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Original Research

Idmatch Bike Fitting Enhances Power Output in Recreational Cyclists: A Pilot Study

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Abstract

International Journal of Exercise Science 18(2): 864-880, 2025. https://doi.org/10.70252/CMDY5909 Optimizing bike position is essential for enhancing cycling performance, improving comfort, and reducing injury risk. This study examined the acute effects of a bike fit using the idmatch® system on power output, rate of perceived exertion (RPE), and discomfort in recreational cyclists. Twelve participants (10 males, 2 females; 37.0 ± 9.4 years) underwent an idmatch system bike fit, which employs three-dimensional motion capture to optimize rider position. Cyclists completed a six-second peak power test (PPT6) and a 20-minute functional threshold power (FTP) test before and after the fit. Performance metrics (power, cadence, and torque) and subjective measures (RPE, discomfort and region-specific pain) were recorded. Post-fit, peak power during the PPT6 test was 8.6% higher (pre: 952.1 ± 268.2 W; post: 1033.6 ± 263.6 W; $p = 0.043$). In the post-fit FTP test, average power output (pre: 190.0 ± 50.0 W; post: 198.7 ± 47.8 W; $p = 0.047$) and torque (pre: 15.6 ± 3.5 ft-lb.; post: 16.6 ± 2.2 ft-lb.; $p = 0.035$) were increased, while RPE ($p = 0.029$) and discomfort ($p = 0.035$) were decreased compared to pre-fit values. Performance improvements in both tests were positively correlated with the magnitude of saddle-to-handlebar distance adjustment ($p < 0.05$). Self-reported hand, foot, and hamstring pain trended lower following the bike fit (all: $p = 0.125$). These findings suggest that optimizing bike configuration using the idmatch system acutely improves power production and reduce discomfort in recreational cyclists. Motion-capture-based fitting systems may offer a practical solution for enhancing cycling performance.

Keywords: Cycling discomfort, functional threshold power, peak power, bike configuration

Introduction

Establishing an optimal riding position is crucial for maximizing cycling performance, improving comfort, and reducing injury risk.[1] Achieving this position requires a precise match between the bike's configuration (e.g., saddle height, setback, and handlebar reach) and the rider's anatomical characteristics, including limb length, joint mobility, and range of motion.[2] Consequently, many cyclists turn to experienced bike fitters to help tailor their positioning to their anatomy. A properly fitted position is not only key to improving performance but also to prevent overuse injuries, such as patellofemoral pain syndrome, iliotibial band syndrome, lower back and neck pain, and ulnar neuropathy ('cyclist's palsy).[3,4] By promoting a more efficient and sustainable riding posture, good fit benefits both competitive and recreational cyclists.

Although numerous studies have explored the effects of individual bike fitting components, such as saddle height, knee angle, and handlebar position, on cycling performance and biomechanics, comprehensive evaluations of full-system, technology-guided bike fitting remain limited. For example, Peveler[1] demonstrated that a saddle height corresponding to approximately 25° of knee flexion significantly reduced VO_2 during submaximal cycling compared to 35° of knee flexion and the traditional 109% inseam method, suggesting improved efficiency without changes in heart rate or perceived exertion. Follow-up work in well-trained cyclists [5] showed that the 25° knee angle also led to significantly higher peak anaerobic power output during maximal efforts. Similarly, in a study involving a 30-second Wingate test, Peveler et al[6] found that cyclists whose inseam-based setup fell outside the recommended knee angle range produced significantly lower mean anaerobic power than when fitted to a 25° angle. Ferrer-Roca et al[7] observed that static saddle height methods often resulted in suboptimal knee angles and altered pedaling kinematics, while recent research by Bini et al[8] highlighted that fitting-derived handlebar positions do not always translate accurately to sprint cycling conditions. A recent systematic review[9] further concluded that while there is moderate evidence supporting joint-angle-based saddle height adjustments, most existing studies focus on isolated variables, with relatively few examining comprehensive fitting protocols or their effect on high-intensity performance outcomes.

Traditionally, bike fitting has relied heavily on subjective feedback (such as pain, comfort, and rider experience) to guide adjustments. Experienced bike fitters depend on this individualized input to tailor the bike setup to the rider's unique biomechanics and preferences.[10] However, this subjectivity introduces variability and may limit the consistency and accuracy of fittings. To address this, new technologies have emerged to provide objective data during the fitting process. These include 3D motion capture systems (e.g., Retül), pressure mapping tools for saddle and foot interfaces (e.g., Gebiomized), and force measurement pedals (e.g., Garmin Vector), among others. The idmatch® system, for example, uses 3D motion capture to analyze dynamic cycling movement.[11] This approach provides quantifiable data that moves beyond subjective measures of pain, comfort, and fatigue, allowing for more precise and reproducible adjustments.[12] The integration of motion capture technology in bike fitting represents a paradigm shift toward highly accurate, data-driven modifications aimed at optimizing comfort and performance. However, evidence validating these systems, particularly regarding their impact on measurable outcomes like power, is still limited.[9]

The objectives of this study were twofold: (1) to determine whether an objective-based bike fit using the idmatch system could improve power output in recreational cyclists, and (2) to evaluate whether the bike fit influenced subjective outcomes including rate of perceived exertion (RPE), discomfort, and pain. Power was assessed through both anaerobic (6-second peak power test; PPT6) and aerobic (20-minute functional threshold power test; FTP Test) efforts. Subjective responses were measured immediately post-exercise using validated rating scales. We hypothesized that healthy, non-competitive cyclists would demonstrate improvements in both performance (increased power) and subjective experience (lower RPE, discomfort, and pain) following the idmatch bike fit. These aims reflect a comprehensive evaluation of both physiological and experiential responses to objective bike fitting, supporting a broader understanding of its benefits for recreational cyclists.

