



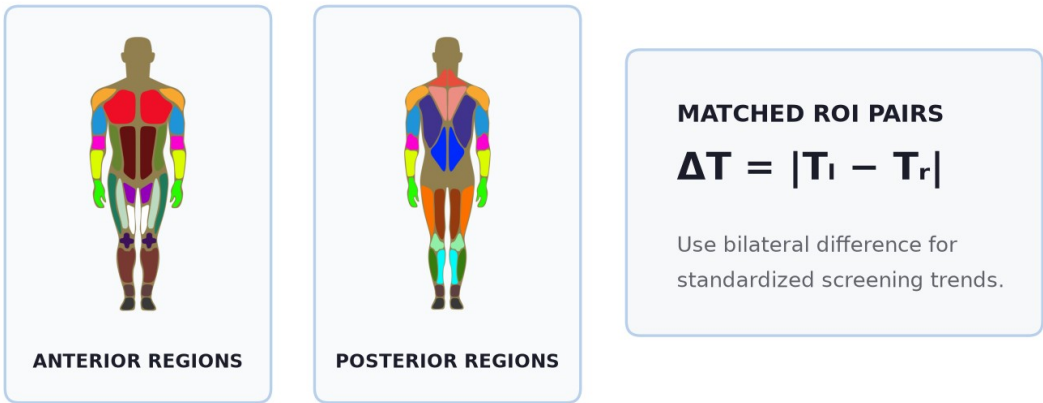
WHITE PAPER 001

Reliability of Bilateral Thermal Asymmetry During Shortened Acclimatization

Operational evidence for time-constrained athlete screening

BILATERAL ASYMMETRY (ΔT)

ATS compares matched left and right regions — not absolute skin temperature.



ATS full-body region maps.

DOCUMENT	STUDY
Type	Operational validation study
Population	31 physically active male athletes
Primary endpoint	Bilateral thermal asymmetry (ΔT)
Edition	2026

Athlete Thermography Screening (ATS)



Executive summary

Daily thermal screening has an operational constraint: established preparation guidance asks athletes to wait at least 15 minutes before imaging. This can make repeatable pre-training screening difficult in time-limited club settings.

This study did not test whether shortened preparation replaces laboratory thermography. It tested a narrower operational question: whether the group-level bilateral asymmetry signal (ΔT) shows systematic change before the 16-minute reference acquisition.

Key interpretation

At 8 and 10 minutes, group mean ΔT showed no significant difference from 16 minutes and mean bias was near zero. Individual agreement remained moderate, so the finding supports standardized operational screening — not replacement of laboratory acclimation guidance.

Study at a glance

Measure	Finding
Participants	31 athletes
Design	Nine acquisitions: 0' to 16' in 2-minute intervals
Planned ROI observations	8,928 (31 × 9 acquisitions × 32 bilateral ROIs)
Group mean over time	RM-ANOVA $p=.392$; Friedman $p=.262$
Operational candidate	8-minute standardized screening timepoint

1. The operational problem

Infrared thermography is used in sport to describe superficial thermal distribution and bilateral asymmetry. It is non-invasive and repeatable, but its practical value depends on whether clubs can fit standardized preparation into daily schedules.

ATS internal imaging guidance specifies 15–20 minutes of room acclimation; the TISEM sports-thermography consensus recommends a minimum 15-minute acclimation period. Those recommendations concern stabilization of skin temperature under controlled measurement conditions.

A different endpoint

Clinical interpretation often relies on the difference between corresponding left and right regions, $\Delta T = |T_{\text{left}} - T_{\text{right}}|$. Absolute skin temperature and bilateral asymmetry are related but distinct endpoints. This paper asks whether ΔT can provide a stable operational signal earlier than absolute temperature fully equilibrates.

