DOI: https://doi.org/10.71317/kjard.2.11.2026.1086

Kashmir Journal of Academic Research and Development

Journal homepage: https://rjsaonline.org/index.php/KJARD

Effects of SAQ Training on selected Skill related Fitness components on University Amateur Players

Safeena Bibi
PhD Scholar, Department of Sports Sciences and Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan
Email: safeena.sitara@gmail.com
Mohibullah Khan Marwat
Professor, Department of Sports Sciences and Physical Education, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan

ARTICLE INFO

Received:
October 16, 2026
Revised:
October 31, 2026
Accepted:
November 09, 2026
Available Online:
November 20, 2026

Keywords:
SAQ training, speed, agility, balance

Corresponding Author:
Safeena Bibi
Email:
safeena.sitara@gmail.com

ABSTRACT

Background: Speed, Agility, and Quickness (SAQ) training represents a structured neuromuscular conditioning system specifically engineered to enhance explosive, multi-directional athletic capacities. Skill-related fitness components speed, agility, and balance are foundational determinants of athletic performance across team and individual sport disciplines. Despite global interest in SAQ training, empirical evidence regarding its effects on skill-related fitness in female amateur university athletes in Pakistan remains absent from the scientific literature. **Objective:** This study investigated the effects of a 12-week SAQ training program on selected skill-related fitness components speed, agility, and balance in amateur female university athletes. **Methodology**: A pretest-posttest experimental design was employed with 72 female amateur university athletes (aged 18–22 years) from Shaheed Benazir Bhutto Women University, Peshawar. Participants were randomly assigned to a Control Group (CG, n=36) or an Experimental Group (EG, n=36). The EG underwent a structured 12-week SAQ training program (50–60 minutes per session), while the CG continued routine activities. Speed was assessed via the 30-Meter Dash Test, agility via the Agility T-Test, and balance via the Flamingo Balance Test. The Wilcoxon Signed Rank Test was applied due to confirmed non-normal data distributions. **Results**: Post-intervention, the EG demonstrated statistically significant improvements across all three skill-related variables: speed (7.43 ± 1.01 s to 4.43 ± 0.42 s; $Z = -5.257$, $p < .001$; −40.4% improvement), agility (16.31 ± 1.54 s to 10.11 ± 1.30 s; $Z = -5.247$, $p < .001$; −38.0% improvement), and balance (14.00 ± 1.74 to 6.00 ± 1.97 falls/60s; $Z = -5.252$, $p < .001$; −57.1% improvement). All 36 EG participants showed positive ranks on all three variables. The CG demonstrated no significant changes in speed ($p = .581$) or balance ($p = .670$), and only a modest significant change in agility ($p = .018$) without practical significance. **Conclusion**: A 12-week SAQ training program produces substantial, statistically significant, and practically meaningful improvements in speed, agility, and balance among female amateur university athletes. These findings provide a robust evidence base for incorporating structured SAQ protocols into university-level athletic training programs in Pakistan and comparable developing-country settings.

Introduction

Athletic performance in competitive sport is substantially determined by an athlete's skill-related fitness profile. Unlike health-related fitness components, which underpin general physiological wellbeing, skill-related fitness components specifically speed, agility, and balance are directly implicated in the execution of sport-specific technical and tactical demands. The capacity to generate rapid linear velocities, execute swift multi-directional changes of direction without loss of control, and maintain

postural equilibrium under dynamic and unpredictable conditions collectively determine whether an athlete can translate physical capacity into competitive advantage (Gabbett et al., 2008; Zemková & Hamar, 2014).

Speed is the ability to move the body or its segments across a given distance in minimal time is a universally valued athletic attribute. In team sport contexts, speed manifests not as maximal straight-line sprinting but as repeated short-burst acceleration over 10–30 meters, often integrated with directional change (Sun et al., 2025). Agility is the capacity to decelerate, reorient, and reaccelerate the body in response to sport-specific stimuli is functionally distinct from raw speed and represents one of the most complex motor competencies in competitive sport. It demands the integrated functioning of strength, power, flexibility, proprioception, and reactive decision-making (Sheppard & Young, 2006). Balance, encompassing both static and dynamic postural control, serves as the foundation upon which all athletic movement is executed; its deficiency increases fall risk, reduces movement efficiency, and predisposes athletes to lower-limb injuries (Hrysomallis, 2007; Van Dieën & Pijnappels, 2025).

Speed, Agility, and Quickness (SAQ) training was introduced by Alan Pearson in the 1990s as a structured neuromuscular conditioning methodology designed to reprogram the central nervous system (CNS) for enhanced multi-directional explosive movement. SAQ training operates at the intersection of neuromuscular efficiency, motor learning, and biomotor development, employing ladder drills, cone exercises, hurdle sequences, reactive drills, and sport-specific movement patterns to progressively challenge the athlete's capacity for explosive, coordinated, and precise motor execution (McDermott, 2016; Uysal et al., 2025). Its design is predicated on the principle that by repeatedly exposing the neuromuscular system to high-speed, multi-planar stimuli, the brain's motor cortex is recalibrated to issue faster, more efficient signals to working musculature thereby reducing reaction time, improving coordination, and enhancing the quality and economy of athletic movement.