Methods

Participants

This research was carried out fully in accordance with the ethical standards of the *International Journal of Exercise Science*.[13] This study was approved by a local University's Institutional Review (IRB Protocol #2024-07). All procedures were conducted in accordance with the ethical standards of the Helsinki Declaration. All participants provided both verbal and written informed consent prior to participation. Participants were recruited through university, industry partner, and community sources. Sample size was generated using a sample size calculator for small or pilot studies.[14] Based on prior research using similar protocols in recreational cyclists evaluating biomechanical and physiological responses to bike fitting interventions,[15,16] a sample size of 12 participants provided sufficient power (≥ 80%) to detect effects using standard statistical comparisons (e.g., paired t-tests or repeated-measures ANOVA) with an alpha level of 0.05. Of 25 interested individuals, 12 (10 male, 2 female) provided written informed consent and were enrolled. Participants were eligible if they were between 18 and 64 years old, engaged in structured exercise at least twice per week (≥ 30 minutes per session), owned a road or gravel bicycle, and were available for two lab visits within 96 hours. Health screening included completion of the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and a general health history form. Participants also completed questionnaires on cycling experience and injury history. Individuals were excluded if they had a history of professional bike fitting or reported medical conditions on the PAR-Q+ or health history form that required medical clearance prior to exercise testing.

Protocol

Participants completed two laboratory visits. At visit one, participants were screened and had their original bike setup replicated on a Wattbike Pro ergometer (Wattbike Ltd., Nottingham, UK). They then completed a 6-second peak power test (PPT6) on the Wattbike, followed by a 20-minute functional threshold power (FTP) test on their personal bike, as described below. A 10-minute passive rest period separated the PPT6 and FTP tests, which aligns with short-term recovery intervals (5-15 min) observed in sprint cycling contexts and allows partial recovery without compromising session feasibility for recreational cyclists.[17] RPE, discomfort, and pain were reported during both efforts. Participants then underwent a bike fitting using the idmatch system. Participants returned 48-96 hours later to repeat the PPT6 and FTP tests with their new bike configuration. Following completion of the fitting session on the idmatch fitting bike, the resulting fit coordinates were transferred to the Wattbike Pro prior to the post-fit PPT6 and to each participant's personal bike prior to the post-fit FTP test. Adjustments were made to saddle height, setback, handlebar position, and cleat placement to match the fit parameters as closely as possible.

Bike fittings were performed using the idmatch system (Casella d'Asolo, Italy), as previously described.[18,19] Briefly, the idmatch system combines 3D motion capture, static body scans (e.g., limb length, lumbar flexion, foot dimensions), and machine learning algorithms to optimize rider position. Initially, the system collects detailed measurements of the rider's body and analyzes key biomechanical parameters such as joint angles, flexibility, and posture on their bike during three static body scans: 1) limb length in anatomical position; 2) lumbar flexion assessed via a straight-legged forward fold; and 3) foot length and width. Next, each participant's original bike configuration is replicated on the idmatch system fitting bike. Using integrated machine learning algorithms, the system adjusts saddle height, handlebar position, and other components to achieve the most efficient and comfortable riding position, based on a biomechanical database. The process is guided by participant and input from a certified idmatch bike fitter, ensuring that the rider's fit is personalized for both performance and injury prevention. Prior to the fitting session, each participant discussed their cycling history and pain concerns prior to fitting, and rated pain by body region on a 1–10 scale.

The PPT6 was conducted on a Wattbike Pro ergometer (Wattbike Ltd., Nottingham, UK), as previously described,[20] with the participant's original bike position replicated on the ergometer for the pre-fit test and the idmatch-recommended configuration applied for the post-fit test. After a five-minute warm-up and a two-minute rest, participants completed a seated, maximal sprint from a dead stop lasting six seconds. Power and cadence data were collected directly via the Wattbike's integrated sensors and Wattbike Hub software. Metrics included peak power (W), relative peak power (W/kg), peak and average cadence (rpm), and leg imbalance (%). Two participants did not complete both tests: one due to height limitations on the Wattbike, and one due to a post-fitting hamstring injury.

Participants completed a 20-minute FTP test, as previously described,[21] on their personal bike mounted to a Wahoo KICKR MOVE cycling trainer (Wahoo Fitness, Atlanta, GA). Briefly, after a five-minute warm-up and one-minute rolling start, participants rode at maximal sustainable effort for 20 minutes. Power, cadence, and torque were recorded using Wahoo's internal sensors and software. Heart rate (HR) was monitored using a Polar H10 sensor, and respiratory data (VO_2, VCO_2, RER) were collected using a COSMED Quark CPET system (Cosmed USA Inc.). Performance data [FTP (W), relative FTP (W/kg), average cadence (rpm), torque (ft-lb.)] were captured via the Wahoo trainer. After each FTP test, participants reported their perceived exertion using the Borg 6-20 RPE scale,[22] rated overall discomfort using a 1-20 Likert-style discomfort scale modeled after previous ergonomic studies,[23] and completed a modified body map questionnaire to identify the location and severity of pain or discomfort experienced while cycling.[24]

Statistical Analysis

Results are presented as mean ± SD. Significance was set at $P < 0.05$. Paired, Student's t-tests assessed pre- vs. post-fitting differences. To reduce the risk of Type I error from multiple comparisons, we applied the Benjamini-Hochberg (BH) false discovery rate correction ($Q = 0.05$) to all paired t-tests. For performance outcomes where a directional hypothesis was pre-specified (e.g., peak power, FTP), one-tailed tests were used; for all others, two-tailed tests were applied.

Cohen's d effect sizes were calculated for all comparisons. Post-hoc power analyses were conducted using G*Power (version 3.1.9.7) to estimate achieved power based on observed effect sizes. Pearson correlation coefficients examined associations between variables; all correlated variables were normally distributed. McNemar's tests were used to assess changes in region-specific discomfort (yes/no) reported by participants immediately following the pre- and post-bike fit FTP test. Sex differences were not analyzed due to the small number of female participants. Analyses were conducted using SPSS Version 29.0 (SPSS Inc., Chicago, IL, USA).

Results

Participant characteristics and pre- and post-fit performance metrics are presented in Table 1. Of note, prior to bike fit, participants had a peak power output of 952.1 ± 268.2 W and a relative peak power output of 11.9 ± 2.0 W/kg during the PPT6. During the FTP test, average power was 190.0 ± 50.0 W and relative FTP was 2.3 ± 0.5 W/kg prior to the bike fit.

Table 1. Participant characteristics.

