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Match Activity Analysis in U15-U17 Elite Iranian Soccer Players

Seyd Ali Hosseini [1], Kia Ranjbar [1], Sadegh Amani Shalamzari [1,*]

[1] Department of Exercise Physiology, Faculty of Physical Education and Sports Science, Kharazmi University, Tehran, Iran

[*] ***Corresponding Author:*** Department of Exercise Physiology, Faculty of Physical Education and Sports Science, Kharazmi University, Tehran, Iran. Email: amani_sadegh@khu.ac.ir

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Abstract

Background: Understanding age-related differences in match demands is crucial for player development in youth soccer. Although physical and physiological improvements with age are well documented, how these changes translate into match behavior, particularly in terms of running performance and acceleration-deceleration actions, remains unclear.

Objectives: This study aimed to compare the physical match demands of elite U15 and U17 players, with a particular focus on speed-zone running metrics and acceleration–deceleration profiles.

Methods: Sixty-two highly trained male youth soccer players (U15: n = 30; U17: n = 32) were included in the study. Match activity was monitored using 10-Hz GPS units across 12 official full-length matches (six per age group). When players participated in more than one match, data from the match in which each player recorded the greatest distance were selected for analysis. To ensure data reliability, only players who completed the full 90 minutes were included, resulting in 62 match observations. Match metrics included total distance, distance covered within standardized speed zones, and the frequency of accelerations and decelerations across four intensity categories. All variables were normalized to meters per minute to account for differences in playing time. For group comparisons, independent t-tests were conducted, and Cohen's d was calculated to estimate effect sizes.

Results: U15 players covered significantly greater total distance (9742.4 ± 1269.6 m vs. 8434.5 ± 775.2 m; $P < 0.001$) and distance per minute (103.64 ± 13.51 vs. 89.73 ± 8.25 $m \cdot min^{-1}$; $P < 0.001$), primarily due to higher volumes of low-intensity running (jogging). In contrast, U17 players demonstrated a superior capacity for high-intensity mechanical actions, performing significantly more high-intensity accelerations ($\geq 3\ m \cdot s^{-2}$; $P = 0.001$) and high-intensity decelerations ($\leq -3\ m \cdot s^{-2}$; $P < 0.001$). No significant differences were observed between groups in high-speed running or sprinting distances.

Conclusions: Age-related progression in elite youth soccer is characterized not by an increase in running volume but by a qualitative shift toward more explosive and tactically meaningful actions. Older players exhibit greater high-intensity acceleration and deceleration capacity, whereas younger players rely more on continuous low-intensity running. These findings underscore the importance of integrating neuromuscular development and tactical education into age-specific training programs to prepare players for the evolving demands of competition.

Keywords: Match Analysis, GPS, Youth Soccer, Acceleration, Deceleration, Running Performance

1. Background

Physical and physiological capacities are key determinants of success in soccer and closely interact with technical, tactical, and psychological factors (1). At youth levels, professional clubs and academies aim not only to identify talented players with the potential to progress to elite status but also to design age-appropriate training programs that reflect the specific demands of match play (2). Therefore, a detailed understanding of match activity profiles across different age categories is essential for optimizing player development, monitoring training load, and reducing injury risk.

Match activity analysis has been widely used in recent decades to quantify players' work rate and physical exertion during competition across various sports (3, 4). Among the available technologies, global

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positioning systems (GPS) have become practical and reliable tools for assessing external load in soccer (5). GPS-based time-motion analysis typically provides data on total distance covered and distances accumulated within discrete speed zones (e.g., walking, jogging, running, high-intensity running, and sprinting) (6). Among these, high-intensity running and sprinting are particularly critical, as decisive moments in matches, such as creating goal-scoring opportunities or recovering defensively, often depend on these actions. Indeed, elite players have been shown to perform up to 28% more high-intensity running than their trained counterparts, highlighting high-intensity actions as a key discriminating factor between performance levels (7). While several studies have reported that total distance covered tends to stabilize from approximately 14 years of age onward, particularly when relativized to effective playing time (8-14), many investigations have demonstrated that high-intensity running and sprinting continue to increase with age, even after adjusting for minutes played (10-15). This pattern reflects a broader trend in modern soccer, in which the overall volume of running remains relatively stable, whereas the number of high-intensity efforts has progressively increased in both youth and senior competition (16).

