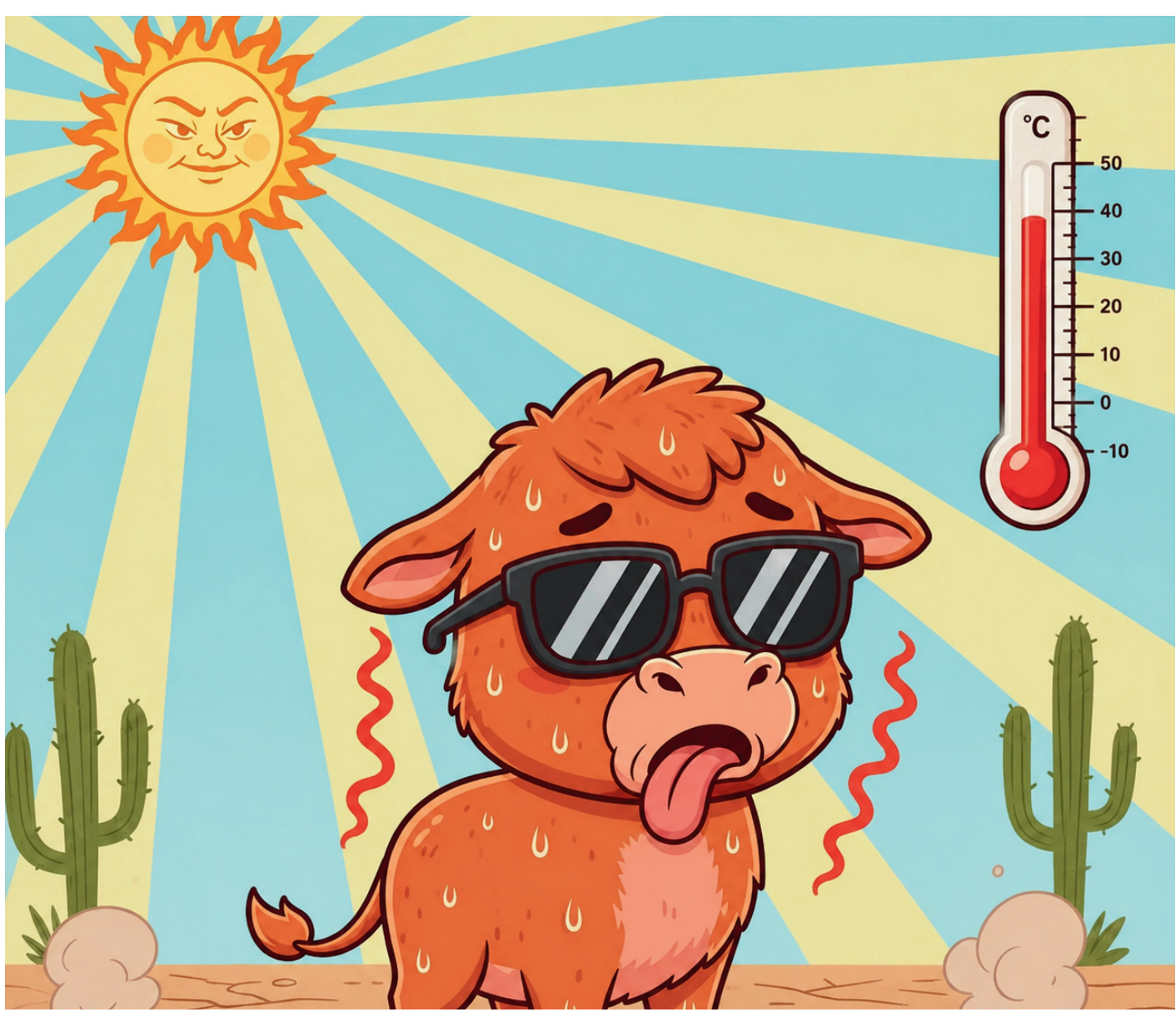


Heat Stress Effects on Semen Quality in Dairy Bulls Under Commercial AI Conditions: A 5-Year Comparative Study Between the Netherlands and New Zealand