	Pre-Fit	**Post-Fit**
Anthropometric measurements (n = 12)		
Age (yrs)	37.0 ± 9.4	-
Sex (M/F)	10/2	-
Body weight (kg)	81.8 ± 16.0	80.4 ± 17.6
Height (cm)	178.7 ± 10.8	-
BMI (kg/m^2)	25.4 ± 2.7	25.5 ± 2.8
Peak power test measurements (n = 10)		
Peak power (W)	952.1 ± 268.2	1033.6 ± 263.6
Relative peak power (W/kg)	11.9 ± 2.0	12.8 ± 1.7
Average cadence (rpm)	137.7 ± 9.9	142.7 ± 7.5
Peak cadence (rpm)	145.9 ± 9.7	150.4 ± 7.7
Right and left leg balance (%)	50.9 ± 1.4	51.0 ± 1.3
FTP test measurements (n = 12)		
FTP (W)	190.0 ± 50.0	198.7 ± 47.8
Relative FTP (W/kg)	2.3 ± 0.5	2.4 ± 0.4
Average cadence (rpm)	90.8 ± 12.7	89.0 ± 10.4
Average torque (ft-lb.)	15.6 ± 3.6	16.6 ± 2.2
Average heart rate (bpm)	162.5 ± 14.9	162.8 ± 15.1
Average VO_2 (mL/kg/min)	38.1 ± 6.5	38.2 ± 4.7
Average RER	0.98 ± 0.03	0.98 ± 0.03
RPE (Borg 6-20 scale)	16.3 ± 2.0	15.5 ± 1.8
Discomfort (1-20 scale)	11.3 ± 3.4	8.2 ± 1.3

Data are presented as mean ± SD. Peak power was measured during a 6-second peak power test and functional threshold power was measured during a 20-minute test. Abbreviations: FTP: functional threshold power; RER: respiratory exchange ratio; RPE: rate of perceived exertion. Notes: Two participants were unable to complete the peak power test: one participant was too tall to comfortable ride the WattBike and the second injured his hamstring during testing. Due to technical errors, indirect calorimetry was not performed in one participant during the FTP test.

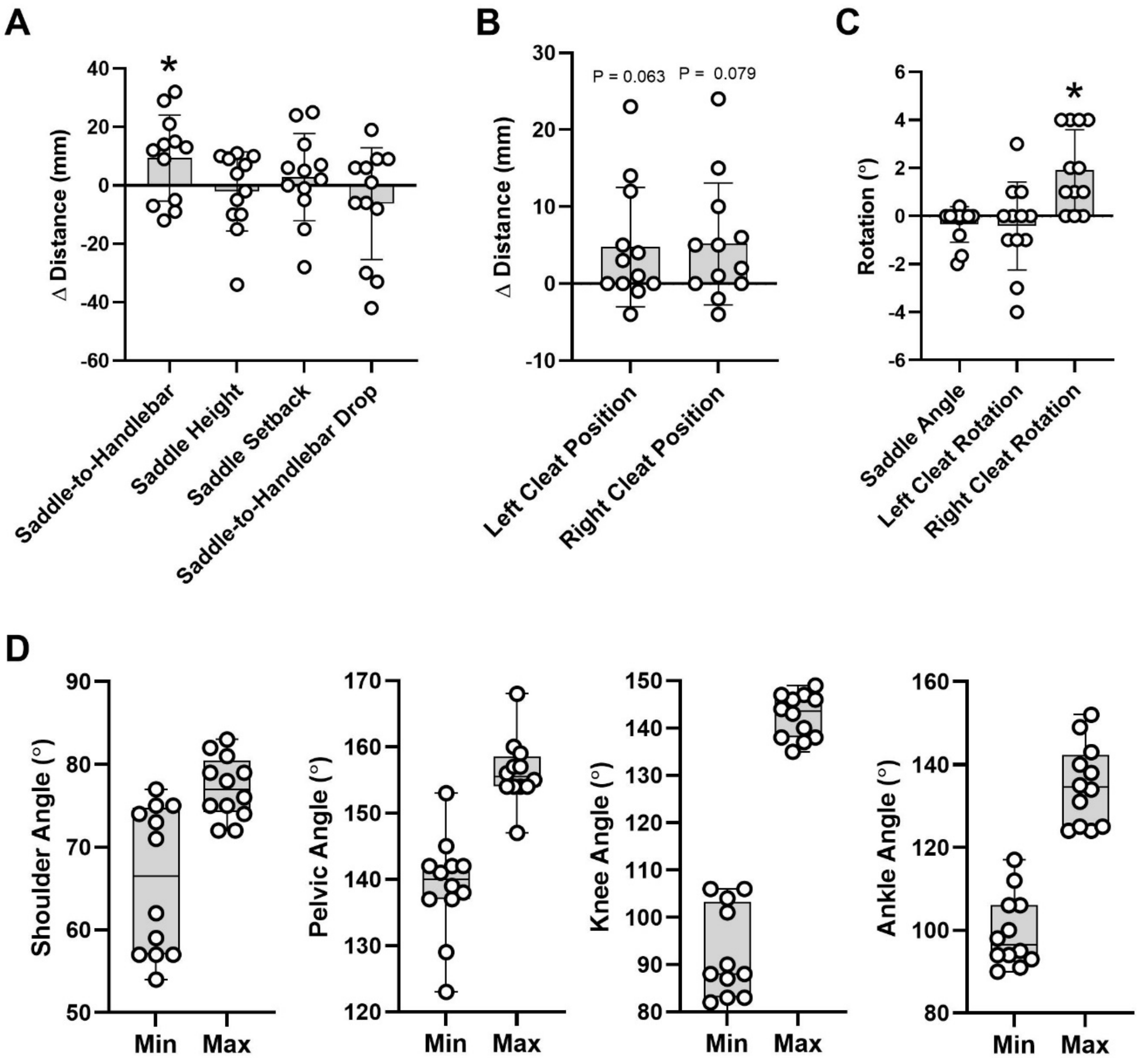

Figure 1. Changes in bicycle configuration following the idmatch bike fit. (A) Saddle-to-handlebar distance was increased following the biking fit. (B) Both left and right cleat position trended to be increased (i.e., moved forward) following the bike fit. (C) Right cleat rotation was increased (i.e. heel pointing outward) following the bike fit. (D) Minimum and maximum shoulder, pelvis, knee, and ankle joint angles following the bike fit. Data represent mean ± SD. Data in panels A-C were analyzed by two-tailed, paired-sample t-test, and p-values were adjusted using the Benjamini–Hochberg procedure to control the false discovery rate. * $P < 0.05$. N = 12.