More recently, the analysis of accelerations and decelerations has been emphasized as an important complement to distance- and speed-based metrics for characterizing external load (17). Although most match activities occur at low speeds within walking and jogging zones, these periods often include brief bursts of rapid accelerations and decelerations that impose substantial mechanical and neuromuscular demands. Acceleration and deceleration require greater force development and increased muscle activation than steady-speed running, with deceleration in particular being associated with elevated eccentric loading and muscle damage (18, 19). Consequently, quantifying both the frequency and intensity of accelerations and decelerations provides deeper insight into the physical demands placed on athletes, alongside traditional measures such as total distance and high-intensity running. Despite their importance, acceleration–deceleration demands have been less extensively investigated in youth players than in adults; however, the past decade has seen a growing body of research in this area (12, 15, 20-22). Furthermore, developmental changes related to growth and biological maturation may influence the ability of youth players in different age categories (e.g., U15 vs. U17) to tolerate and produce high-intensity actions, underscoring the need for age-specific match analysis.

Currently, there is a lack of research examining the in-game physical performance profiles of elite Iranian adolescent soccer players competing in the U15 and U17 categories. Most existing studies in this area have been conducted in European (9, 11-13) and South American (14, 23) contexts, with data from Asian populations remaining relatively scarce. Additionally, many previous studies have analyzed matches of varying durations between age groups or have assessed less than the full 90 minutes of play, which may limit the comparability of results across categories. Only a few investigations have evaluated physical performance over the entire 90-minute match, although a standardized match duration provides a more accurate basis for comparing age-related differences.

2. Objectives

The present study was designed to analyze and compare the match physical performance of elite Iranian soccer players in the U15 and U17 age groups using GPS-based time-motion analysis during full 90-minute matches. Based on previous evidence, we hypothesized that U17 players would cover similar total distances but greater high-intensity running and sprinting distances than U15 players and would perform a higher frequency of accelerations and decelerations, reflecting increased physical and mechanical demands with advancing age.

3. Methods

3.1. Study Design

A cross-sectional comparative design was used to examine age-related differences in match-running performance among elite youth soccer players. Data were collected during the 2024 - 2025 competitive season from two U15 teams and two U17 teams, with six official full-length matches analyzed for each age category. Only outfield players who completed the full 90 minutes were included to ensure reliable workload assessment; substituted or partially participating players were excluded. The teams competed in the Tehran Premier League, the highest tier of youth soccer in Iran. In addition, the teams finished the season among the top three in their respective age categories, confirming the inclusion of elite, high-performing athletes. After applying these criteria, activity data from 30 U15 players and 32 U17 players were retained for analysis. The analytical unit was the individual player, with each participant contributing a single independent match observation to the final dataset. GPS-derived locomotor variables, including distance covered across speed zones and the frequency of accelerations and decelerations, served as dependent variables, whereas age category served as the independent grouping factor.

3.2. Participants

Data were collected from 62 highly trained male youth soccer players across four teams (two U15 teams and two U17 teams), representing two chronological age categories. The U15 group consisted of 30 outfield players (age: 14.5 ± 0.5 years; height: 174.1 ± 5.0 cm; weight: 62.0 ± 8.1 kg), whereas the U17 group included 32 outfield players (age: 16.3 ± 0.5 years; height: 177.0 ± 6.5 cm; weight: 69.0 ± 6.5 kg). Only outfield players were included because goalkeepers exhibit distinct movement profiles that are not comparable to those of field players. To ensure reliable match-load assessment, players were eligible for analysis only if they completed the full 90 minutes of match play; those who were substituted or injured were excluded. For players who competed in more than one match, only data from the match in which they recorded the greatest distance covered, as an indicator of best performance, were selected for analysis. Accordingly, the final dataset consisted of 62 independent player-level observations (U15: n = 30; U17: n = 32). All participants were members of the same professional youth academies and followed similar weekly training schedules. Before data collection, all players and their legal guardians received detailed information regarding the study procedures, and written informed consent was obtained. The club provided anonymized GPS data to ensure confidentiality. The study complied with the ethical principles outlined in the National Health Council Resolution for human research and received approval from the Research Ethics Committee of Kharazmi University, Iran (Protocol No. 4.983.415).

