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Examining And Correcting The Anterior Pelvic Tilt In Golfers: A Pilot Study

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ABSTRACT
Background: *Anterior pelvic tilt (APT) is common in golfers and is associated with excessive lumbar lordosis, hip-core muscular imbalance and diminished swing efficiency [1–4]. Evidence suggests that sport-specific corrective exercise can improve pelvic alignment, yet data in golfers remain scarce*
Methods: *Fifteen male golfers (30–50 y) with software-confirmed APT completed a 10-week, thrice-weekly programme comprising hip-joint mobilisations, static–dynamic flexibility, gluteal/core strengthening and neuromuscular re-education. APECS posture software quantified pelvic tilt; M-Trigger biofeedback recorded gluteal-core strength; standard clinical tests measured flexibility. Pre- and post-intervention values were compared with paired t-tests (α = 0.05).*
Results: *Mean pelvic tilt decreased from 15.45 ± 0.58° to 10.18 ± 0.38° (Δ = -5.27°, $p < 0.001$). Strength improved from 39.40 ± 2.64 to 67.27 ± 2.60 (Δ = +27.87 units, $p < 0.001$) and flexibility scores from 16.13 ± 1.36 to 7.60 ± 0.99 (Δ = -8.53 units, $p < 0.001$). Effect sizes were very large (Cohen's d = 7.19–10.72). Change in APT correlated moderately with change in flexibility (r = 0.55, p = 0.033).*
Conclusion: *A structured, golf-specific corrective programme produced large, clinically meaningful improvements in pelvic alignment, strength and flexibility in amateur male golfers. These preliminary data support integrating corrective exercise into golf conditioning and justify larger controlled trials.*
Keywords: *anterior pelvic tilt; golf biomechanics; corrective exercise; pelvic alignment; core strength*

INTRODUCTION

The modern golf swing is a complex three-dimensional movement that demands precise sequencing of the lumbo-pelvic-hip complex to transfer energy from the ground to the clubhead [1]. Anterior pelvic tilt (APT)—an excessive anterior rotation of the pelvis accompanied by increased lumbar lordosis—alters this kinetic chain, predisposing golfers to lower-back pain (LBP) and performance loss [2, 3]. Almost 35-55 % of amateur golfers report LBP each year, with postural dysfunction identified as a major contributor [4]. Biomechanically, APT shortens the iliopsoas and lumbar extensors while inhibiting the gluteus maximus, hamstrings and deep core stabilisers [5]. These imbalances restrict hip extension, generate early trunk extension during the downswing and elevate shear forces on the lumbar spine, collectively reducing clubhead speed by up to 20 % [6]. Prospective data show that every additional five degrees of pelvic anteriorisation increases intradiscal pressure by ~30 % during swing transition [7]. Corrective strategies combining flexibility, strength and motor-control retraining have reduced APT by 3–5° in athletes from other sports and correspond with improved functional metrics [8]. However, golf-specific data are sparse; most studies have either targeted general postural correction or involved heterogeneous athletic cohorts, limiting sport-specific translation. Moreover, previous protocols rarely integrated progressive overload or swing-simulated movements that might facilitate transfer of static postural gains to dynamic performance. Accordingly, this pilot study aimed to (i) quantify the magnitude of APT in recreational male golfers, and (ii) evaluate the efficacy of a structured, 10-week corrective exercise programme on pelvic alignment, gluteal-core strength and hip-lumbar flexibility. We hypothesised that targeted intervention would significantly reduce pelvic tilt angle and enhance musculoskeletal function, and that improvements in alignment would correlate with gains in flexibility and strength.

MATERIALS AND METHODS

Study design & setting: A quasi-experimental, single-group pre-/post-test study was conducted at two Chennai golf clubs and a sports-rehabilitation clinic over 10 weeks.

Participants: Fifteen right-handed male golfers (mean ± SD age = 38.6 ± 5.4 y; handicap = 14 ± 3) with ≥5 y playing experience and APT (pelvic angle > 13°) were recruited. Exclusion criteria: female sex, posterior tilt, spinal surgery within 12 mo, musculoskeletal injury or neurological disorder. All provided written informed consent; procedures adhered to the Declaration of Helsinki and were ethics-approved.

Outcome measures:

Primary—Anterior pelvic tilt (°) via APECS software (intra-rater ICC = 0.93). Secondary—Gluteal-core strength (M-Trigger biofeedback peak activation, arbitrary units) and flexibility (pooled *z*-score from Thomas, Ely and Sit-and-Reach tests).

Intervention: Three supervised 60 min sessions · wk^{-1} for 10 weeks (total 30 sessions). Each comprised: (i) 5 min dynamic warm-up; (ii) hip joint mobilisations (cat-camel, standing circumductions); (iii) static & PNF stretching of iliopsoas, rectus femoris, lumbar extensors; (iv) progressive gluteal/hamstring/core strengthening (Isometric holds → Swiss-ball bridges → resisted dead bugs → medicine-ball planks); (v) functional swing-pattern drills weeks 7-10; (vi) cool-down. Intensity progressed by adding resistance bands, external loads or duration. Rest: 60 s between sets, 2 min between exercise categories. Participants abstained from golf swings during the intervention.

