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Conference Abstract

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Relative Age Effect and Performance Bias in Italian Youth Road Cycling

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Keywords

relative age effect; youth cycling; age-specific analysis; talent identification

1 Introduction

The Relative Age Effect (RAE) refers to the over-representation of athletes born earlier in the competition year in sport participation (Dudink, 1994) and is documented across sports, particularly in youth. RAE is generally stronger in adolescence and may progressively attenuate with age (Jakobsson et al., 2021). RAE has also been documented in performance outcomes, potentially leading to selection biases related to differential maturation. Therefore, the aims of this study were: (1) to examine the presence and magnitude of RAE among successful athletes compared with the total population of registered athletes within the Italian Cycling Federation (FCI) from 2015 to 2025; and (2) to investigate differences in seasonal points according to birth quartile across age categories.

2 Material and Methods

A retrospective analysis was conducted using official registration data from the FCI from 2015 to 2025. The sample included 34,764 male athletes (aged 13–18 years). Birth dates were categorized into quartiles: Q1 (Jan–Mar), Q2 (Apr–Jun), Q3 (Jul–Sep), and Q4 (Oct–Dec). Athletes were classified as successful if they achieved at least one top-5 finish in road races during the competitive season, corresponding

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to at least one point in the official FCI ranking system. The presence of RAE was assessed separately by age (13–18 years) using chi-squared goodness-of-fit tests comparing the distribution of successful athletes with the expected distribution derived from all registered athletes within the same birth cohorts. Effect size was quantified using Cramér's V, and standardized residuals were inspected to identify specific over- and under-represented quartiles. Performance differences across birth quartiles were examined using non-parametric Kruskal–Wallis tests on seasonal points, stratified by age. When significant, pairwise post-hoc comparisons were performed using the Dwass–Steel–Critchlow–Fligner (DSCF) test with Holm adjustment. All analyses were conducted separately for each age. Statistical significance was set at $p < 0.05$.