3.3. Methodology

Match activity data were collected from six official U15 matches and six official U17 matches played during the 2024 - 2025 competitive season. To ensure data reliability, the analysis included only outfield players who completed the full 90 minutes of each match. Players substituted during the game were excluded from the analysis. All matches were played on regulation-sized pitches (105 × 68 m) with 11 players per side on artificial turf, following the standard format of two 45-minute halves with a 15-minute halftime interval. All players followed a comparable weekly training schedule consisting of five football-specific sessions and one strength training session.

External load variables were collected using 10-Hz GPS units (Polar Team Pro, Polar Electro Oy, Finland) equipped with 200-Hz triaxial accelerometers. These devices have been shown to provide valid and reliable measurements for youth match analysis in previous studies. Each player wore the GPS unit in a tight-fitting vest positioned between the scapulae, and the same device was consistently assigned to each player throughout the study to minimize interdevice variability. All units were activated 30 minutes before kick-off to ensure optimal satellite lock and signal stabilization. Data were downloaded and processed using Polar Team Pro software, with warm-up and halftime periods excluded; only live match data were retained.

GPS-derived variables included total distance and distance covered within predefined speed zones, based on classifications widely used in youth soccer research (12, 24): walking (< 7.2 $km \cdot h^{-1}$), jogging (7.2 - 14.3 $km \cdot h^{-1}$), running (14.4 - 19.7 $km \cdot h^{-1}$), high-speed running (19.8 - 25.1 $km \cdot h^{-1}$), and sprinting (> 25.2 $km \cdot h^{-1}$). Acceleration and deceleration demands were quantified across four intensity bands: accelerations, Zone 1 (0.50 - 0.99 $m \cdot s^{-2}$), Zone 2 (1.00 - 1.99 $m \cdot s^{-2}$), Zone 3 (2.00 - 2.99 $m \cdot s^{-2}$), and Zone 4 (≥ 3.00 $m \cdot s^{-2}$); decelerations, Zone 1 (−0.99 to −0.50 $m \cdot s^{-2}$), Zone 2 (−1.99 to −1.00 $m \cdot s^{-2}$), Zone 3 (−2.99 to −2.00 $m \cdot s^{-2}$), and Zone 4 (≤ −3.00 $m \cdot s^{-2}$). All GPS metrics were expressed in relative terms (per minute) to allow direct comparison between players and across matches with varying individual playing times.

3.4. Statistical Analysis

All statistical analyses were conducted using SPSS (version 28; IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to assess data distribution, and Levene's test was used to evaluate the equality of variances. Independent-samples t-tests were performed to analyze the data. All statistical tests were two-tailed, with a significance level set at $P < 0.05$. Effect sizes (Cohen's d) and 95% confidence intervals were also reported. Standard thresholds were applied to interpret Cohen's d: 0.2 (small), 0.5 (moderate), and 0.8 (large). Given the exploratory nature of this study and to minimize the risk of Type II errors (i.e., failing to detect true differences), no adjustments for multiple comparisons were made. Consequently, the findings should be interpreted cautiously, and significant results with p-values between 0.01 and 0.05 should be considered exploratory rather than confirmatory. All match-running variables (distance in speed zones and acceleration-deceleration counts) are presented as mean ± standard deviation, with relative values (per minute) used to standardize comparisons across players and matches.

4. Results

The Shapiro-Wilk test confirmed that the data were normally distributed across all variables; therefore, a parametric independent *t*-test was used to compare the two groups. Table 1 presents the running activity profiles of the two age groups, U15 and U17, along with confidence intervals and independent t-test results. Based on the independent t-test results, U15 players demonstrated a significantly greater overall match running distance than U17 players ($t = -4.351$, $P < 0.001$, $d = -1.23$), with a large effect size. This difference remained consistent when the data were expressed relative to playing time, with U15 players also showing higher distance-per-minute values ($t = -4.351$, $P < 0.001$, $d = -1.23$). Analysis of locomotor demands across individual speed zones indicated that the between-group difference was driven exclusively by Zone 2 (jogging), in which U15 players covered substantially greater distances ($t = -4.671$, $P < 0.001$, $d = -1.34$). No significant differences were observed in very low-intensity activity (Zone 1), moderate running (Zone 3), high-speed running (Zone 4), or sprinting (Zone 5) (all $p > 0.05$). Consequently, the composite high-speed running (HSR) metric, calculated as the sum of Zones 3 - 4, also did not differ between groups ($t = -1.426$, $P = 0.161$, $d = -0.41$). These findings suggest that, although U15 players performed greater overall and low-intensity movement, both age groups exhibited comparable high-speed running profiles during competitive match play.