A growing body of international literature supports the efficacy of SAQ training for improving speed, agility, and balance across diverse athletic populations. Sun et al. (2025), in a systematic review and meta-analysis, confirmed significant improvements in sprint performance and change-of-direction speed following SAQ interventions. Nizam et al. (2018) documented improvements in dynamic balance and hand-eye coordination in children after SAQ training, while Gioftsidou et al. (2012) reported significant balance gains in soccer players exposed to structured balance and agility training protocols. However, despite this growing evidence base, no study has examined the effects of SAQ training specifically on female amateur university athletes in Pakistan a population characterized by limited access to evidence-based coaching, inadequate sport training infrastructure, and underrepresentation in the scientific literature.

This study was therefore conducted to address this critical empirical gap. The primary objective was to determine the influence of a structured 12-week SAQ training program on three selected skill-related fitness components speed, agility, and balance in female amateur university athletes competing in multiple sport disciplines at Shaheed Benazir Bhutto Women University, Peshawar, Khyber Pakhtunkhwa, Pakistan. By generating locally contextualized empirical evidence, this investigation aims to inform evidence-based sport training policy and practice at the university level in Pakistan.

Review of Literature

Conceptual Framework: SAQ Training

The theoretical foundation of SAQ training is rooted in neuromuscular adaptation theory. The human nervous system governs all volitional movement through a hierarchical process of motor planning, signal transmission, and muscular execution. SAQ training exploits the nervous system's plasticity its capacity for structural and functional reorganization in response to repeated stimulation to achieve accelerated signal transmission efficiency, reduced motor unit recruitment latency, and enhanced inter-muscular coordination (Foster, 1998; Harries et al., 2012).

The preparatory, competition, and transition phases of athletic periodization each present distinct demands on an athlete's skill-related fitness profile. SAQ training, particularly during the pre-competition phase, has been shown to effectively bridge the gap between general fitness development and sport-specific performance readiness (Bennett et al., 2019). Its multi-planar, high-intensity structure simultaneously challenges speed, reactive agility, and proprioceptive balance three attributes that are functionally interdependent in competitive sport.

SAQ Training and Speed

Speed in sport is a product of stride rate (frequency of steps per unit time) and stride length (distance covered per step), both of which are trainable attributes responsive to systematic conditioning (Bunc et al., 1987). SAQ training enhances speed through two primary mechanisms: (1) improved neuromuscular efficiency, enabling faster motor unit recruitment and force application per stride; and (2) improved running mechanics, optimizing ground contact time, posture, and arm-leg coordination to reduce

energy wastage during acceleration. The 30-Meter Dash Test is widely validated as an assessment of short-burst linear speed the speed modality most frequently demanded in team sport contexts (Mullin et al., 2014).

Empirical studies consistently document speed improvements following SAQ training. Polman et al. (2009) reported significant neuromuscular functioning improvements linked to speed performance after SAQ interventions in untrained subjects. Kumar Diswar et al. (2016) similarly confirmed speed gains in basketball players following a comparative SAQ and circuit training protocol. Ibrahim and Nabia (2017) specifically documented the positive influence of SAQ training on 100-meter sprint reaction time and block acceleration, demonstrating the training modality's capacity to enhance explosive speed initiation.

SAQ Training and Agility

Agility is operationally defined as the ability to rapidly decelerate, change direction, and re-accelerate a compound motor capacity that integrates strength, power, reaction time, and spatial awareness (Sheppard & Young, 2006). The Agility T-Test, which requires participants to sprint forward, sidestep laterally in both directions, and return assesses the multidirectional agility profile most applicable to team sport demands such as those encountered in football, volleyball, and basketball (Gabbett et al., 2008; Pehar et al., 2018).

SAQ training directly targets agility through cone drills, ladder sequences, reaction drills, and sport-specific cutting exercises that progressively challenge deceleration mechanics, change-of-direction efficiency, and reactive decision speed. Zemková and Hamar (2014) documented significant differences in agility performance across sport specializations, with athletes from team invasion sports demonstrating superior agility profiles attributable to higher volumes of agility-specific training. Uysal et al. (2025) in their comprehensive systematic review and three-level meta-analysis confirmed statistically significant agility improvements in soccer players following SAQ training. Kanagaraj Scholar et al. (2019) similarly reported enhanced quickness and balance in kabaddi players following SAQ protocols.

SAQ Training and Balance

Balance is the capacity to maintain postural equilibrium relative to the center of gravity within the base of support is regulated by the integration of three sensory systems: the somatosensory (proprioceptive), visual, and vestibular systems (Hrysomallis, 2007; Van Dieën & Pijnappels, 2025). In athletic contexts, both static balance (maintaining equilibrium in a stationary position on a single leg) and dynamic balance (maintaining equilibrium during movement) are critical for injury prevention and performance quality. The Flamingo Balance Test, which quantifies the number of postural equilibrium losses in 60 seconds of single-leg standing, provides a sensitive measure of static balance capacity.