Post-bike fit, saddle-to-handlebar distance was increased (9.3 ± 14.7 mm; $t(11) = 2.50$, $p = 0.029$, BH-adjusted $p = 0.048$, Cohen's $d = 0.76$, power = 0.66), while saddle height (-2.1 ± 13.6 mm; $t(11) = -0.53$, $p = 0.61$, BH-adjusted $p = 0.61$, Cohen's $d = -0.16$, power = 0.08), saddle setback (2.8 ± 14.9 mm; $t(11) = 0.66$, $p = 0.52$, BH-adjusted $p = 0.57$, Cohen's $d = 0.20$, power = 0.10), and saddle-to-handlebar drop (-6.3 ± 19.1 mm; $t(11) = -1.13$, $p = 0.28$, BH-adjusted $p = 0.40$, Cohen's $d = -0.34$, power = 0.19) were unchanged (Figure 1A). Cleats showed non-significant trends to be moved forward on both left (5.1 ± 8.0 mm; $t(11) = 2.53$, $p = 0.030$, BH-adjusted $p = 0.063$, Cohen's $d = 0.76$, power = 0.70) and right (5.8 ± 8.2 mm; $t(11) = 2.34$, $p = 0.041$, BH-adjusted $p = 0.079$, Cohen's $d = 0.71$, power = 0.61) feet (Figure 1B). Analysis of bike angles also showed that the right cleat rotation was increased (i.e., heel pointing outward) post-bike fit (2.0 ± 1.7 °; t(11) = 3.38, p = 0.003, BH-adjusted p = 0.023, Cohen's d = 1.02, power = 0.89) (Figure 1C), while left cleat rotation (-0.4 ± 1.9 °; t(11) = -0.63, p = 0.54, BH-adjusted p = 0.57, Cohen's d = -0.19, power = 0.09) and saddle angle (-0.3 ± 0.7 °; t(11) = -1.61, p = 0.14, BH-adjusted p = 0.23, Cohen's d = -0.48, power = 0.33) were unchanged. Post-fit joint angles for the shoulder, pelvis, ankle, and knee aligned with idmatch recommendations (Figure 1D) [25]. No pre-fit joint angles were recorded.

Post-bike fit, peak power during the PPT6 increased by 81.5 ± 96.6 W (t(9) = 2.66, p = 0.013, BH-adjusted p = 0.043, Cohen's d = 0.89, power = 0.89), which translated to a non-significant trend for greater relative peak power by 0.9 ± 1.2 W/kg (t(9) = 2.33, p = 0.024, BH-adjusted p = 0.061, Cohen's d = 0.78, power = 0.81) (Figures 2A-B). Increases in peak power were likely attributed increased average cadence (5.0 ± 5.8 rpm; t(9) = 2.75, p = 0.011, BH-adjusted p = 0.042, Cohen's d = 0.92, power = 0.84) (Figure 2C) and a trend for increased peak cadence (4.5 ± 7.2 rpm; t(9) = 1.93, p = 0.043, BH-adjusted p = 0.076, Cohen's d = 0.64, power = 0.67) (Figure 2D) during the post-bike fit PPT6. Supporting this, improvements peak power after bike fitting positively correlated with increased average cadence (R = 0.76, P = 0.01) (data not shown). No change in leg imbalance was observed (0.1 ± 0.7%; t(9) = 0.43, p = 0.34, BH-adjusted p = 0.46, Cohen's d = 0.14, power = 0.12) (Figure 2E). Further, improvements in peak power positively associated with the magnitude of change in saddle–handlebar distance (R = 0.63, P = 0.05), regardless of whether it increased or decreased, suggesting that correcting larger misalignments in the saddle-to-handlebar distance was associated with greater gains in performance (Figure 4A).

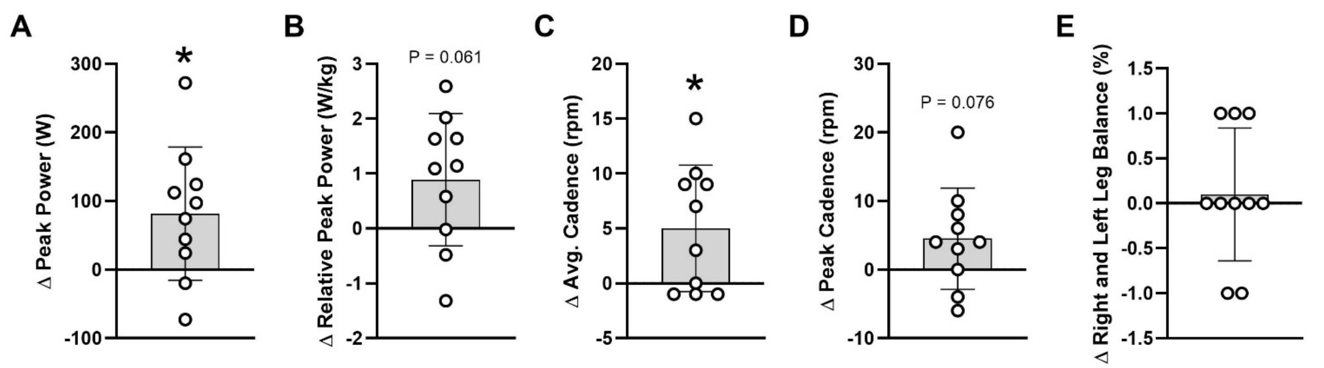

Figure 2. Changes in performance during the six-second peak power test. (A-C) Peak power, relative peak power, and average cadence were increased following the idmatch bike fit. (D) Peak cadence trended to increase (p = 0.076) following the idmatch bike fit. (E) No difference in right and left leg power balance was observed in response to the idmatch bike fit. Note: in Panel E an increase in right and left leg power balance indicates more even force application between feet while a decrease indicates less even force application between feet. Data represent mean ± SD and were analyzed by one-tailed, paired-sample t-test. p-values were adjusted using the Benjamini–Hochberg procedure to control the false discovery rate. * P < 0.05. N = 10.