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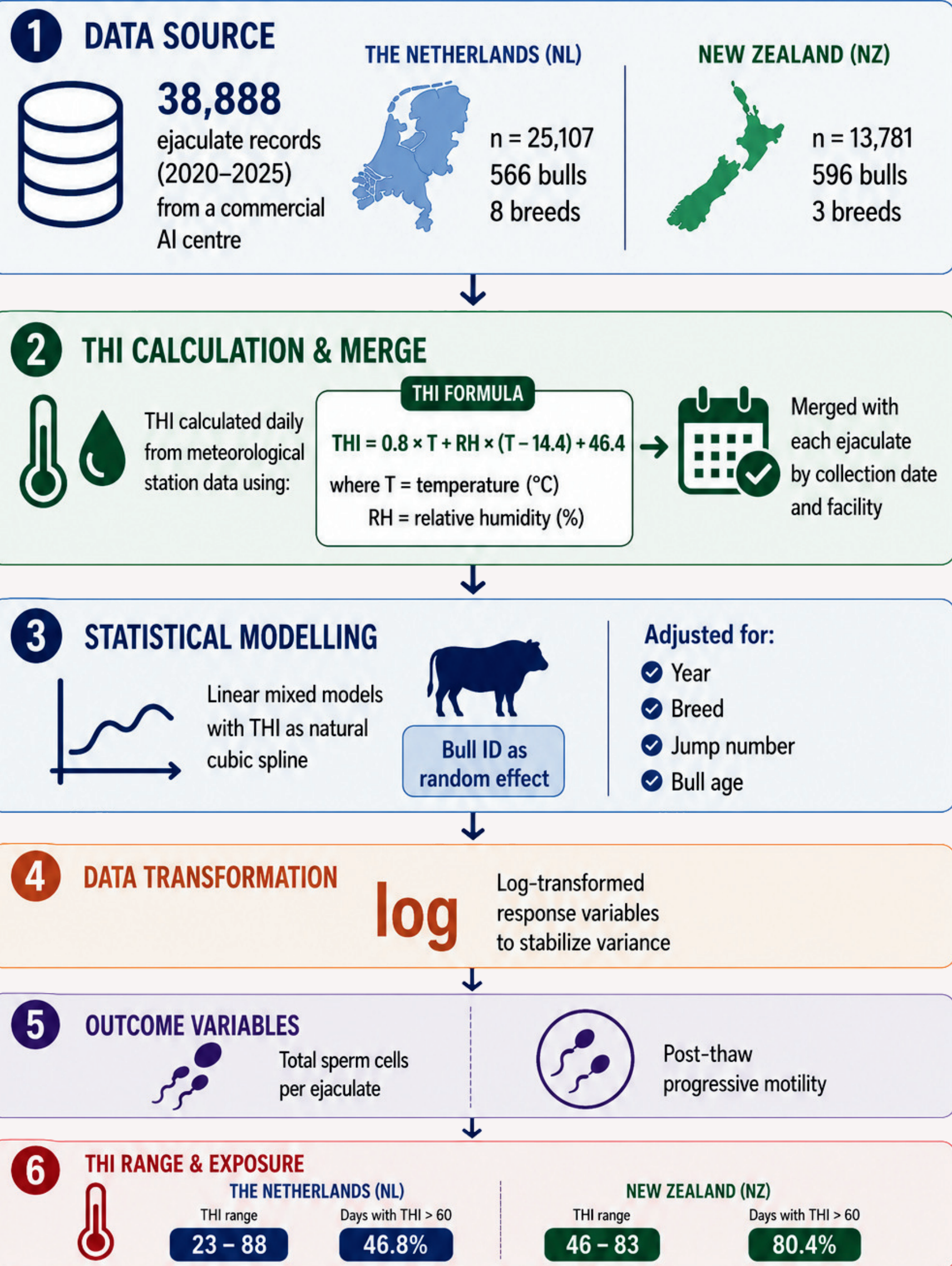
1 Background

- In bulls, elevated temperatures impair spermatogenesis and semen quality
- Reduced fertility in bulls leads to significant economic losses in the dairy and beef industries
- THI thresholds reported for cow studies and not validated for bulls

2 Objectives

- Assess the effects of Temperature humidity Index (THI) on fresh semen quality in dairy bulls in the Netherlands.
- Determine the impact of THI and age on post-thaw sperm output and motility in a large commercial AI dataset in The Netherlands and New Zealand.