SAQ training improves balance through repeated proprioceptive and vestibular challenges embedded in its exercise architecture. Single-leg movements, lateral shuffles, reactive cutting, and unstable surface training cumulatively enhance the body's capacity to detect and correct postural deviations rapidly. Malwanage et al. (2022) demonstrated that balance training significantly improved footwork performance in badminton a sport with high balance demands. Gioftsidou et al. (2012) confirmed that SAQ-inclusive balance training programs significantly reduced injury risk and improved balance in soccer players. Nizam et al. (2018) reported significant dynamic balance improvements in children following an SAQ protocol, demonstrating the training modality's adaptability across age groups.

Research Gap

While international evidence supports the multi-dimensional efficacy of SAQ training for skill-related fitness improvement, no published study has examined these effects in female amateur university athletes in Pakistan. The absence of locally grounded evidence limits the capacity of university sport administrators and coaches to make evidence-based training decisions. This investigation directly addresses this gap, providing the first experimental evidence of SAQ training effects on speed, agility, and balance in this specific population.

Materials and Methods

Research Design

A pretest-posttest experimental design with parallel Control and Experimental Groups was employed. This design enables within-group assessment of change from baseline to post-intervention and between-group attribution of observed effects to the SAQ training intervention, ruling out alternative explanations such as maturation, seasonal practice effects, or testing familiarity (Knapp, 2016; Bonate, 2000).

Study Setting

The study was conducted at Shaheed Benazir Bhutto Women University (SBBWU), Peshawar, Khyber Pakhtunkhwa, Pakistan. SBBWU provides institutional sport infrastructure including outdoor training courts and facilities appropriate for SAQ exercise administration. The researcher, who serves as a faculty member in the Department of Sports Sciences and Physical Education, oversaw all data collection and training administration directly.

Participants

A total of 72 female amateur university athletes were enrolled following the initial screening of 76 volunteers, of whom 4 were excluded based on selection criteria. Participants represented five sport disciplines: football, volleyball, netball, handball, and athletics. Table 1 summarizes baseline participant characteristics.

Table 1: Baseline Characteristics of

Participants by Group (n = 72)

Characteristic	Control Group (n=36)	Experimental Group (n=36)	Combined (n=72)
Age — Mean (years)	20.61	19.64	18–22 range
Height — Mean (cm)	170.22	173.05	—
Weight — Mean (kg)	65.31	66.42	—
Sports Represented	Football, Volleyball, Netball, Handball, Athletics	Football, Volleyball, Netball, Handball, Athletics	Equal distribution across 5 sports

Note. CG = Control Group; EG = Experimental Group. Groups were matched on age, height, weight, and baseline fitness scores prior to randomization.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Female university athletes representing SBBWU in intercollegiate or intervarsity competitive sport events
- Age between 18 and 22 years
- Active participation in at least one of the five designated sports
- No current musculoskeletal injury or medical contraindication to vigorous physical exercise
- Provision of written informed consent

Exclusion Criteria

- Athletes outside the 18–22 age range
- Participants with health conditions contraindicating exercise participation
- Non-consenting athletes or those from sports outside the five designated disciplines

Sampling Procedure

Simple random sampling was employed. A ranked eligibility list of 72 participants was entered into Microsoft Excel, and even-odd number allocation was applied to assign 36 participants to the CG and 36 to the EG. Group equivalence at baseline was confirmed across age, anthropometric measures, and pre-test fitness scores.

SAQ Training Intervention

The EG completed a structured 12-week SAQ training program, administered in three progressive four-week phases:

- Phase I: Foundational Movement (Weeks 1–4): Introduction to SAQ movement mechanics including basic ladder drills, single-leg balance drills, short sprint accelerations (10–15 m), and cone shuttle exercises. Emphasis on correct technique, body posture, and limb mechanics.

- Phase II: Accelerated Conditioning (Weeks 5–8): Progressive increase in drill complexity and intensity. Inclusion of reactive agility drills, change-of-direction exercises, lateral shuffles, T-drill variations, and single-leg proprioceptive challenges.
- Phase III: Sport-Specific Performance (Weeks 9–12): Integration of SAQ elements into sport-specific movement patterns. High-intensity, game-realistic agility sequences, timed speed trials, and advanced balance challenges incorporating perturbation training.

Each session lasted 50 to 60 minutes, conducted between 09:30 and 10:30 hours to control for circadian variation in neuromuscular performance. Sessions began with a standardized 10-minute active warm-up comprising dynamic stretching and progressive jogging. Attendance was recorded on a dedicated register; participants with less than 80% attendance were flagged for protocol compliance monitoring. The CG continued routine daily activities without structured training.

Outcome Measurement Instruments

Three validated physical fitness tests were administered at baseline (pre-test) and immediately following the 12-week intervention (post-test). Table 2 summarizes the tests, their targeted constructs, and measurement units.