3 Results

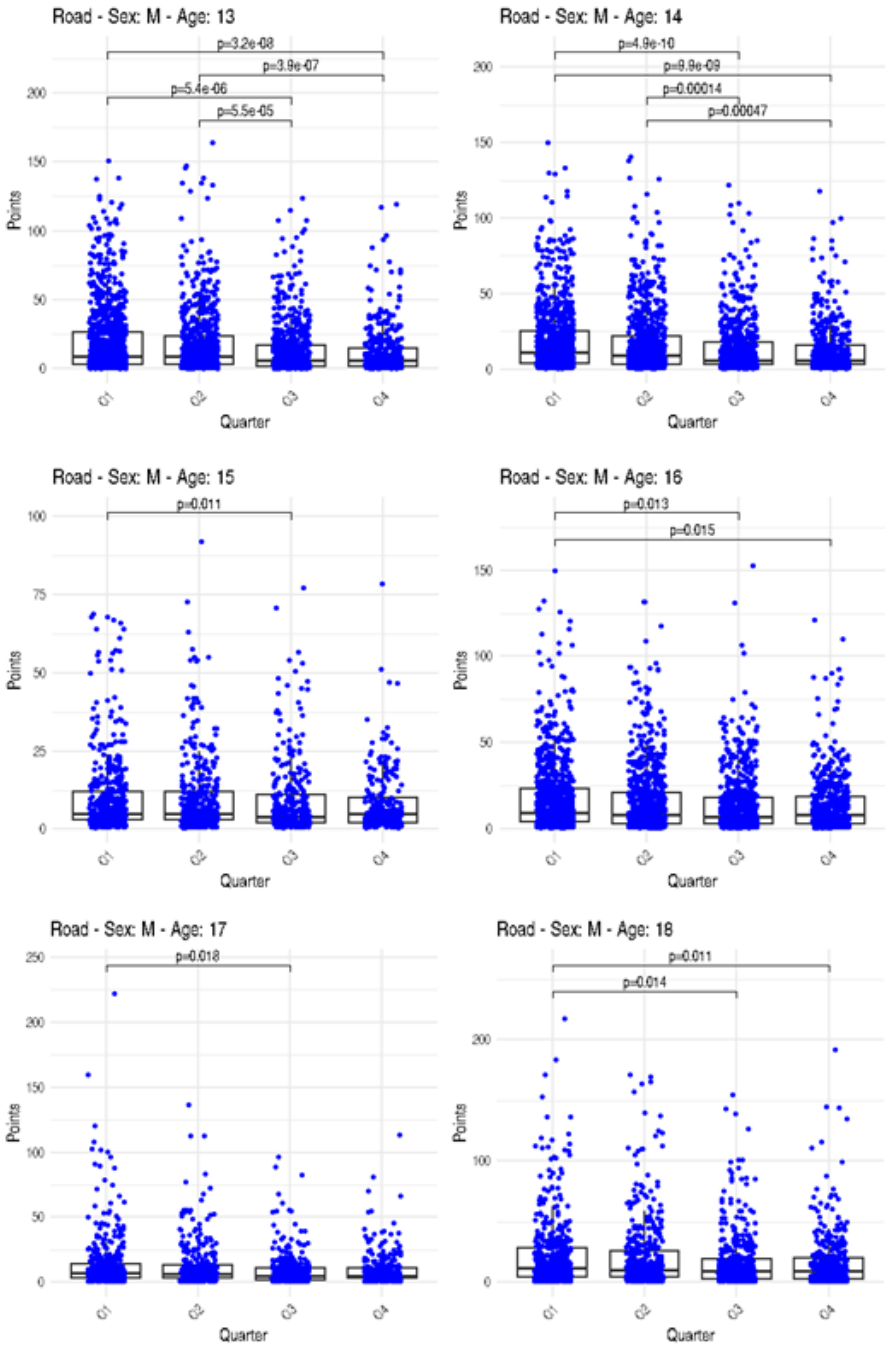

Figure 1. Distribution of seasonal points divided by age.

A significant RAE was observed among male athletes at ages 13, 14, 15, and 16. The strongest deviation from the expected distribution was observed at age 13 ($\chi^2 = 191.63$, $p < 0.001$, $V = 0.11$), followed by age 14 ($\chi^2 = 154.62$, $p < 0.001$, $V = 0.10$), age 15 ($\chi^2 = 86.40$, $p < 0.001$, $V = 0.08$), and age 16 ($\chi^2 = 55.34$, $p < 0.001$, $V = 0.06$). The effect was not statistically significant at ages 17 and 18. Standardized residuals indicated a consistent over-representation of Q1 athletes and under-representation of Q4 athletes in younger categories. Effect sizes were small, with a clear attenuation across age.

Significant differences in seasonal points were observed across birth quartiles in athletes aged 13 to 18 years (all $p < 0.014$) (Fig. 1). Post-hoc DSCF analyses revealed that differences were primarily driven by higher performance in Q1 compared with Q3 and Q4 in younger categories. At ages 13 and 14, Q1 athletes obtained significantly higher median points than Q3 and Q4 athletes ($p < 0.001$). A similar pattern was observed at ages 16, 17, and 18, with Q1 athletes consistently outperforming later-born peers. Median values generally followed a descending gradient from Q1 to Q4 in younger age groups.

4 Discussion

The presence of RAE among successful athletes compared to registered athletes is significant, although the size effect is small and, as reported in the literature, tends to decrease with age (Jakobsson et al., 2021). In line with the findings of Gallo et al. (2022) and Filipas et al. (2024), no significant RAE emerged at ages 17 and 18. However, RAE was evident in Italian road cycling from ages 13 to 16. Although effect sizes were small, a clear and consistent performance advantage was observed for relatively older athletes across all age categories. The points obtained consistently favored athletes born in the first quartile across the examined period. The magnitude of the effect progressively decreased with age; however, performance disparities were still evident at age 18 and should be carefully considered in annual talent identification and selection processes, as suggested by the results shown by Voet and colleagues (2022).

5 Practical Applications

The results of the study contribute to a better understanding of how the day of birth could influence success in young cycling categories. For talent scouting, it may be misleading to base talent selection solely on current performance, as this may favor relatively older cyclists. Federations may need to consider restructuring youth competitions according to biological rather than solely chronological age.

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Conflicts of Interest: The authors declare no conflict of interest.

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