Post-bike fit, average power during the FTP test increased by 9.7 ± 14.9 W (t(11) = 2.37, p = 0.018, BH-adjusted p = 0.047, Cohen's d = 0.71, power = 0.75) and relative FTP increased by 0.11 ± 0.19 W/kg (t(11) = 2.36, p = 0.019, BH-adjusted p = 0.047, Cohen's d = 0.71, power = 0.74) (Figures 3A-B). No change in average cadence (-1.8 ± 9.5 rpm; t(11) = -0.67, p = 0.26, BH-adjusted p = 0.40,

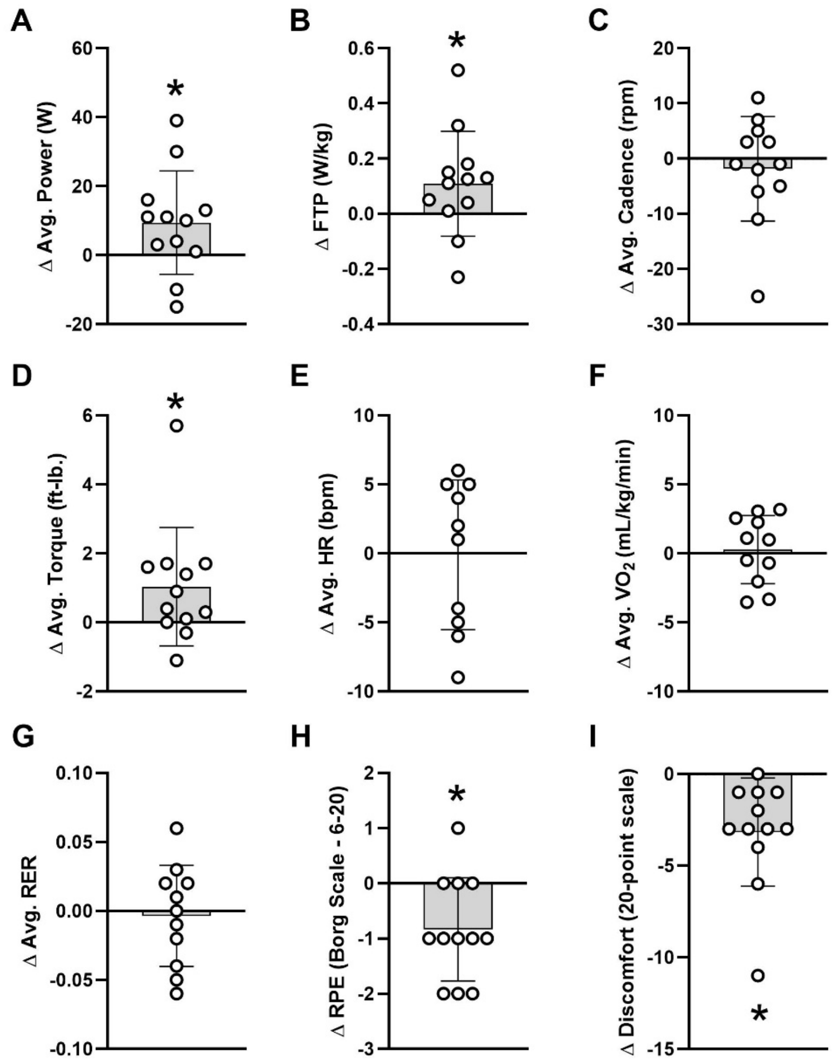

Figure 3. Changes in performance during the 20-minute functional threshold power test. Average power (A) and functional threshold power (FTP) relative to body weight (B) were significantly increased following the idmatch bike fit. Increases in average power and FTP following the idmatch bike fit were independent of changes in average cadence (C) but occurred concurrently to increased average torque (D). (E-G) No changes in average heart rate (HR), average oxygen consumption (VO_2), or respiratory exchange ratio (RER) were observed in response to the idmatch bike fit. (H-I) Rate of perceived exertion (RPE), measured using the 6-20 Borg scale, and discomfort, measured using a 20-point scale, were significantly decreased during exercise following the idmatch bike fit. Note: RER and VO_2 were not accurately measured in one participant and HR was not accurately measured in two participants, and these data have been excluded. Data represent mean ± SD and were analyzed by one-tailed, paired-sample t-test. p-values were adjusted using the Benjamini–Hochberg procedure to control the false discovery rate. * $P < 0.05$. N = 10-12.

Cohen's d = -0.20, power = 0.16) was observed (Figure 3C). Instead, increases in average power and FTP during the post-bike fit FTP test occurred concurrent to increased average torque (1.0 ± 1.7 ft-lb.; $t(11) = 2.88$, $p = 0.008$, BH-adjusted $p = 0.035$, Cohen's d = 0.87, power = 0.88) (Figure 3D), which positively correlated with increased FTP after the bike fit ($R = 0.72$, $P < 0.01$) (data not shown). Cardiorespiratory measures including average HR (0.4 ± 11.4 bpm; $t(9) = 0.11$, p =

0.46, BH-adjusted p = 0.55, Cohen's d = 0.03, power = 0.06), VO_2 (0.1 ± 4.4 mL/kg/min; t(10) = 0.08, p = 0.47, BH-adjusted p = 0.54, Cohen's d = 0.02, power = 0.06), and RER (-0.003 ± 0.04; t(10) = -0.24, p = 0.37, BH-adjusted p = 0.48, Cohen's d = -0.08, power = 0.08) were unchanged, suggests that improvements in power during the post-bike fit tests were independent of differences in cardiorespiratory exertion (Figures 3E-G). Interestingly, participants reported lower RPE (-0.8 ± 0.9; t(11) = -3.08, p = 0.005, BH-adjusted p = 0.029, Cohen's d = -0.93, power = 0.91) and discomfort (-3.2 ± 2.9; t(11) = -3.72, p = 0.001, BH-adjusted p = 0.035, Cohen's d = -1.12, power = 0.98) post-bike fit, suggesting that participants associated feelings of exertion and discomfort more so with pain due to an improper bike fit rather and cardiorespiratory effort (Figures 3H, I).