3 Methodology



4 Results

1 Seasonal THI Profiles — NL vs NZ

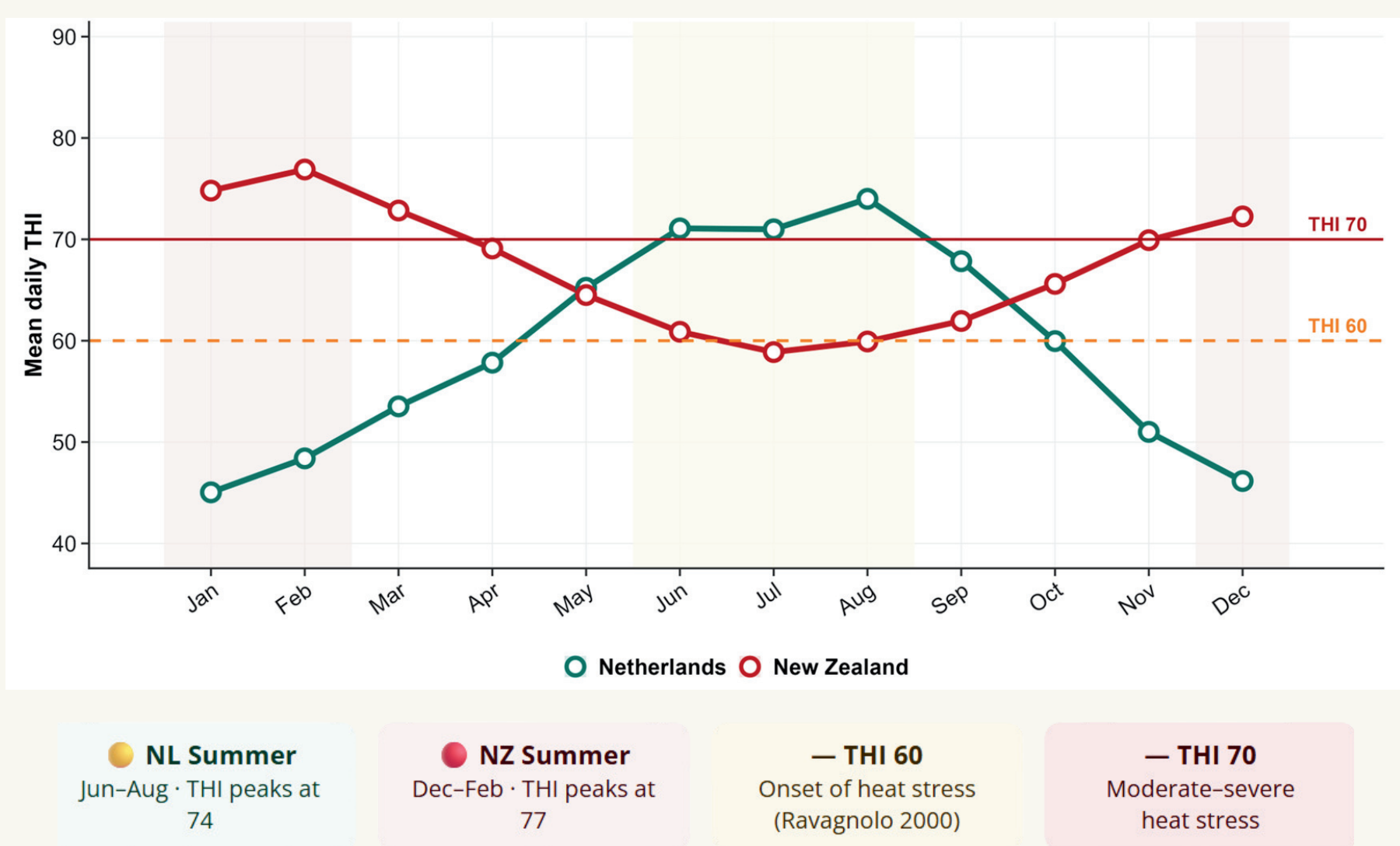


Figure 1: Seasonal temperature-humidity index (THI) profiles in NL and NZ from 2020–2025. Monthly mean THI values were calculated from meteorological station data. Dashed horizontal lines indicate commonly used heat-stress thresholds (THI 60 and THI 70). Shaded regions represent periods of seasonal heat stress exposure. NZ experienced prolonged periods above THI 60 compared with NL.