ACCLIMATIZATION TIMEPOINTS

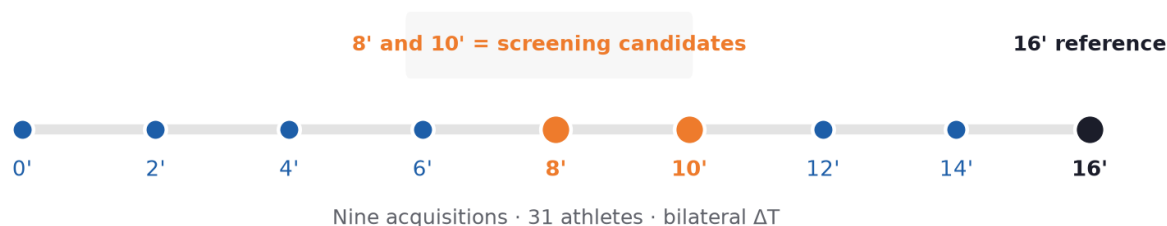


Figure 1. Study design. The 8- and 10-minute acquisitions were evaluated against the 16-minute study reference.

2. Study objective and methods

Objective

To quantify the stability of bilateral thermal asymmetry from baseline to 16 minutes, and to characterize 8- and 10-minute acquisitions against the 16-minute reference for operational screening.

Participants and acquisition

Thirty-one physically active male athletes completed nine consecutive thermal acquisitions at two-minute intervals. The protocol included 32 bilateral anatomical regions across anterior and posterior views. Athletes were prepared in a controlled room ($24 \pm 1^\circ\text{C}$; relative humidity 40–60%), wearing athletic shorts and no footwear. Imaging used a handheld FLIR ONE Edge system.

Analysis

The primary endpoint was ΔT . Group change over time was tested with repeated-measures ANOVA, Greenhouse–Geisser correction, and a Friedman sensitivity analysis. The 8- and 10-minute acquisitions were compared with 16 minutes using ICC(2,1), Bland–Altman bias and 95% limits of agreement (LoA), SEM, and MDC95. Missing source measurements were retained as missing; paired analyses use available 8/16' or 10/16' observations.

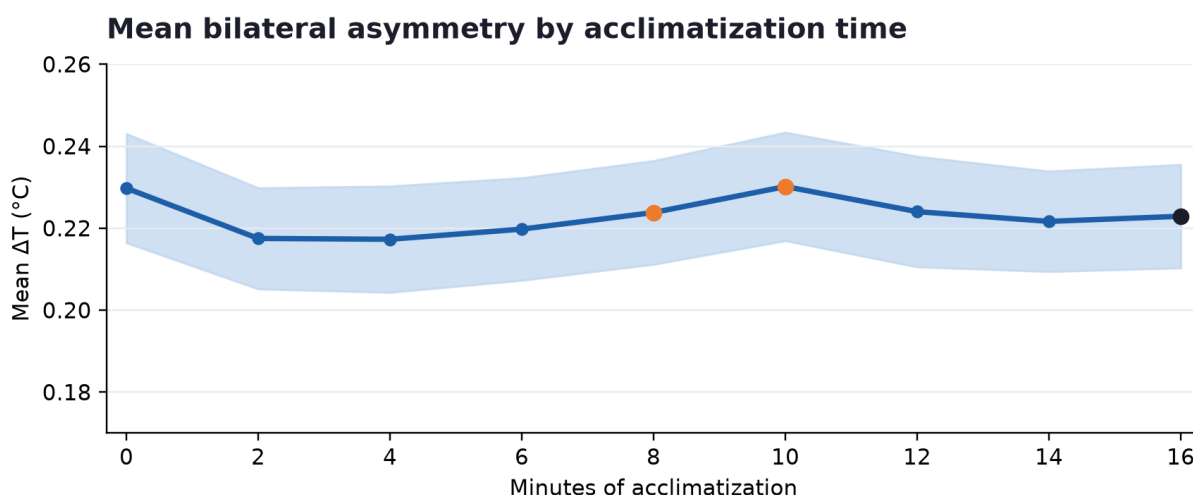


Figure 2. Mean ΔT and 95% confidence interval at each acquisition. The group mean is stable across the measured interval.