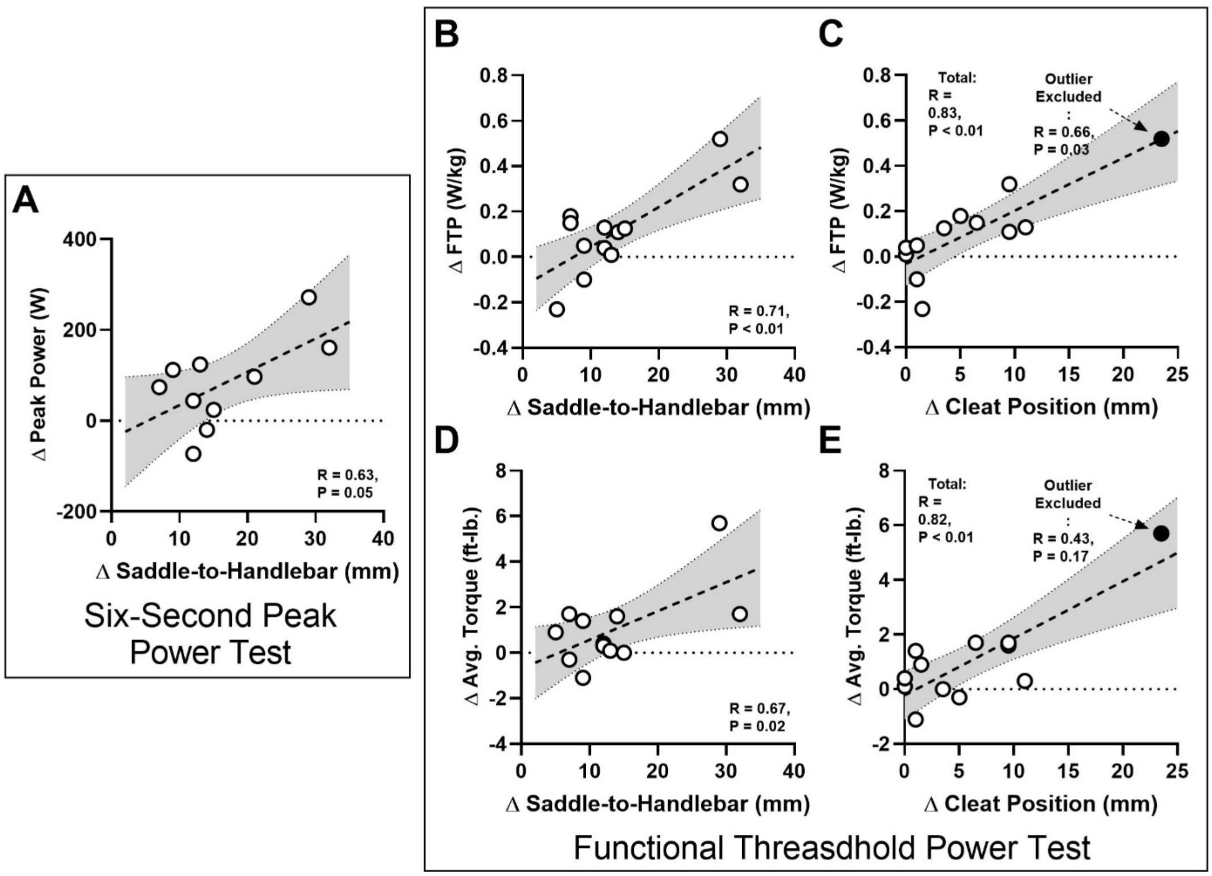

Figure 4. Associations between changes in bike configuration and test performance. Changes in peak power during the six-second peak power test in response to the idmatch bike fit correlated with the magnitude of change in saddle-to-handlebar distance, regardless of whether it increased or decreased (A). (B-E) During functional threshold power (FTP) testing, changes in the magnitude of change in saddle–to-handlebar distance and magnitude of changes in cleat position, calculated as the average adjustment of both right and left cleats, correlated with changes in FTP (B, C) and changes in average torque (D, E) between pre- and post-bike fit tests. Data were analyzed by Person correlations (N = 10-12).

Correlational analysis revealed significant positive relationships between the magnitude of change in saddle–handlebar distance, regardless of whether it increased or decreased, and improvements in both FTP (R = 0.71, P < 0.01) and average torque (R = 0.67, P = 0.02), suggesting that larger adjustments in this measurement were associated with greater gains in performance (Figure 4B, C). Similarly, greater overall changes in cleat position, calculated as the average adjustment of both right and left cleats, strongly associated with increases in FTP ($R = 0.83$, $P < 0.01$) and average torque ($R = 0.82$, $P < 0.01$) (Figure 4D, E). However, this relationship was influenced by an outlier (($R = 0.43$, $P = 0.17$) when this data point was excluded), suggesting this association between improved cleat position and torque may be less robust. Collectively, these findings suggest that adjustments to both saddle–handlebar distance and cleat position played a meaningful role in enhancing performance and comfort during the post-bike fit FTP test.

Although not statistically significant, likely due to the small sample size, fewer participants reported discomfort or pain in most anatomical regions following the bike fit (Figure 5). Specifically, reductions were observed in the shoulder (Pre: 1, Post: 0; $p = 1.0$), wrist (Pre: 3, Post: 0; $p = 0.25$), hand (Pre: 6, Post: 2; $p = 0.125$), lower back (Pre: 1, Post: 0; $p = 1.0$), pelvis and sit bones (Pre: 6, Post: 3; $p = 0.25$), hamstring (Pre: 4, Post: 0; $p = 0.125$), knee (Pre: 1, Post: 0; $p = 1.0$), ankle (Pre: 1, Post: 0; $p = 1.0$), and feet (Pre: 7, Post: 3; $p = 0.125$). No change in neck discomfort was observed (Pre: 2, Post: 2; $p = 1.0$).