2 Post-thaw Progressive Motility — Within-Country Response

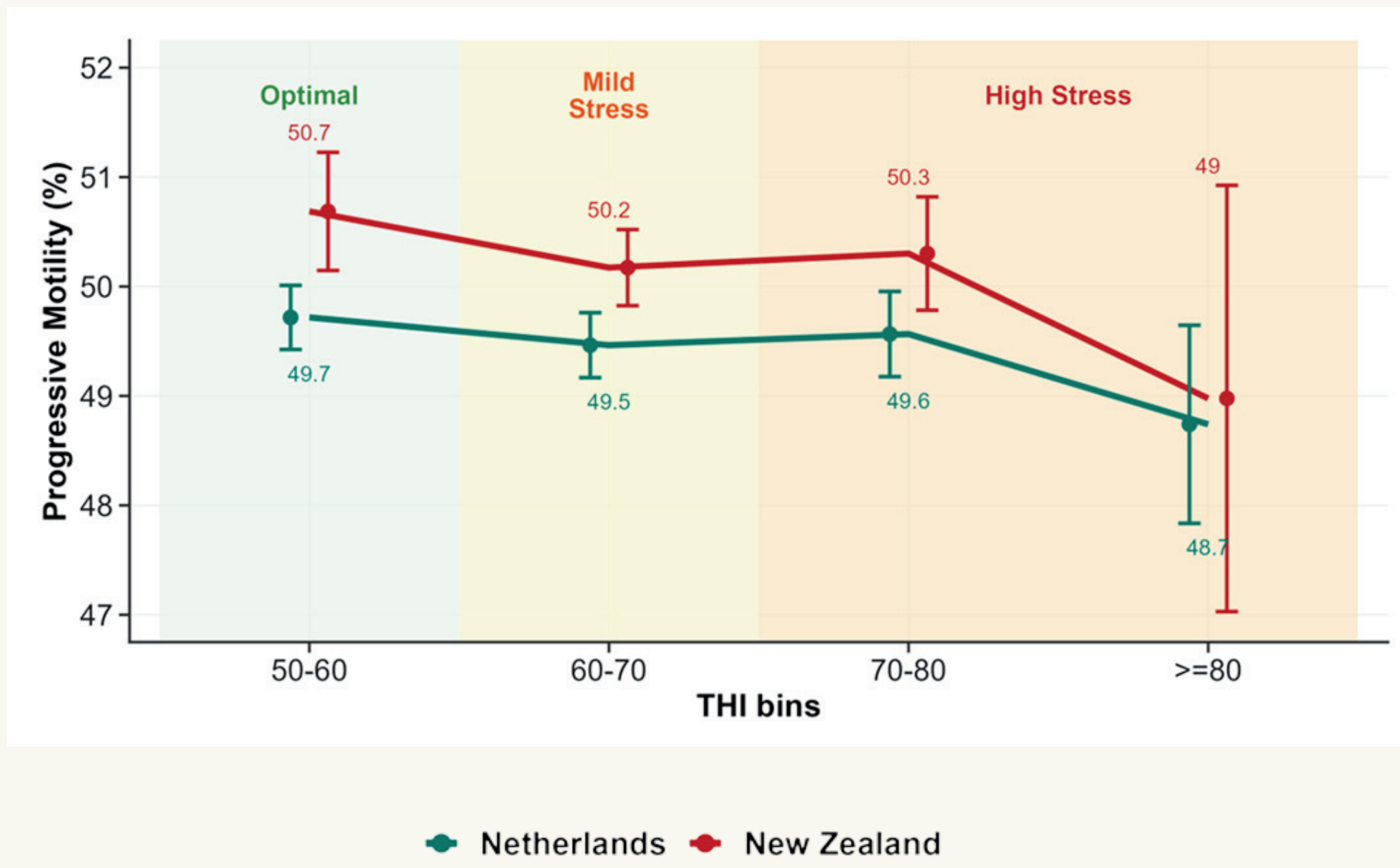


Figure 2A. Model-adjusted post-thaw progressive motility (%) by THI bin, Netherlands (Green) vs. New Zealand (Red). Points show model-adjusted means $\pm$ 95% CI for each 10-unit THI bin. In NL, post-thaw progressive motility showed a statistically significant decline from 49.7% at THI 50–60 to 48.7% at THI $\geq$ 80 ($p = 0.011$). In contrast, no significant effect of THI was observed in New Zealand ($p = 0.095$; not significant).