3. Results

Group-level asymmetry did not show a temporal shift

Across 917 complete athlete-region trajectories, the repeated-measures model did not detect a time effect ($F(8, 7328)=1.06$, $p=.392$; Greenhouse–Geisser $p=.390$). The non-parametric sensitivity analysis was consistent (Friedman $\chi^2=10.04$, $p=.262$). These results describe stability of the group mean; they do not imply identical readings for every individual athlete or region.

8 and 10 minutes versus the 16-minute reference

Metric	8' vs 16'	10' vs 16'
Paired region observations	952	958
ICC(2,1)	.531	.565
Mean bias	+0.000 °C	+0.006 °C
95% LoA	−0.380 to +0.379 °C	−0.369 to +0.381 °C
SEM / MDC95	.137 / .379 °C	.135 / .375 °C
Wilcoxon p	.627	.405
Within 95% LoA	94.0%	93.7%

Bias was near zero at both operational timepoints and neither comparison showed a significant mean difference from 16 minutes. The LoA and moderate ICC values, however, demonstrate individual-level spread — the reason this paper frames the protocol as screening support rather than full methodological substitution.

8' versus 16': individual agreement around a near-zero mean bias

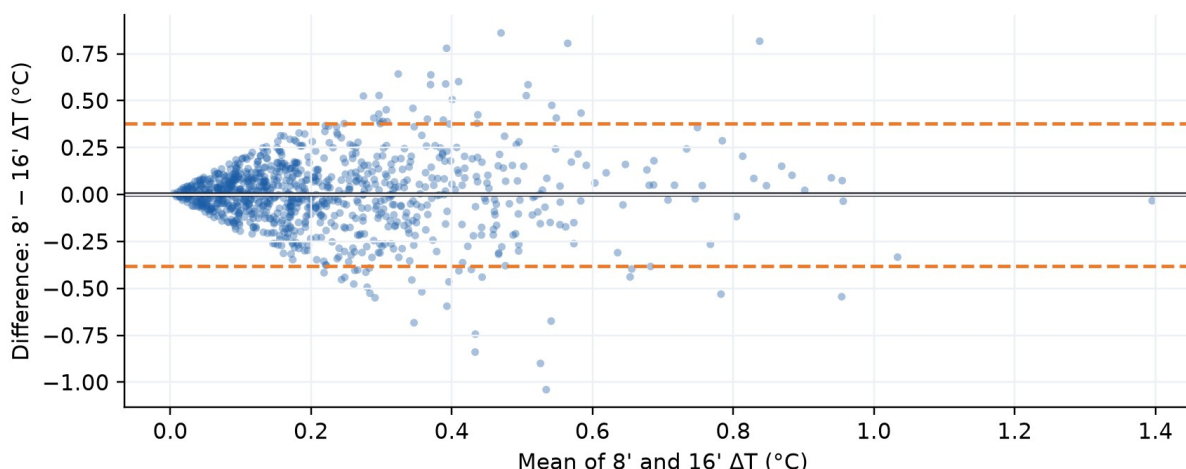


Figure 3. Bland–Altman agreement for 8' versus 16'. Near-zero bias coexists with individual-level variation within the 95% limits of agreement.

Reliability differs across anatomical regions

The 8-minute result is not uniform across regions. The strongest 8'/16' reproducibility was observed in Groin (ICC .72), Lower Abdomen (.71), Rear Upper Arm (.70), and Ankle (back) (.69). This regional variation reinforces the need for standardized capture, longitudinal interpretation, and cautious individual decision-making.