4.1. Acceleration and Deceleration Profiles

A clear intensity-dependent pattern emerged in both acceleration and deceleration demands. As shown in Table 2, U15 players performed significantly more low-intensity accelerative actions, including very low-intensity ($t = -3.245$, $P = 0.002$, $d = -0.93$) and low-intensity accelerations ($t = -2.793$, $P = 0.008$, $d = -0.80$), resulting in a greater total number of accelerations overall ($t = -2.562$, $P = 0.014$, $d = -0.73$). In contrast, U17 players demonstrated a distinct specialization in high-intensity movement patterns, completing significantly more severe accelerations ($t = 3.713$, $P = 0.001$, $d = 1.06$). No significant between-group differences were found for moderate-intensity accelerations ($P > 0.05$).

A similar intensity-dependent distribution was observed for decelerations (Table 2). U15 players executed significantly more very low-intensity ($t = -3.077$, $P = 0.003$, $d = -0.88$) and low-intensity decelerations ($t = -2.569$, $P = 0.013$, $d = -0.74$), resulting in a higher total number of decelerative actions ($t = -2.280$, $P = 0.027$, $d = -0.65$). Conversely, U17 players performed significantly more high-intensity decelerations ($t = 4.027$, $P < 0.001$, $d = 1.15$), whereas moderate-intensity decelerations did not differ significantly between groups ($P > 0.05$).

5. Discussion

The present study aimed to compare match-related physical performance between elite U15 and U17 soccer players using GPS-derived metrics. The main findings showed that U15 players covered significantly greater total distances and outperformed their older counterparts in the jogging speed zone (7.2 - 14.3 $km \cdot h^{-1}$), whereas no meaningful differences were observed in higher-speed running categories. Conversely, U17 players performed substantially more high-intensity accelerations ($\geq 3\ m \cdot s^{-2}$) and decelerations ($\leq -3\ m \cdot s^{-2}$), whereas U15 players executed a greater number of very low- and low-intensity acceleration-deceleration actions; moderate-intensity efforts did not differ between groups. Collectively, these results indicate that the initial hypothesis was only partially supported: although U17 players were expected to demonstrate superior high-speed running outputs, age-related distinctions were expressed primarily through acceleration-deceleration profiles rather than linear running velocities. This pattern may suggest that neuromuscular maturation and more complex tactical engagement in older players play a greater role in shaping match demands than distance-based running metrics alone.

Previous research has consistently shown that chronological age correlates with improvements in both physiological and physical capacities (8, 25). However, in youth soccer, match running performance is influenced by factors beyond fitness alone. Buchheit et al. showed that although older players exhibit superior physical test results, age-related differences in match running output disappear when distances are normalized for playing time (8). Their findings emphasize that tactical maturity, game intelligence, and ball-possession proficiency, rather than physical capacity, primarily govern locomotor activity during

Table 1. Comparison of Match Running Performance Between U15 (N = 30) and U17 (N = 32) Elite Iranian Soccer Players [a]

Variables	U15	U17	P-Value	Mean diff [95% CI]	Cohen's d [95% CI]
Total distance (m)	9742.4 ± 1269.6	8434.5 ± 775.2	< 0.001	−1307.6 [−1912, −703]	−1.23 [−1.83, −0.61]
Distance/minute (m/min)	103.64 ± 13.51	89.73 ± 8.25	< 0.001	−13.9 [−20.3, −7.5]	−1.23 [−1.83, −0.61]
Walking (m)	3782 ± 323.3	3858.2 ± 378.7	0.457	75.3 [−126.7, 277.4]	0.21 [−0.34, 0.77]
Jogging (m)	4123.4 ± 868.6	3143.2 ± 561	< 0.001	−980.2 [−1402.4, −558.0]	−1.3 [−1.95, −0.70]
Running (m)	1086.3 ± 443.4	938.2 ± 255.1	0.161	−148.2 [−357.3, 60.9]	−0.4 [−0.97, 0.16]
HIR (m)	371.3 ± 197.4	402.1 ± 182.1	0.574	30.7 [−78.5, 140.0]	0.16 [−0.4, 0.72]
Sprint (m)	81.7 ± 92.3	100.6 ± 73.4	0.432	18.9 [−9.1, 67.0]	0.22 [−0.33, 0.78]
HSR/minute (m/min)	16.19 ± 6.61	14.89 ± 4.61	0.429	−1.31 [−4.59, 1.98]	−0.23 [−0.78, 0.33]