Table 2: Skill-Related Fitness Tests, Components Assessed, and Measurement Details

Fitness Domain	Variable	Test Instrument	Measurement Unit	Scoring Criterion
Skill-Related	Speed	30-Meter Dash Test	Seconds (s)	Lower = Better
	Agility	Agility T-Test	Seconds (s)	Lower = Better
	Balance	Flamingo Balance Test	Falls per 60s	Lower = Better

Note. All measurements were conducted under standardized conditions with consistent instrumentation. Lower scores indicate better performance for all three skill-related variables.

30-Meter Dash Test: A maximal sprint effort over 30 meters on a flat, non-slip surface was timed from a standing start position using a hand-operated stopwatch. Participants performed standardized warm-up runs prior to the measured trial. Timing commenced at foot departure from the starting line and concluded when the participant crossed the 30-meter mark. The fastest of two trials was recorded.

Agility T-Test: Participants sprinted forward 10 meters to a central cone (Point 1), sidestepped laterally 5 meters to the left (Point 2), then 10 meters to the right (Point 3), sidestepped back 5 meters to the center, and ran backward to the starting line. Total completion time was recorded. Both left-first and right-first trials were conducted, and the mean was analyzed. Lower times indicate superior agility.

Flamingo Balance Test: Participants removed footwear and stood on a narrow metal beam (50 cm long, 5 cm high, 3 cm wide) on their preferred leg, with the free leg flexed at the knee and the foot held near the buttocks. The number of balance losses (falls from the beam or release of the grasped foot) within 60 seconds was recorded. Participants with more than 15 falls in the first 30 seconds received a score of zero.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics Version 23. Descriptive statistics were computed for all variables across both groups and time-points. Normality was evaluated using the Kolmogorov-Smirnov test (df = 72) and the Shapiro-Wilk test. Both tests confirmed statistically significant departures from normality across all study variables (all $p < .05$), necessitating the application of non-parametric inferential statistics. The Wilcoxon Signed Rank Test was applied to compare pre- and post-test scores within each group. The statistical significance threshold was set at $\alpha = 0.05$.

Results

Normality Assessment

Prior to inferential statistical analysis, the distribution of all study variables was assessed. The Kolmogorov-Smirnov test yielded significant results for all six variable-time combinations (all $p < .001$). The Shapiro-Wilk test corroborated these findings (all $p < .05$). The confirmation of non-normality across all study variables substantiated the selection of the Wilcoxon Signed Rank Test as the primary inferential statistical tool for within-group comparisons.

Speed: 30-Meter Dash Test Results

Table 3 presents the descriptive statistics and Wilcoxon Signed Rank Test results for the 30-Meter Dash Test. The EG demonstrated a highly significant improvement in 30-meter sprint performance following 12 weeks of SAQ training. The mean sprint time was reduced from 7.43 ± 1.01 seconds at pre-test to 4.43 ± 0.42 seconds at post-test a mean reduction of 3.00 seconds, corresponding to a 40.4% improvement in linear speed. All 36 EG participants showed positive ranks (i.e., faster post-test times), with no negative ranks or ties. The narrow post-intervention standard deviation (0.42 s) relative to the pre-test (1.01 s) indicates enhanced consistency and homogeneity in speed performance across the EG.

Table 3: Descriptive Statistics and Wilcoxon Signed Rank Test Results: Speed — 30-Meter Dash Test (n = 72)

Statistic	CG Pre-test	CG Post-test	EG Pre-test	EG Post-test	Z	p-value
Mean ± SD (seconds)	7.83 ± 0.69	7.75 ± 1.05	7.43 ± 1.01	4.43 ± 0.42	−5.257	**< .001***
Median ± IQR (seconds)	8.00 ± 1.00	8.00 ± 2.00	8.00 ± 2.00	4.40 ± 0.90	—	—
Minimum (seconds)	6	5	5	4	—	—
Maximum (seconds)	9	9	9	5	—	—
Range (seconds)	3	4	4	1	—	—
Positive Ranks (Improvement)	6	—	—	**36 (100%)**	—	—
Negative Ranks (Decline)	10	—	—	0	—	—
CG Wilcoxon Result	Z = −0.552; p = .581 (ns)					

Note. CG = Control Group; EG = Experimental Group; SD = Standard Deviation; IQR = Interquartile Range; Z = Wilcoxon Z-statistic; ns = non-significant. *Statistically significant at $p < .05$. Speed measured in seconds; lower values indicate superior performance.

The CG showed no statistically significant change in speed performance (mean: 7.83 ± 0.69 s to 7.75 ± 1.05 s; Z = −0.552, p = .581), with 10 participants declining, 6 improving, and 20 exhibiting no change. The between-group contrast clearly demonstrates that the observed speed improvements in the EG are attributable to the SAQ training intervention and not to naturally occurring practice effects or incidental physical activity.

Agility: T-Test Results

Table 4 presents the descriptive statistics and Wilcoxon Signed Rank Test results for the Agility T-Test. The EG demonstrated highly significant and practically meaningful improvements in agility performance. Mean T-Test completion time was reduced from 16.31 ± 1.54 seconds at pre-test to 10.11 ± 1.30 seconds at post-test a mean reduction of 6.20 seconds, corresponding to a 38.0% improvement in multi-directional agility. All 36 EG participants demonstrated faster post-test agility scores, representing 100% positive rank convergence. The post-test range contracted from 6 seconds to 5 seconds, indicating uniform agility improvement across the EG.