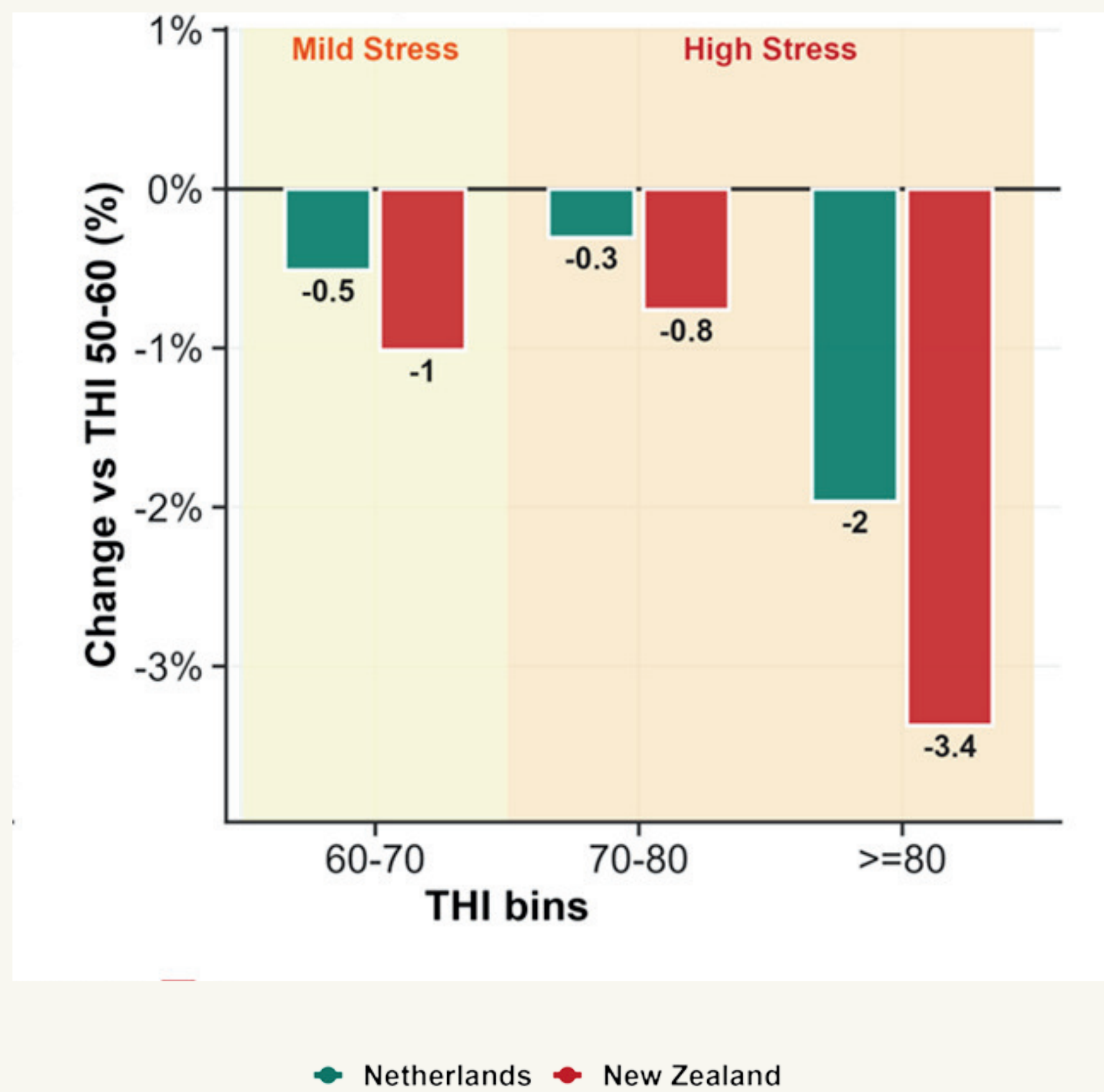


Figure 2B: Change in motility relative to the THI 50–60 reference bin. NL: –0.5 pp at 60–70, –0.3 pp at 70–80, –2.0 pp at $\geq$ 80. NZ: –1.0 pp at 60–70, –0.8 pp at 70–80, –3.4 pp at $\geq$ 80 (all ns). Background shading: amber = mild stress, orange = high stress.