[a] Values are expressed as mean ± SD unless otherwise indicated. Speed zones: walking (< 7.2 $km \cdot h^{-1}$), jogging (7.2 - 14.3 $km \cdot h^{-1}$), running (14.4 - 19.7 $km \cdot h^{-1}$), high-speed running (19.8 - 25.1 $km \cdot h^{-1}$), and sprinting (> 25.2 $km \cdot h^{-1}$). Acceleration intensities: very low (0.50 - 0.99 $m \cdot s^{-2}$), low (1.00 - 1.99 $m \cdot s^{-2}$), moderate (2.00 - 2.99 $m \cdot s^{-2}$), and high (≥ 3.00 $m \cdot s^{-2}$). Deceleration intensities: very low (−0.99 to −0.50 $m \cdot s^{-2}$), low (−1.99 to −1.00 $m \cdot s^{-2}$), moderate (−2.99 to −2.00 $m \cdot s^{-2}$), and high (≤−3.00 $m \cdot s^{-2}$). Significant differences were defined as P < 0.05. Abbreviations: HSR, High-speed running (sum of running and high-intensity running distances [Zones 3 + 4]); M, meters; n, numbers.

Table 2. Comparison of Acceleration and Deceleration Profiles Across Intensity Zones During Match Play in U15 (N = 30) and U17 (N = 32) Elite Iranian Soccer Players [a]

Variables	U15	U17	P-Value	Mean diff [95% CI]	Cohen's d [95% CI]
Very low acceleration (n)	329.4 ± 108.5	226.9 ± 112.5	0.002	−102.3 [−168.4, −32.9]	−0.93 [−1.51, −0.33]
Low acceleration (n)	212.6 ± 67.2	161.9 ± 59.5	0.008	−50.7 [−87.3, −14.2]	−0.79 [−1.37, −0.21]
Moderate acceleration (n)	62.6 ± 19.4	64.1 ± 16.7	0.770	1.5 [−8.9, 11.9]	0.08 [−0.47, 0.64]
High acceleration (n)	13.1 ± 7.9	32.4 ± 24.6	0.001	19.2 [8.84, 29.7]	1.06 [0.45, 1.65]
Very low deceleration (n)	334.5 ± 107.6	235.3 ± 117.9	0.003	−99.1 [−164, −34]	−0.87 [−1.46, −0.28]
Low deceleration (n)	246.4 ± 70.9	169.7 ± 54.9	0.013	−46.6 [−83, −10]	−0.73 [−1.31, −0.15]
Moderate deceleration (n)	63.8 ± 19.5	64.2 ± 17	0.926	0.49 [−10.05, 11.04]	0.02 [−0.53, 0.58]
High deceleration (n)	22.9 ± 10.1	39.9 ± 18.3	< 0.001	16.9 [8.4, 25.4]	1.15 [0.53, 1.75]

[a] Values are expressed as mean ± SD unless otherwise indicated. Acceleration zones were defined as follows: very low (0.50 - 0.99 $m \cdot s^{-2}$), low (1.00 - 1.99 $m \cdot s^{-2}$), moderate (2.00 - 2.99 $m \cdot s^{-2}$), and high (≥ 3.00 $m \cdot s^{-2}$). Deceleration zones were classified as follows: very low (−0.99 to −0.50 $m \cdot s^{-2}$), low (−1.99 to −1.00 $m \cdot s^{-2}$), moderate (−2.99 to −2.00 $m \cdot s^{-2}$), and high (≤ −3.00 $m \cdot s^{-2}$). P < 0.05 Indicates a statistically significant between-group difference.

competition. Consistent with this framework, the greater total distance covered by U15 players in the present study should not be interpreted as superior performance. Instead, it may reflect lower tactical-technical efficiency, possibly resulting in more unnecessary movement, particularly at low-intensity jogging speeds. This interpretation is further supported by contextual information: the U17 teams won all six matches analyzed, whereas each U15 team lost one game, and match outcome is known to influence running outputs (26). Therefore, the observed pattern aligns with the notion that younger players may compensate for limited tactical cohesion and decision-making by engaging in greater volumes of low-intensity movement.