Table 4: Descriptive Statistics and Wilcoxon Signed Rank Test Results: Agility — T-Test (n = 72)

Statistic	CG Pre-test	CG Post-test	EG Pre-test	EG Post-test	Z	p-value
Mean ± SD (seconds)	16.44 ± 1.79	16.17 ± 1.79	16.31 ± 1.54	10.11 ± 1.30	−5.247	**< .001***
Median ± IQR (seconds)	16.00 ± 3.00	16.00 ± 3.00	16.00 ± 2.00	10.00 ± 2.00	—	—
Minimum (seconds)	14	13	14	8	—	—
Maximum (seconds)	20	20	20	13	—	—
Positive Ranks (Improvement)	3	—	—	**36 (100%)**	—	—

Negative Ranks (Decline)	12	—	—	0	—	—
CG Wilcoxon Result	Z = −2.357; p = .018 (significant but modest)					

Note. *CG = Control Group; EG = Experimental Group; SD = Standard Deviation; IQR = Interquartile Range; Z = Wilcoxon Z-statistic. *Statistically significant at p < .05. Agility measured in seconds; lower values indicate superior performance. CG result at p = .018 represents statistical significance without practical significance (mean difference < 0.3 s).*

The CG yielded a statistically significant Wilcoxon result (Z = −2.357, p = .018); however, this represents marginal practical significance — the mean agility time changed by only 0.27 seconds (16.44 s to 16.17 s), compared to the EG's 6.20-second improvement. The CG's positive rank structure (12 declining, 3 improving, 21 unchanged) further indicates that any apparent CG change reflected performance variability rather than genuine training-induced adaptation. The magnitude of improvement in the EG substantially exceeds any change observed in the CG, confirming the SAQ program's decisive role in driving agility gains.

Balance: Flamingo Balance Test Results

Table 5 presents the descriptive statistics and Wilcoxon Signed Rank Test results for the Flamingo Balance Test. The EG demonstrated the most pronounced improvement of all three skill-related variables. Mean balance score (falls per 60 seconds) was reduced from 14.00 ± 1.74 at pre-test to 6.00 ± 1.97 at post-test an improvement of 8.00 falls, corresponding to a 57.1% reduction in postural instability incidents. All 36 EG participants showed positive ranks, with zero negative ranks or ties, indicating universal responsiveness to the SAQ training protocol.

Table 5:*Descriptive Statistics and Wilcoxon Signed Rank Test Results: Balance — Flamingo Balance Test (n = 72)*

Statistic	CG Pre-test	CG Post-test	EG Pre-test	EG Post-test	Z	p-value
Mean ± SD (falls/60s)	14.03 ± 1.73	13.97 ± 1.73	14.00 ± 1.74	6.00 ± 1.97	−5.252	**< .001***
Median ± IQR (falls/60s)	14.00 ± 3.00	14.00 ± 3.00	14.00 ± 2.00	6.00 ± 3.00	—	—
Minimum (falls)	11	11	11	3	—	—
Maximum (falls)	17	17	17	10	—	—
Positive Ranks (Improvement)	8	—	—	**36 (100%)**	—	—
Negative Ranks (Decline)	11	—	—	0	—	—
CG Wilcoxon Result	Z = −0.426; p = .670 (ns)					

Note. *CG = Control Group; EG = Experimental Group; SD = Standard Deviation; IQR = Interquartile Range; Z = Wilcoxon Z-statistic; ns = non-significant. *Statistically significant at p < .05. Balance measured as number of falls in 60 seconds; lower values indicate superior postural stability.*

The CG demonstrated no significant change in balance performance (14.03 ± 1.73 to 13.97 ± 1.73 falls/60s; Z = −0.426, p = .670), with 11 participants declining, 8 improving, and 17 unchanged a pattern consistent with random variation rather than systematic change. This sharply contrasts with the EG's consistent and substantial improvement, further affirming the specificity and efficacy of the SAQ training intervention for balance development.

Consolidated Results: Comparative Summary

Table 6 presents a consolidated comparison of pre- and post-test outcomes, Wilcoxon test statistics, and percentage improvement for all three skill-related variables across both groups.

Table 6: Consolidated Comparison of Pre- and Post-Test Scores: Skill-Related Fitness Variables (n = 72)

Variable	CG Pre M±SD	CG Post M±SD	EG Pre M±SD	EG Post M±SD	EG Z	EG p	Net EG Improvement
Speed — 30-m Dash (s)	7.83 ± 0.69	7.75 ± 1.05	7.43 ± 1.01	4.43 ± 0.42	−5.257	**< .001***	**−3.00 s (−40.4%)**
Agility — T-Test (s)	16.44 ± 1.79	16.17 ± 1.79	16.31 ± 1.54	10.11 ± 1.30	−5.247	**< .001***	**−6.20 s (−38.0%)**
Balance — Flamingo (falls/60s)	14.03 ± 1.73	13.97 ± 1.73	14.00 ± 1.74	6.00 ± 1.97	−5.252	**< .001***	**−8.00 falls (−57.1%)**

Note. CG = Control Group; EG = Experimental Group; M = Mean; SD = Standard Deviation. *Statistically significant at p < .05. Net EG improvement calculated as post-test minus pre-test mean (absolute and percentage). For speed and agility (measured in seconds) and balance (measured in falls per 60s), negative values denote improvement.