3 Fresh number of cells per Ejaculate. (NL)

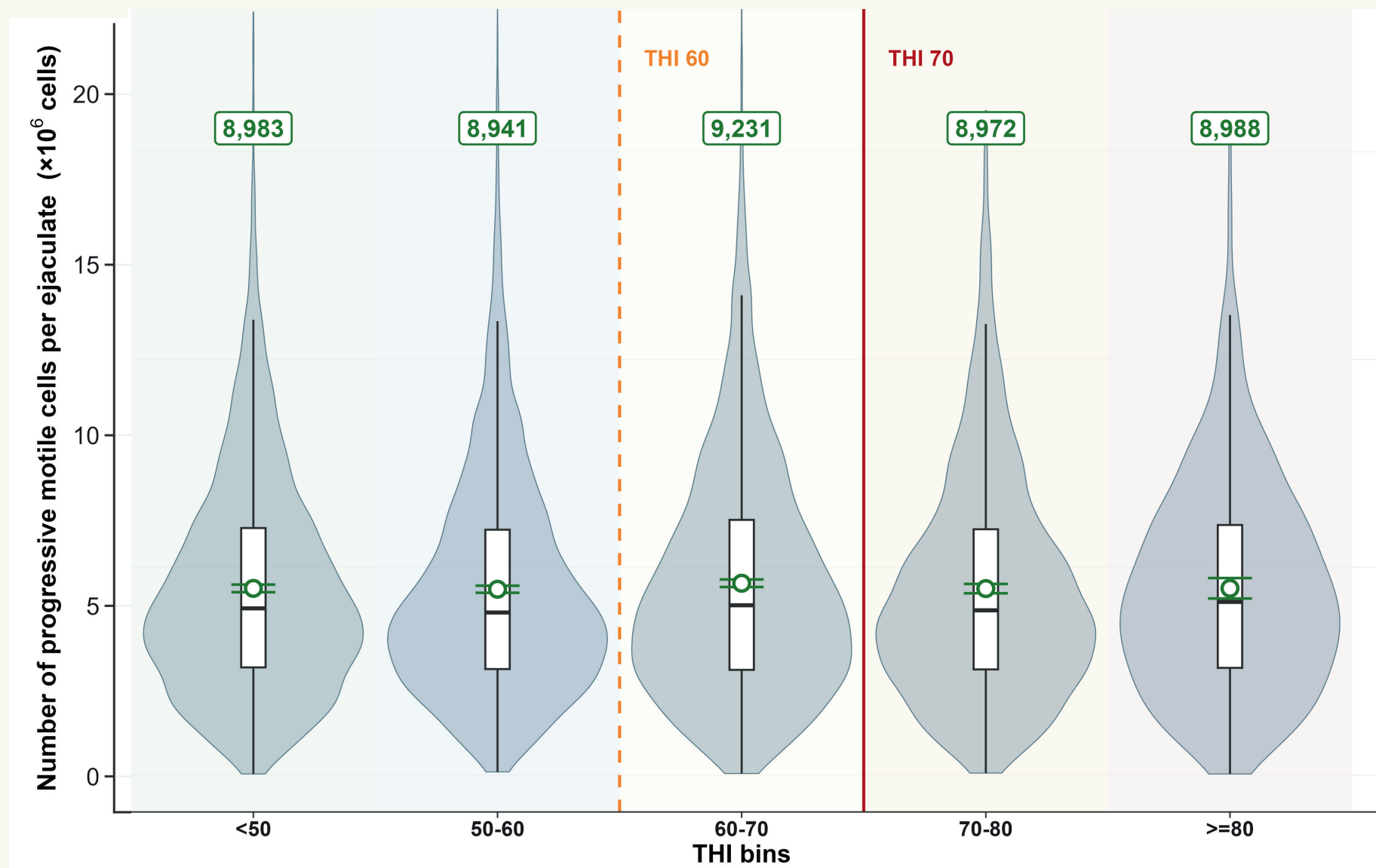
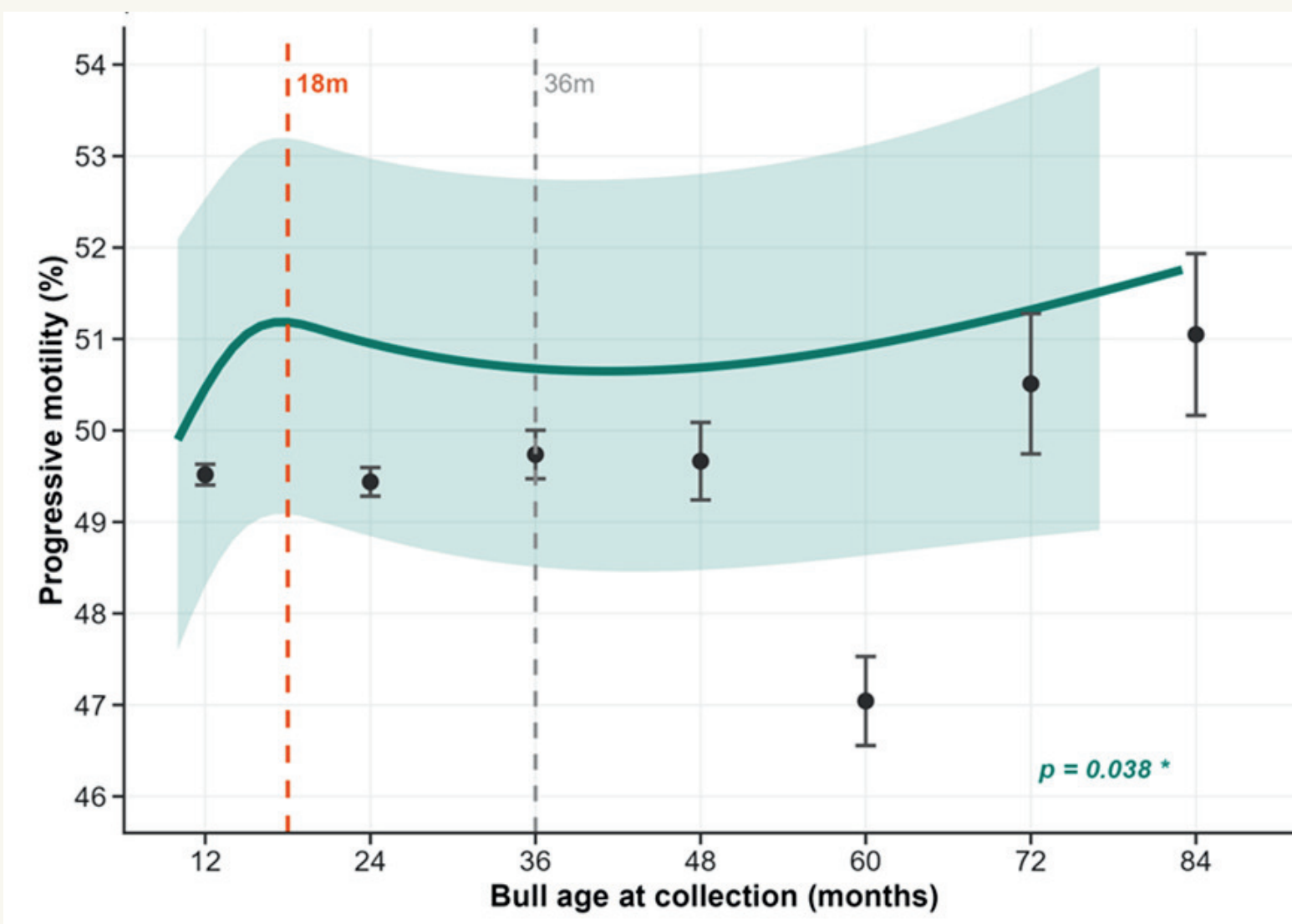


