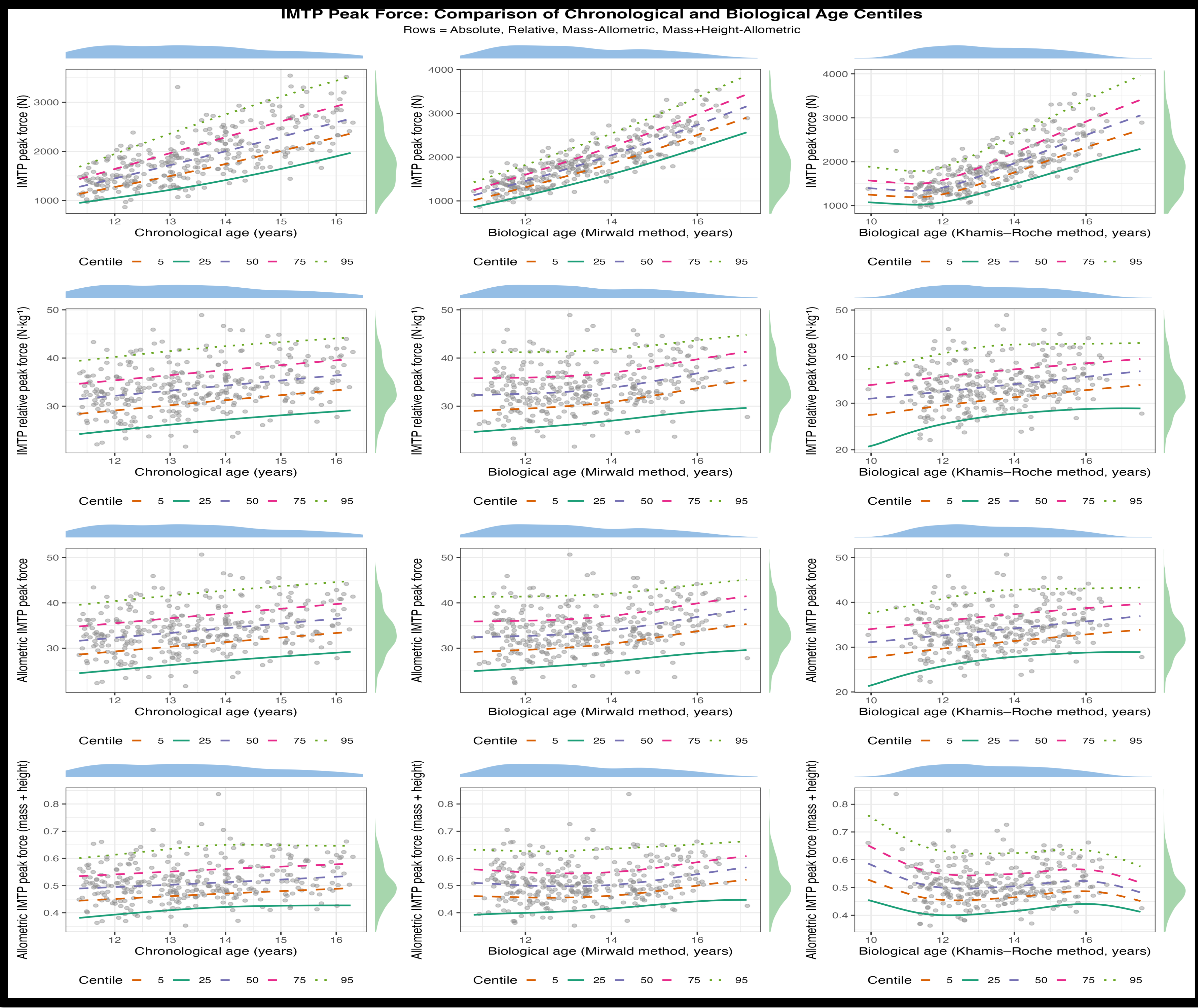


Centile modelling

All centile models demonstrated excellent goodness-of-fit, with residual means approximating zero, residual variances approximating one, and Filliben correlation coefficients consistently >0.99. Hold-out validation indicated low prediction error, providing confidence in the generated reference values across the observed age range. →

Strength Classification Depends on Age Construct

Substantial movement between centile classifications was observed when athletes were transitioned from CA to either BA-MIR or BA-KR. Athletes who appeared strong relative to their CA often moved to lower centiles when maturity was considered, whereas biologically younger athletes frequently moved to higher centiles. The largest shifts occurred in athletes occupying the middle of the performance distribution. →



Discussion and Conclusions

Key Findings

- Biological age meaningfully alters strength classification in youth ice hockey players.
- Reclassification is common when athletes move from chronological-age to maturation-sensitive reference systems.
- Multidimensional (mass + height) allometric scaling improves model performance and reduces residual stature effects.
- The combination of biological-age centiles and allometric scaling provides a more biologically meaningful assessment of youth strength performance.

For Coaches and Practitioners

- Chronological age alone may provide an incomplete picture of athlete strength.
- Biological-age centiles offer a maturation-sensitive alternative for athlete evaluation.
- Allometric scaling improves the fairness of comparisons between athletes of different body sizes.
- Mass + height allometry provides the most size-independent estimate of strength.
- Combining biological-age classification with multidimensional allometric scaling may improve talent identification and long-term athlete monitoring.

References