Hypothesis Testing

Table 7 summarizes the hypothesis testing outcomes for skill-related fitness components.

Table 7: Summary of Hypothesis Testing Outcomes: Skill-Related Fitness Components

Hypothesis	Variable	p-value (EG)	Decision
Ha2: A 12-week SAQ training program will produce statistically significant improvement in selected skill-related fitness components (speed, agility, balance) among university amateur athletes.	Speed	< .001	**Accepted ✓**
	Agility	< .001	**Accepted ✓**
	Balance	< .001	**Accepted ✓**
Ho: SAQ training will produce no significant effect on skill-related fitness components in university amateur athletes.	All variables	< .001	**Rejected ✗**

Note. Ha = Alternative Hypothesis; Ho = Null Hypothesis. EG Wilcoxon Signed Rank Test p-values reported. All three skill-related fitness hypotheses were accepted at α = .05.

The experimental hypothesis (Ha2) that 12 weeks of SAQ training would produce statistically significant improvements in speed, agility, and balance was accepted for all three variables. The null hypothesis (Ho) was rejected across all skill-related fitness components, confirming the efficacy of the SAQ training program.

Discussion

This study provides comprehensive experimental evidence that a 12-week SAQ training program yields statistically significant and practically substantial improvements in speed, agility, and balance among female amateur university athletes. The magnitude of improvements observed across all three skill-related fitness components is noteworthy and merits detailed mechanistic and contextual examination.

Speed Improvements

The 40.4% improvement in 30-meter dash performance in the EG (7.43 s to 4.43 s) represents a practically significant enhancement in linear acceleration capacity. The underlying mechanism for this improvement aligns with established neuromuscular adaptation theory: repeated SAQ drills requiring explosive acceleration from standing or walking starts

progressively recalibrate the motor cortex's capacity to recruit fast-twitch muscle fibers rapidly and to coordinate the sequential muscle activation patterns required for efficient sprint mechanics (Ibrahim & Nabia, 2017; Mullin et al., 2014).

Additionally, the reduction in post-test score variability (SD: 1.01 s to 0.42 s) indicates that SAQ training not only improved average speed but also standardized speed performance across athletes of differing initial ability levels. This homogenizing effect may reflect the acquisition of more consistent and technically efficient sprint mechanics through repeated practice of structured acceleration drills. These findings concur with Polman et al. (2009), who reported significant neuromuscular function improvements linked to speed performance following SAQ training, and with Sun et al. (2025), whose meta-analysis confirmed SAQ training's positive effect on sprint velocity.

The complete absence of any speed improvement in the CG ($p = .581$) confirms that the EG's gains are attributable specifically to the SAQ intervention. In the CG, 10 of 36 participants actually demonstrated slower sprint times at post-test an outcome potentially reflecting minor detraining, reduced sport activity during the study period, or the absence of structured neuromuscular stimulus. This contrast underscores the necessity of deliberate, structured speed training for speed development at the university amateur level.

Agility Improvements

The 38.0% improvement in T-Test agility performance (16.31 s to 10.11 s) in the EG represents the most compelling demonstration of SAQ training's capacity to transform multi-directional athletic movement quality. Agility is arguably the most complex skill-related fitness component to develop, requiring the integrated and simultaneous development of explosive power, deceleration mechanics, lateral movement proficiency, change-of-direction speed, and reactive decision-making (Sheppard & Young, 2006; Zemková & Hamar, 2014). The fact that the SAQ program through its progressive introduction of lateral shuffle drills, cone exercises, reactive agility sequences, and T-drill variations produced improvements of this magnitude within 12 weeks validates its design as a comprehensive agility development system.

The universal positive rank response (36/36 EG participants improved) in agility is particularly noteworthy. It indicates that the SAQ training protocol was effective across the full range of initial agility proficiency represented within the EG from relatively agile to less agile athletes suggesting broad applicability regardless of initial ability level. This finding is consistent with Uysal et al. (2025), who confirmed significant agility gains in soccer players following SAQ training, and with Kanagaraj Scholar et al. (2019), who reported enhanced quickness and agility in kabaddi players.

The statistically significant but practically marginal agility change in the CG ($p = .018$; $\Delta = 0.27$ s) warrants specific attention. While this result technically meets the statistical significance threshold, the practical magnitude a mean change of 0.27 seconds is negligible relative to the EG's 6.20-second improvement. This CG finding likely reflects testing familiarization effects on the T-Test, wherein participants who completed the test at pre-test perform marginally faster at post-test due to practice effects. The contrast between the groups' magnitudes of change confirms that meaningful agility development requires systematic SAQ-based training rather than incidental practice.