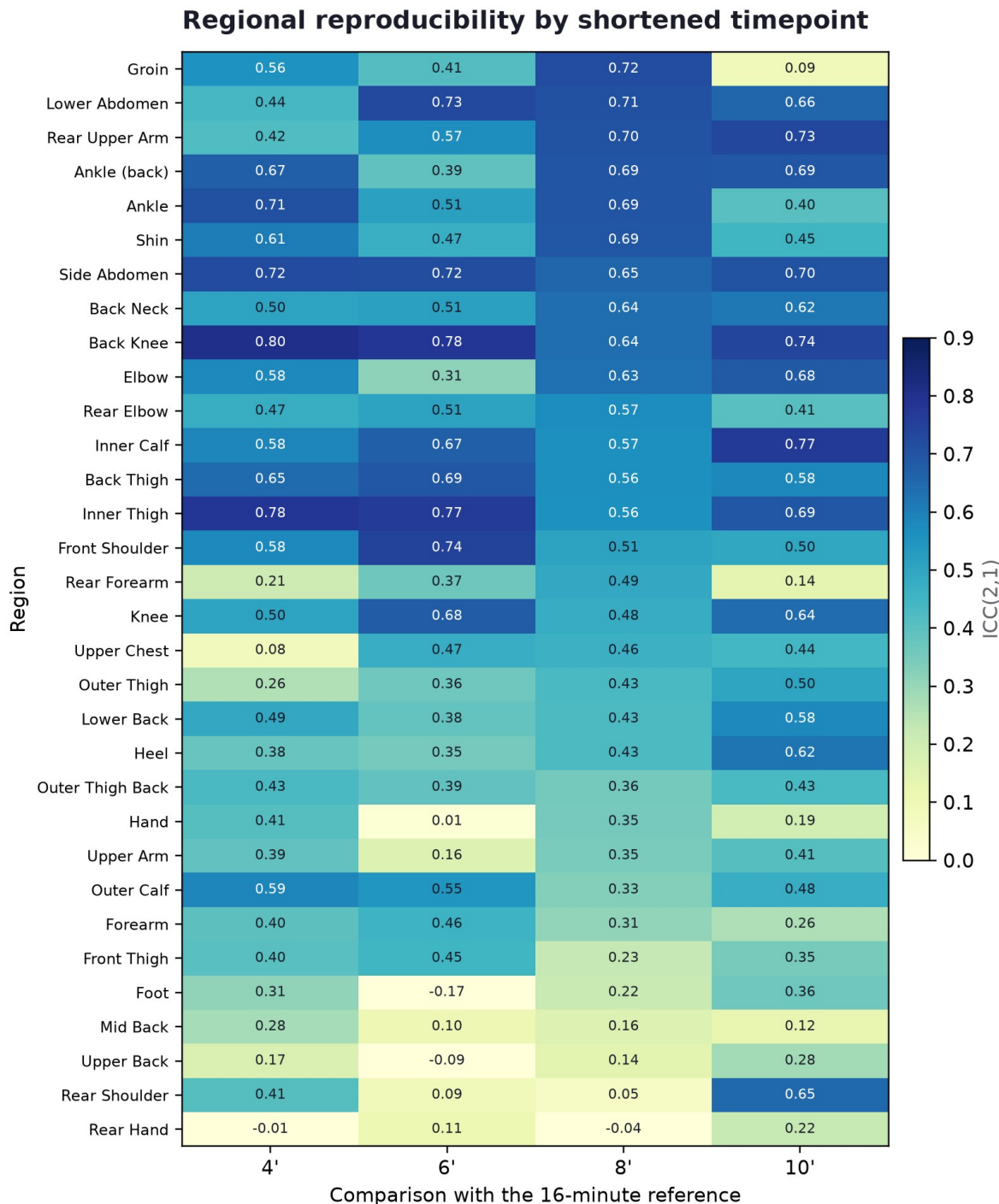


Figure 4. Regional ICC(2,1) by shortened timepoint versus 16 minutes. No region reaches the $\geq .90$ laboratory-validation target.