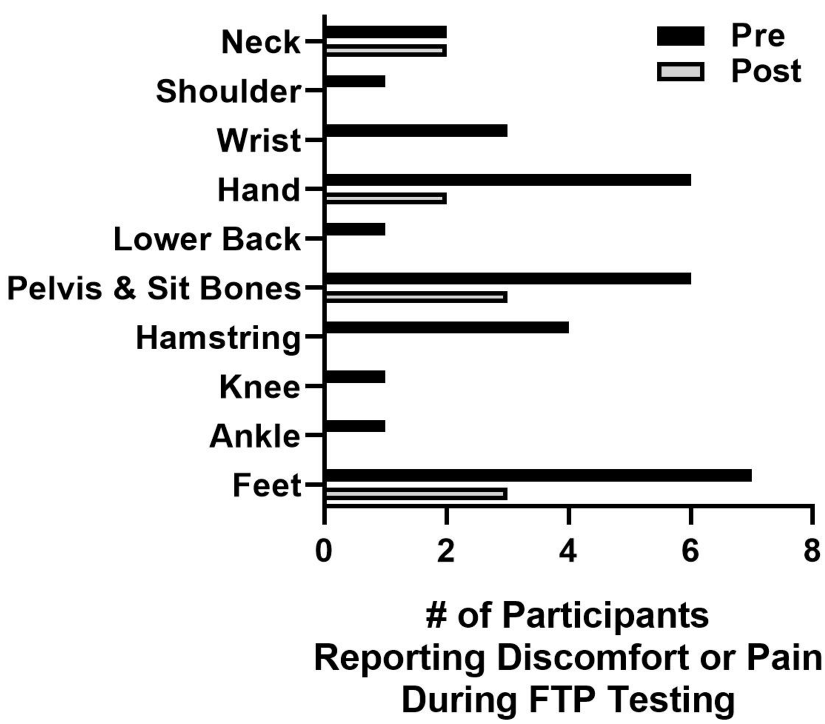

Figure 5. Number of participants with region-specific pain or discomfort during the pre- and post-bike fit functional threshold power tests. Data represents the number of participants with self-reported discomfort or pain in various body regions at the conclusion of functional threshold power (FTP) tests pre-bike fit (black bars) and post-bike fit (gray bars). N = 12.

Discussion

We investigated the acute impact of a bike fit using the idmatch system on cycling performance, discomfort, and pain during cycling in healthy, recreational cyclists. Our findings demonstrate that a bike fit using the idmatch system resulted in meaningful improvements in key performance outcomes, including peak anaerobic power during the PPT6 and power and torque during an FTP test, while concurrently reducing RPE and musculoskeletal discomfort. These outcomes were associated with quantifiable changes in bike configuration, specifically an increase in saddle–handlebar distance and anterior displacement of right and left cleat position. Notably, these adjustments brought participants bike configurations closer to the idmatch system's biomechanically optimal reference values.[25]

We observed that many of the study participants presented with saddle–handlebar distances that were too short, which were significantly altered by bike fitting. The increase in saddle-to-handlebar distance observed post-fit likely played a multifaceted role in improving cycling performance. From a biomechanical standpoint, increasing the distance between the saddle and handlebar effectively opens the hip-torso angle and redistributes upper body weight more efficiently across the contact points (saddle, pedals, handlebars).[26,27] This can reduce mechanical strain in the shoulders, cervical spine, and lumbar region, while simultaneously enhancing trunk stability and breathing capacity.[2] Importantly, the positive correlation between the magnitude of saddle–handlebar distance change and improvements in peak suggests that correcting maladaptive fit patterns, whether they involve overextension or compression, can unlock untapped performance potential. Given that our participants included recreational cyclists, short saddle–handlebar distances prior to bike fitting may be due to an intentional preference for a more upright, comfort-oriented posture, often influenced by limited core stability, spinal flexibility, or concerns about reach-induced discomfort.[28] While this setup may feel stable or relaxed, it often results in a closed hip angle that restricts hip extension, limits gluteal engagement, and can impair power production.[29,30] Over time, such configurations may also contribute to overuse injuries due to poor load distribution across the spine and upper body,[31] potentially contributing to the high prevalence of hand and wrist pain that participants experienced in their pre-bike fit FTP test. The adjustments made during our study suggest that idmatch system fitting can help recreational cyclists adopt a more biomechanically advantageous posture without compromising comfort.

Similarly, many of our participants needed their cleats repositioned anteriorly, which also likely contributed to improved power output. Cleats placed too far posteriorly are often chosen by riders under the belief that they reduce calf strain; however, this setup actually increases reliance on ankle plantar flexion and can reduce stability at the pedal-foot interface.[15,32] Excess posterior cleat position increases the ankle's range of motion and promotes excessive dorsiflexion during the upstroke, which can compromise force transfer efficiency and lead to foot numbness or discomfort on longer rides and/or during intense efforts,[33] potentially contributing to the high level of foot pain reported during the pre-bike fit FTP test. By better aligning cleat position, the pedal spindle is better aligned with the metatarsophalangeal joint, resulting in improved joint stacking, reduced ankle involvement, and more consistent torque production across the pedal stroke.[2,11] This adjustment, though subtle, may have contributed to the observed increases in both torque and FTP by enabling more stable and biomechanically efficient pedaling mechanics.

These potential biomechanical explanations for our observed performance improvements are summarized in Table 2.

Table 2. Summary of hypothesized performance effects from bike configuration changes aimed at improving rider position following the idmatch bike fit.

Bike Adjustment	Body Changes	Effect on Pelvis, Knee, and Ankle	Impact on Riding Experience	Impact on Power Output and Torque
Increase saddle-to-handlebar distance	Reach to handlebars is longer	More forward tilt of the pelvis Slight extra bend at the hips Toes may point more downward while pedaling	Improved breathing and hip extension when properly adjusted Better aerodynamics if desired May correct low back and neck pain if position was too conservative or cause low back or neck discomfort if reach is too aggressive	Increase in power output due to improved hip extension and muscle recruitment Higher torque production, especially during strong efforts
Move Cleats Forward (toward the toes)	Foot moves backward over pedal	Knee is a little straighter at the bottom of the pedal stroke Ankles move less; more stable foot position	More stable and comfortable foot pressure Less "hot spots" or numbness on longer rides Smoother, more efficient pedaling	Increase in power output by creating a more stable platform for force transfer Higher and more consistent torque across the pedal stroke

Note: Changes in bike configuration included increased saddle-to-handlebar distance and forward-cleat positioning.