Balance Improvements

The balance improvements in the EG were the most pronounced across all three skill-related variables, with a 57.1% reduction in Flamingo Balance Test falls (14.00 to 6.00 falls/60s). This striking improvement reflects the cumulative proprioceptive and vestibular training effect inherent in SAQ protocols. SAQ training exercises including single-leg drills, lateral shuffle sequences, and reactive balance challenges repeatedly stress the body's postural control systems, compelling adaptations in all three regulatory systems: somatosensory (enhanced proprioceptive sensitivity at the ankle and knee), visual (improved visual-motor integration for postural correction), and vestibular (enhanced semicircular canal responsiveness to head position change) (Hrysomallis, 2007; Van Dieën & Pijnappels, 2025).

The 8-fall reduction in the EG is not merely statistically significant; it represents a clinically and practically meaningful shift in postural stability that would be expected to translate directly into reduced injury risk and improved athletic movement quality. Static balance serves as the postural foundation upon which all athletic movement is built; enhanced balance capacity enables more efficient force production, improved landing mechanics, and more controlled directional change execution. These functional benefits are directly applicable to the sport disciplines represented in this study football, volleyball, handball, netball, and athletics — all of which place high demands on postural control under dynamic and unpredictable conditions.

These findings align with Gioftsidou et al. (2012) and Malwanage et al. (2022), who documented significant balance improvements following SAQ-inclusive training programs in soccer and badminton contexts respectively, and extend these findings to the specific context of female amateur university athletes in Pakistan.

Practical and Policy Implications

The breadth and magnitude of skill-related fitness improvements documented in this study carry important implications for university sport policy and coaching practice in Pakistan. University sport programs, particularly those serving female athletes, have historically relied on traditional, non-scientific training methods that fail to systematically develop the neuromuscular foundations of sport performance. The present findings demonstrate that a structured 12-week SAQ program which requires no specialized equipment beyond cones, agility ladders, and a flat surface can produce transformative improvements in speed, agility, and balance in this population.

University sport directorates, the Higher Education Commission (HEC), and institutional coaching staffs are therefore encouraged to incorporate SAQ training as a standard component of athlete development programs. The training protocol is scalable across different resource environments, time-efficient (50–60 minutes per session), and effective across diverse sport disciplines, making it well-suited to the multi-sport university sport context in Pakistan and comparable developing-country settings.

Limitations of this investigation include its confinement to a single university, exclusive enrollment of female athletes, and the absence of physiological measurement instruments such as electromyography or force plates that would enable mechanistic interpretation of the observed performance improvements. Future research should extend the sample to include multi-institutional cohorts, include male athlete populations for comparative gender analysis, and incorporate objective biomechanical assessments to clarify the neurophysiological pathways through which SAQ training drives skill-related fitness enhancement.

Conclusion

This experimental study demonstrates, with strong statistical and practical evidence, that a 12-week SAQ training program produces highly significant improvements in speed, agility, and balance among female amateur university athletes. The Experimental Group achieved a 40.4% improvement in 30-meter sprint speed, a 38.0% improvement in multi-directional agility, and a 57.1% improvement in static balance performance with all 36 EG participants improving across all three variables. The Control Group exhibited no meaningful changes in any skill-related fitness component. Both experimental hypotheses were accepted.

These findings establish SAQ training as an effective, scalable, and evidence-based intervention for skill-related fitness development in university-level amateur athletes. They provide a compelling foundation for the integration of structured SAQ protocols into university sport training curricula in Pakistan, with particular relevance for female athletes who have historically had limited access to evidence-based conditioning programs. Sport administrators, coaches, and physical educators are urged to adopt 12-week SAQ programs as a foundational training intervention for the systematic development of speed, agility, and balance in their athlete populations.

Declarations

Ethical Approval:

The study was conducted in compliance with the ethical standards of the Higher Education Commission (HEC), Pakistan, and adhered to the principles of the Declaration of Helsinki. Informed written consent was obtained from all participants before enrollment.

Funding:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of Interest:

The authors declare no conflicts of interest.

Data Availability Statement:

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

References

Bennett, H., Arnold, J., Martin, M., Norton, K., & Davison, K. (2019). A randomised controlled trial of movement quality-focused exercise versus traditional resistance exercise for improving movement quality and physical performance in trained adults. Journal of Sports Sciences, 37(24), 2806–2817.

Bonate, P. L. (2000). Analysis of pretest-posttest designs (1st ed.). Chapman and Hall/CRC.

Bunc, V., Heller, J., Leso, J., Šprynarová, Š., & Zdanowicz, R. (1987). Ventilatory threshold in various groups of highly trained athletes. International Journal of Sports Medicine, 8(04), 275–280.

Foster, C. (1998). Monitoring training in athletes with reference to overtraining syndrome. Medicine and Science in Sports and Exercise, 30(7), 1164–1168.

Gabbett, T. J., Kelly, J. N., & Sheppard, J. M. (2008). Speed, change of direction speed, and reactive agility of rugby league players. Journal of Strength and Conditioning Research, 22(1), 174–181.