4. What the findings mean

Two observations can be true at once. First, there is no evidence that mean bilateral asymmetry shifts systematically across the measured acclimation window. Second, individual agreement with the 16-minute reference is only moderate. ANOVA answers the first question; ICC and Bland–Altman analysis answer the second.

HOW TO READ THE RESULTS



Figure 5. Group-mean stability is not the same as individual interchangeability.

Scope boundary

This evidence supports an 8-minute, standardized operational screening workflow when clubs cannot practically wait for a full laboratory preparation period. It does not demonstrate equivalence to a 15–20 minute protocol for absolute-temperature assessment, diagnostic use, or clinical decision-making.

5. Practical implementation for clubs

The operational benefit is not a claim that clubs should abandon established preparation standards. It is a practical option for a defined use case: frequent, standardized screening in which teams review bilateral patterns over time and escalate atypical findings rather than make diagnoses from a single thermal image.

OPERATIONAL SCREENING WORKFLOW

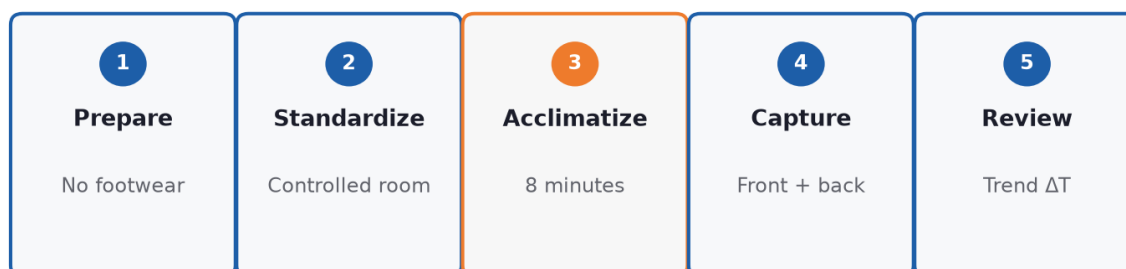


Figure 6. Proposed ATS operational screening workflow. Eight minutes refers to acclimatization time, not a replacement for laboratory protocol duration.



Time implication

Reference within this study	Acclimatization waiting time	Operational implication
16-minute acquisition	16 minutes	Study reference
8-minute screening acquisition	8 minutes	50% less waiting before capture

6. Strengths and limitations

Strengths

- Repeated within-session measurements at nine timepoints
- Thirty-one athletes and up to 32 bilateral regions
- Complementary group-level, agreement, and regional analyses
- A question anchored in real club workflow constraints

Limitations

- Male athletes only and a moderate sample size
- One controlled session; no inter-day reliability
- A single environmental context and device workflow
- ICC values indicate moderate, not high, individual-level reproducibility
- Findings should not be generalized to diagnosis, pathology detection, or unrestricted field conditions

7. Conclusion

Bilateral thermal asymmetry showed no significant group-level temporal shift from baseline to 16 minutes. At 8 and 10 minutes, comparison with the 16-minute acquisition produced near-zero mean bias and no significant paired difference.

The appropriate operational interpretation is deliberately narrow: under standardized conditions, an 8-minute acclimatization period can provide a useful bilateral-asymmetry signal for time-constrained club screening. It is not evidence that shortened preparation replaces established laboratory thermography guidance, nor that one scan should drive a clinical conclusion.

References

1. Moreira DG, Costello JT, Brito CJ, et al. Thermographic imaging in sports and exercise medicine: A Delphi study and consensus statement on the measurement of human skin temperature. *Journal of Thermal Biology*. 2017;69:155–162. doi:10.1016/j.jtherbio.2017.07.006
2. Athlete Thermography Screening. Imaging Guidelines: Thermographic screening — preparation and capture protocol. Internal protocol, 2026.
3. ATS validation dataset: 31 athletes, 0–16 minute acclimatization protocol; internal analysis workbook, 2026.

For screening only. Not a medical diagnosis.