In contrast, age-related differences were more pronounced in high-intensity indicators. Although the absolute distances covered during high-speed running and sprinting did not differ significantly between groups, U17 players allocated a larger proportion of their total running distance to these efforts (HSR: 4.77% vs. 3.81%; sprinting: 1.19% vs. 0.84%), increasing the overall high-speed running share from 4.65% in U15 to 5.96% in U17. Moreover, U17 players performed substantially more high-intensity accelerations and decelerations, actions strongly associated with decisive match moments and neuromuscular capacity (17). Conversely, U15 players exhibited more very low- and low-intensity accelerations and decelerations. Thus, acceleration-deceleration demands appear to differentiate match performance across adolescent age categories more sensitively than distance-based variables.

As reported above, the U15 and U17 groups differed in total jogging distance and high-intensity acceleration-deceleration actions. This pattern of age-related differences in acceleration-deceleration profiles aligns with previous research indicating that biological maturation is less associated with simple increases in total running distance and more with qualitative changes in match demands, such as a higher proportion of high-intensity actions and more efficient low-intensity running (8, 27, 28). In this context, older players may display better tactical organization and technical proficiency, thereby reducing unnecessary low-intensity movement while preserving capacity for decisive high-intensity accelerations and decelerations, actions that impose substantial mechanical and metabolic loads and often occur around key match incidents (28, 29). Thus, age-related progression from U15 to U17 may be characterized more by neuromuscular and tactical refinement, reflected in the acceleration-deceleration profile, than by simple increases in linear high-speed running.

5.1. Study Limitations

This study has several limitations that should be considered when interpreting the findings. Match data were obtained from a limited number of games within two elite academies for each age category, which may restrict the external validity and generalizability of the results to broader youth populations. In addition, key contextual variables such as opponent strength, tactical game models, ball-possession patterns, and match status were not controlled and may have influenced the observed running and acceleration-deceleration profiles. Variability between matches in a competitive context (e.g., opponent tactics and match flow) could not be accounted for. Furthermore, playing position was not analyzed because substitution patterns varied across teams and only players who completed the full 90 minutes were included; consequently, the positional composition of the sample was inconsistent across matches. Biological maturation status was also not assessed, limiting the ability to distinguish age-related developmental differences from maturation-driven performance changes. Although 10-Hz GPS technology is widely used in applied soccer research, it provides lower accuracy for very high-speed movements and abrupt accelerations or decelerations. Importantly, although neuromuscular maturation, tactical understanding, and cognitive-perceptual clarity were considered possible explanations for the observed age-related differences, these constructs were not directly measured in the present study. Therefore, these interpretations remain hypothetical and should be tested in future research incorporating direct assessments of neuromuscular function, tactical decision-making, and perceptual-cognitive abilities. Future studies should consider multi-club or multi-regional samples, include maturation assessments, and employ higher-frequency tracking systems (e.g., LPS or 18 - 20-Hz GPS) to more precisely evaluate the interaction between developmental stage, tactical context, and match demands in youth soccer.

5.2. Conclusions

The findings of this study suggest that age-related differences in match running performance among elite youth soccer players primarily reflect qualitative shifts in movement patterns rather than increases in total running volume. This shift toward explosive, match-defining actions observed in older players may be associated with greater neuromuscular maturity, possibly enhanced tactical awareness, and more efficient regulation of physical effort. Collectively, these results emphasize that acceleration-deceleration metrics provide a more sensitive indicator of developmental progression than distance-based variables alone and underscore the importance of integrating neuromuscular and tactical considerations into age-appropriate training programs for youth soccer players.

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Footnotes

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Ethical Approval: The study complied with the ethical principles outlined in the National Health Council Resolution for human research and received approval from the Research Ethics Committee of Kharazmi University, Iran (Protocol No. 4.983.415).

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