An important observation was the consistency of performance improvements across both anaerobic (peak power) and aerobic (FTP) domains, indicating that the biomechanical changes supported force production under varied metabolic conditions. Torque improvements, in particular, suggest that participants became more effective at applying force across the pedal stroke, possibly due to a more stable pelvis and optimized joint angles.[34-36] These enhancements may be particularly impactful for recreational cyclists, where small changes in fit can lead to disproportionate gains in output. These changes may also reflect enhanced proprioceptive feedback and muscle coordination, both of which are affected by the spatial relationship between the cyclist and the bike.[37,38]

Our findings align with prior research demonstrating that precise biomechanical positioning can improve cycling performance. For example, Peveler [1] found that recreational cyclists exhibited significantly lower oxygen consumption (VO_2) during submaximal cycling when saddle height was set to achieve approximately 25° of knee flexion, compared to both 35° and the traditional 109% of inseam method, without differences in heart rate or RPE. Similarly, in a cohort of well-trained cyclists, Peveler and Green[5] reported significantly lower VO_2 (~44.8 ± 6.4 mL/kg/min vs. ~46 ± 5.3 mL/kg/min) and greater peak anaerobic power output (~1042 ± 169 W vs. ~1002 ± 148 W) when using the 25° knee angle fit compared to the inseam-based approach during submaximal exercise economy and anaerobic power trials, respectively. These studies highlight the importance of knee-angle–based saddle height adjustments in enhancing both economy and performance. However, it is important to note that these earlier investigations focused on single positional variables in isolation, whereas the current study evaluated a comprehensive, technology-guided bike fitting system that simultaneously adjusts multiple parameters (such as saddle height, setback, handlebar reach, and tilt) based on real-time kinematic feedback. Our results suggest that this integrated approach may produce comparable or greater improvements in objective performance metrics such as power output, cadence, and torque, while also reducing subjective discomfort. These findings support the idea that system-level fitting may provide a more effective method for optimizing performance than adjusting isolated elements alone.

Although not directly measured in this study, the alignment of lower limb kinematics with idmatch target joint angles likely contributed to reductions in discomfort and injury risk. Poor alignment, particularly in the knee and pelvis, has been associated with common overuse injuries in cyclists, including patellofemoral pain, iliotibial band syndrome, and lower back discomfort.[1,39] Participants in this study reported notable reductions in pain across multiple anatomical regions, including the hands, wrist, hamstrings, and feet suggesting that repositioning contact points on the bike reduced cumulative strain on these areas. These self-reported outcomes are clinically relevant, as discomfort during cycling can impair endurance, alter pedaling mechanics, and increase dropout rates, especially among recreational and novice cyclists.[3]

These findings have direct implications for cyclists, coaches, and bike fitters seeking to enhance performance and reduce injury risk. The idmatch system provides an objective, scalable approach to optimizing critical fit parameters, including saddle height, handlebar reach, and cleat position, which are often misestimated using subjective methods or standard sizing charts. For recreational cyclists who may not have access to expert coaching or individualized assessments, our results suggest that idmatch-guided adjustments can yield meaningful improvements in power and comfort. This is particularly relevant for populations prone to suboptimal biomechanics due to inexperience or limited training. The system's ability to align riders with individualized joint-angle reference values may also help prevent common overuse issues such as knee pain, lower back strain, and saddle discomfort,[3] as supported by the reductions in self-reported pain. For practitioners, motion capture-based bike fitting systems may enhance the accuracy and reproducibility, reduce subjective variability[10] and contribute to the broader adoption of biomechanical tools in cycling practice.[4]

Several limitations should be noted. First, our sample size (N = 12) was relatively small, limiting the generalizability of our findings. Moreover, only 10 participants completed the full pre- and post-fit performance assessments, which likely reduced the statistical power to detect small-to-moderate effects. While consistent improvements were observed across most participants, some performance outcomes did not reach statistical significance. This may reflect insufficient power rather than a true absence of effect. To address this, we conducted post-hoc power analyses using G*Power, which confirmed that achieved power varied across outcomes despite moderate-to-large effect sizes. These preliminary findings should therefore be interpreted with caution. Larger, adequately powered studies with more diverse populations, including elite athletes and cyclists with prior injuries, are needed to confirm and extend these results. Second, our sample was predominantly male (10 males, 2 females), which constrains applicability to female cyclists, who may have different anthropometric proportions, biomechanical patterns, and fit-related needs that influence how they respond to bike fitting interventions.[40]

This study evaluated only short-term outcomes. Performance and comfort were assessed within days of the fitting, which does not account for longer-term adaptation or potential delayed onset of discomfort or overuse symptoms. Longitudinal research tracking performance, comfort, and injury incidence over several months would be valuable in assessing the sustainability of observed benefits. Additionally, we did not include a control group that performed the tests without undergoing a bike fit. As a result, it is possible that some of the observed improvements in performance could be attributed to the effects of test repetition or familiarity with the testing procedures, rather than being solely due to the bike fitting intervention.

Critically, although we assessed joint angles post-fit, we lacked detailed pre-fitting joint kinematics, limiting our ability to directly quantify changes in anatomical positioning. While the idmatch system internally uses these parameters for fit optimization, external validation through motion capture or wearable sensors would provide more detailed insight into the biomechanical changes underpinning the observed benefits. Including objective joint angle data in future studies would provide more granular insights into the neuromechanical mechanisms underpinning performance and comfort changes. Lastly, although the idmatch system minimizes operator bias, final adjustments still incorporate rider feedback, introducing a degree of subjectivity. Future research should explore how to balance objective data with rider comfort to refine fitting protocols.

In conclusion, this study provides strong preliminary evidence that individualized, objective bike fitting using the idmatch system improves cycling performance and comfort in recreational cyclists. Increased power output and torque were associated with specific biomechanical changes, particularly to saddle–handlebar distance and cleat position. These findings support the value of comprehensive, motion-guided fitting systems in optimizing both performance and comfort, especially for riders with limited experience or training. Future studies should include larger, more diverse populations and longer follow-up periods to evaluate the durability and broader applicability of these effects.

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