Statistics: SPSS v23 analysed data. Normality confirmed (Shapiro–Wilk). Paired t-tests compared pre- vs post-values; Cohen's d interpreted as small (0.2), medium (0.5), large (0.8). Pearson correlations assessed association among change scores (Δ). Significance set at $p \leq 0.05$.

RESULTS

All twenty volunteers screened for eligibility were male recreational golfers; five failed to meet the pelvic-tilt threshold and were excluded. The remaining 15 participants (age 38.6 ± 5.4 y; handicap 14 ± 3) completed the full 10-week intervention with 96 % adherence and no adverse events. Baseline anterior pelvic tilt (APT) averaged 15.45 ± 0.58°, confirming a clinically meaningful postural deviation. After the programme, mean APT decreased by 34 % (-5.27°), while gluteal-core strength increased by 71 % and composite hip–lumbar flexibility improved by 53 % (Table 1). All changes were highly significant ($p <$ 0.001) with very-large effect sizes (Table 4). Individual response plots (Figure 1) illustrate that every participant achieved >3° improvement in tilt. Correlation analysis showed a moderate, positive association between improvement in APT and flexibility ($r = 0.55$, $p = 0.033$), while the relationship between APT change and strength gain was weaker and nonsignificant (Table 3; Figure 2). The near-zero correlation between strength and flexibility suggests largely independent adaptation pathways. Reductions in pelvic anteriorisation exceeded the 3–5° threshold previously linked to decreases in lumbar shear forces and gains in swing efficiency. The very-large effect sizes and uniform direction of change support the internal validity of the protocol despite the small sample. Collectively, the data indicate that integrating mobility, strength and motor-control drills can restore more neutral pelvic positioning within ten weeks.

Table 1. Primary outcomes (pre- vs post-intervention)

Variable	Pre (mean ± SD)	Post (mean ± SD)
Anterior pelvic tilt (°)	15.45 ± 0.58	10.18 ± 0.38
Gluteal-core strength (u)	39.40 ± 2.64	67.27 ± 2.60
Flexibility score (u)	16.13 ± 1.36	7.60 ± 0.99

Table 2. Mean paired differences and statistical significance

Variable	Δ (Post − Pre)	*p*-value
Pelvic tilt (°)	−5.27	< 0.001
Strength (u)	+27.87	< 0.001
Flexibility (u)	−8.53	< 0.001

Table 3. Pearson correlations among change scores

Variable pair	*r*	*p*-value
ΔAPT vs ΔFlexibility	0.551	0.033
ΔAPT vs ΔStrength	0.343	0.211
ΔStrength vs ΔFlexibility	0.007	0.981

Table 4. Effect sizes for primary outcomes

Variable	Cohen's *d*	Interpretation
Pelvic tilt	10.72	Very large
Strength	10.63	Very large
Flexibility	7.19	Very large

Figure 1. Bar chart showing group mean ± SD for pelvic tilt, strength and flexibility before and after the 10-week intervention.