Figure 3. Violin-boxplot of progressive motile cell count ($\times 10^6$ cells), calculated as Fresh progressive motility (%) $\times$ Number of cells per ejaculate $\div$ 100. White boxes = IQR; green circles = mean $\pm$ 95% CI. Mean values annotated per bin: 8983 (<50), 8941 (50–60), 9231 (60–70), 8972 (70–80), 8988 ($\geq$ 80). Dashed orange line = THI 60 threshold; solid red = THI 70 threshold.

4 Effect of Bull Age post thaw sperm motility

A) Netherlands



B) New Zealand

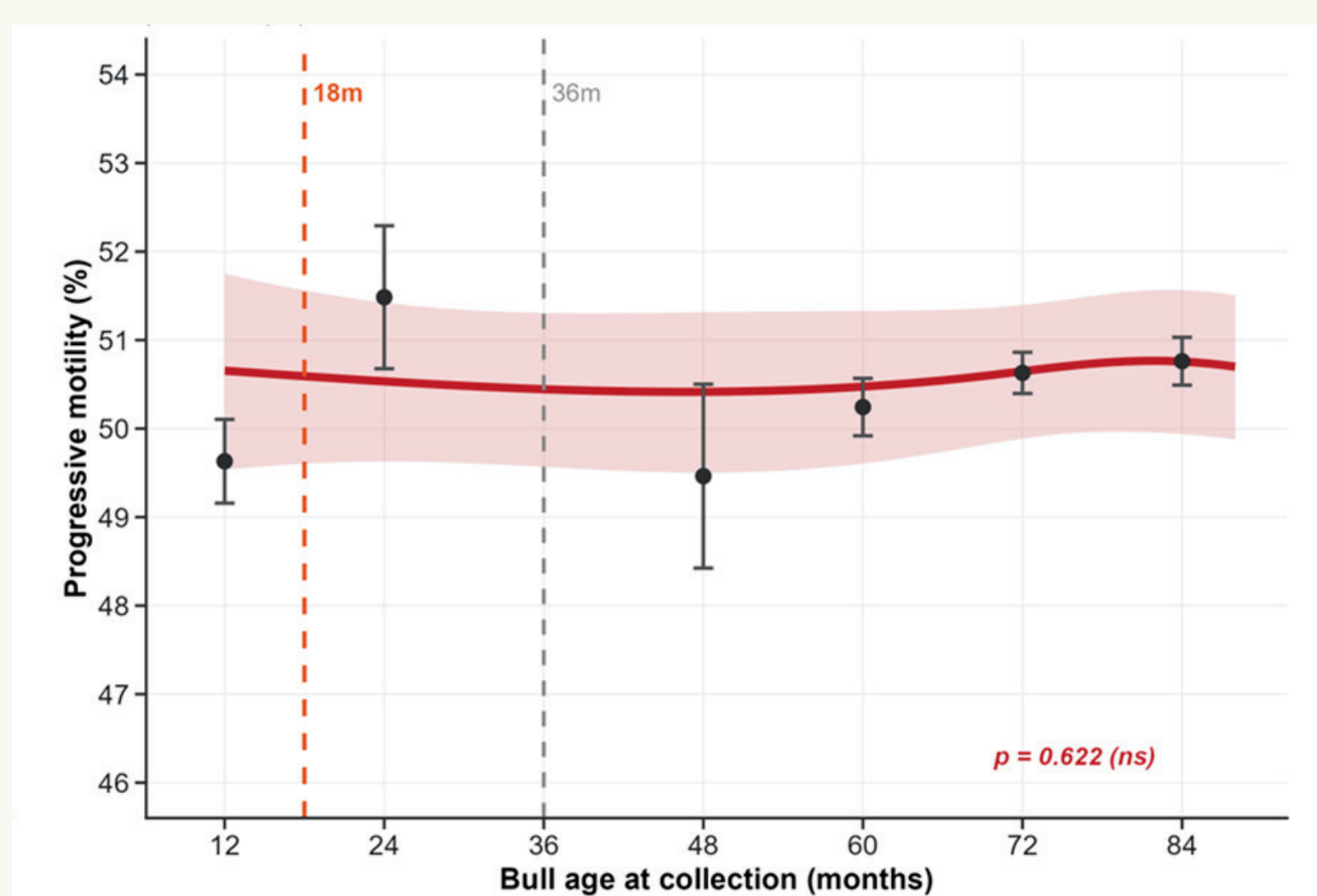


Figure 4: Model-adjusted spline of post-thaw progressive motility (%) by bull age at collection (months) for NL (A, $p = 0.038^*$) and NZ (B, $p = 0.622$, ns). Grey dots = raw means $\pm$ SE at 12, 24, 36, 48, 60, 72, 84 months. Orange dashed line = 18 m (typical AI programme entry); grey dashed = 36 m (established sire).

5 Conclusions

- Heat stress negatively affected semen quality in Dutch bulls but not in New Zealand bulls.
- Fresh sperm concentration was more sensitive to heat stress than post-thaw motility.
- The absence of THI effects in NZ bulls despite higher heat exposure suggests potential thermal adaptation.
- Results challenge the use of universal THI thresholds across regions and production systems.



Key Take-home Message

Heat stress reduces bull semen quality in the Netherlands, but not in New Zealand

Netherlands –0.60 pp progressive motility decline at high THI ($p < 0.05$)	New Zealand –0.39 pp change at high THI, not significant (ns)
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Environment matters



Adaptation matters



One threshold does not fit all

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