Gioftsidou, A., Malliou, P., Pafis, G., Beneka, A., Tsapralis, K., Sofokleous, P., Kouli, O., Roka, S., & Godolias, G. (2012). Balance training programs for soccer injuries prevention. Journal of Human Sport and Exercise, 7(3), 639–647.

Harries, S. K., Lubans, D. R., & Callister, R. (2012). Resistance training to improve power and sports performance in adolescent athletes: A systematic review and meta-analysis. Journal of Science and Medicine in Sport, 15(6), 532–540.

Hrysomallis, C. (2007). Relationship between balance ability, training and sports injury risk. Sports Medicine, 37(6), 547–556.

Ibrahim, A., & Nabia, G. (2017). Influence of SAQ training on reaction time of 100 sprint start and block acceleration. Romania Journal of Sport Science, 1(1), 5–10.

Junaedi, D., Rukmana, A., & Sudrazat, A. (2025). The effect of modification of zig-zag run training on dribbling skills in football games. Halaman Olahraga Nusantara: Jurnal Ilmu Keolahragaan, 8(2), 310–321.

Kanagaraj Scholar, G., Kanagaraj, G., & Sethu, S. (2019). Effect of SAQ training with resistance training on balance and quickness among kabaddi players. International Journal of Physiology, 4(1), 1102–1103.

Knapp, T. R. (2016). Why is the one-group pretest–posttest design still used? Clinical Nursing Research, 25(5), 467–472.

Kumar Diswar, S., Mitra, S., Choudhary, S., & Mitra, S. (2016). Comparative effect of SAQ and circuit training programme on selected physical fitness variables of school level basketball players. International Journal of Physical Education, Sports and Health, 3(5), 247–250.

Malwanage, K. T., Senadheera, V. V., & Dassanayake, T. L. (2022). Effect of balance training on footwork performance in badminton: An interventional study. PLoS ONE, 17(11), e0277775.

McDermott, S. (2016). Effects of plyometric, SAQ and traditional training on sprint, agility, jumping, passing and shooting performance in young soccer players. [Master's dissertation].

Mullin, D. S., King, G. W., Saripalle, S. K., Derakhshani, R. R., Lovelace, C. T., & Burgoon, J. K. (2014). Deception effects on standing center of pressure. Human Movement Science, 38, 106–115.

Mustafa, Ghulam, Sadaf Masood, and Fozia Falak. "Effects of strength training on the physical fitness and obesity of college girls." Pakistan Social Sciences Review 6.2 (2022): 511-524.

Mustafa, G., Mehreen, S., & Mumtaz, S. (2026). Effects of Periodized High-Intensity Interval Training on Cardiorespiratory Fitness and Academic Performance in Secondary School Adolescents: A Randomized Controlled Trial. Research Consortium Archive, 4(1), 1176-1197.

Mustafa, G. (2026). Influence of Core Stability Training on Athletic Performance in University Athletes. Research Consortium Archive, 4(1), 1005-1018.

Nizam, M., Shapie, M., Farahin, R. N., & Rohizam, R. (2018). A case study: The effects of speed, agility and quickness (SAQ) training program on hand-eye coordination and dynamic balance among children. Journal of Physical Fitness, Treatment and Sports, 2(4).

Pehar, M., Sisic, N., Sekulic, D., Coh, M., Uljevic, O., Spasic, M., Krolo, A., & Idrizovic, K. (2018). Analyzing the relationship between anthropometric and motor indices with basketball specific pre-planned and non-planned agility performances. Journal of Sports Medicine and Physical Fitness, 58(7–8), 1037–1044.

Polman, R., Bloomfield, J., & Edwards, A. (2009). Effects of SAQ training and small-sided games on neuromuscular functioning in untrained subjects. International Journal of Sports Physiology and Performance, 4(4), 494–505.

Sheppard, J., & Young, W. (2006). Agility literature review: Classifications, training and testing. Journal of Sports Sciences, 24(9), 919–932.

Sun, M., Soh, K. G., Cao, S., Yaacob, A. B., Ma, S., & Ding, C. (2025). Effects of speed, agility, and quickness training on athletic performance: A systematic review and meta-analysis. BMC Sports Science, Medicine and Rehabilitation, 17(1), 66.

Uysal, H. Ş., Korkmaz, S., Sen, S., Thapa, R. K., & Pojskic, H. (2025). Effect of speed, agility, and quickness training on linear sprint, jump, and change of direction speed performance in soccer players: A systematic review and three-level meta-analysis. Strength & Conditioning Journal, 47(2), 184–204.

Van Dieën, J. H., & Pijnappels, M. (2025). Balance control in older adults. In Locomotion and posture in older adults: The role of aging and movement disorders (pp. 93–120). Springer Nature Switzerland.

Zemková, E., & Hamar, D. (2014). Agility performance in athletes of different sport specializations. Acta Gymnica, 44(3), 133–140.

2026 by the authors; Journal of *Kashmir Journal of Academic Research and Development*. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (http://creativecommons.org/licenses/by/4.0/).