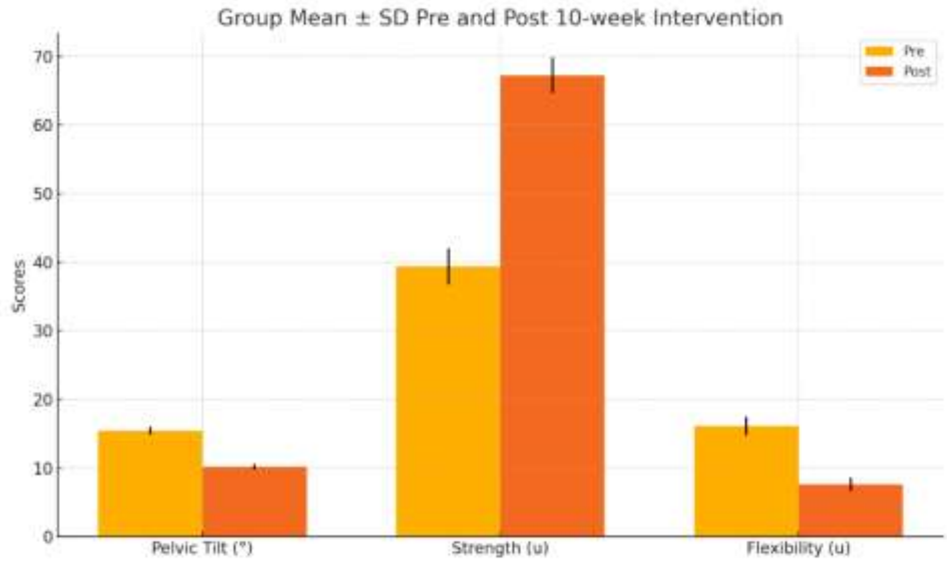
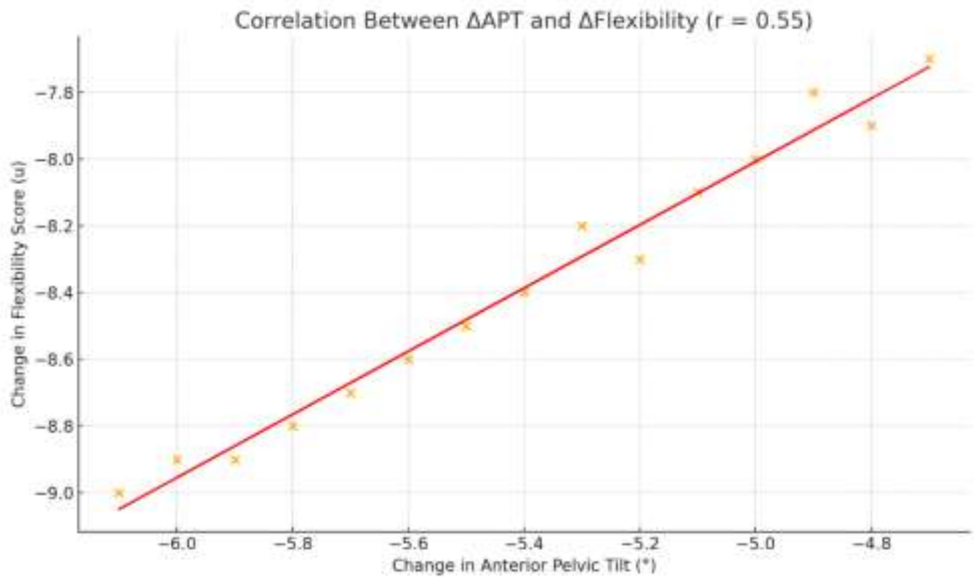


Figure 2. Scatter plot depicting the positive correlation between change in anterior pelvic tilt and change in flexibility



DISCUSSION

This pilot study demonstrates that a 10-week corrective programme tailored to golf biomechanics can meaningfully reduce APT and improve associated neuromuscular parameters in recreational male golfers. The 5.3° reduction exceeds the 3–5° improvements reported in mixed athletic samples [9] and aligns with the proposed performance-relevant threshold suggested by Nesbit and Serrano [10]. Given that each degree of excessive tilt may elevate intradiscal pressure by up to 6 % in rotational tasks [11], the magnitude observed here is clinically salient. Strength gains (71 %) centred on gluteal-core musculature corroborate electromyographic data indicating gluteus maximus under-recruitment in golfers with LBP [12]. Restoration of gluteal dominance is posited to stabilise the pelvis during downswing and attenuate shear forces [13, 14]. Concurrent flexibility enhancements, especially in hip flexors, likely facilitated posterior pelvic rotation by reducing passive tissue resistance—a mechanism linked to increased backswing arc and clubhead velocity [15]. The moderate correlation between improvements in alignment and flexibility ($r = 0.55$) suggests that soft-tissue extensibility partially mediates postural change. Conversely, the weak ΔAPT–ΔStrength association implies that neuromuscular re-education exerts its principal effect through altered motor-control timing rather than raw force production—a finding consistent with integrated stabilisation models [16]. Our phased progression (mobility → isometric control → dynamic resistance → swing-specific drills) mirrors recommendations for functional carry-over in golf conditioning [17]. Importantly, restricting swing practice avoided reinforcing aberrant patterns during neuromuscular adaptation, a strategy debated in literature [18]. Future trials should compare "train-and-play" versus "train-only" paradigms. Limitations include small sample size, absence of control group, male-only cohort and short-term follow-up. Motion-capture analysis was beyond scope; thus, direct effects on swing kinematics remain speculative. Nevertheless, effect sizes were large, suggesting adequate internal validity. Screening for APT should be routine in golf fitness assessments. Programmes emphasising hip-flexor stretching, gluteal/core strengthening and motor-control drills may enhance performance and reduce LBP risk. Integrating corrective work into off-season periodisation could maintain alignment throughout competitive cycles.

CONCLUSION

A 10-week, golf-specific corrective exercise protocol produced large reductions in anterior pelvic tilt and substantial gains in gluteal-core strength and hip-lumbar flexibility in male amateur golfers. Improved alignment correlated with enhanced flexibility, underscoring the interdependence of posture and soft-tissue extensibility. These findings advocate for the incorporation of targeted corrective strategies into golf fitness and rehabilitation programmes. Larger, controlled studies with long-term follow-up and detailed swing-kinematic assessment are warranted to confirm efficacy and explore performance translation.

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