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Road to FIFA Women's World Cup: A Case Study on Changes in Body Composition and Physical Performance Measures in Elite Female Soccer Players

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Abstract

Zabaloy, S, Villaseca-Vicuña, R, Freitas, TT, and Loturco, I. Road to FIFA Women's World Cup: A case study on changes in body composition and physical performance measures in elite female soccer players. *J Strength Cond Res* XX(X): 000–000, 2025—The aim of this study was to evaluate the impact of a 4-month training period on the body composition and physical performance of elite female soccer players during their preparation for the 2019 FIFA Women's World Cup. Twenty-seven players of a women's national soccer team volunteered to participate in this study. Subjects were tested at 3-time points (i.e., time-point 1, time-point 2, and time-point 3) for body composition (sum of 6 skinfolds [$\sum$6SF] measures), maximal dynamic strength (i.e., squat 1 repetition maximum [squat 1RM]), countermovement jump (CMJ), and 10-m sprint performance. Our results demonstrated substantial improvements in body composition (i.e., reduced $\sum$6SF and fat mass percentage and increased muscle mass percentage [MM%]), strength (i.e., enhanced absolute and relative squat 1RM), speed and jump performance (i.e., decreased sprint times and increased CMJ height) ($p < 0.001$; effect size: very large) at the different time points. Post hoc analyses revealed that all measured parameters varied significantly from TP1 to TP2 and TP3 (p: 0.006 to <0.001), except for MM% and CMJ height between TP1 and TP2 ($p > 0.299$). In conclusion, these findings highlight the effectiveness of the 4-month training period in enhancing the overall performance of the female soccer players. Furthermore, it is plausible to suggest that the changes in anthropometric and body composition parameters were directly related to the improvements observed in physical performance measures.

Key Words: female athletes, athletic performance, team sports, resistance training, elite athletes

Introduction

Soccer is a field-based team sport characterized by frequent bouts of high-intensity actions, such as short sprints and directional changes, combined with technical–tactical actions (e.g., dribbling, passing, and shooting, among others), interspersed with periods of low-intensity activities (17). Regarding women's soccer, its popularity has increased significantly in recent years, as documented in several studies (1,9,14). For instance, research has examined gender differences in soccer match-play characteristics (2) and compared the match demands at the highest international level (i.e., Women's World Cup) with those of domestic leagues competitions (20). However, the scientific study of women's soccer remains in its early stages. Therefore, further research into the competition and performance characteristics of female soccer players is required, because it could help coaches identify player weaknesses and develop more precise and targeted training programs.

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A review of the existing literature on women's soccer reveals that, among other relevant aspects, (a) most studies have focused on injury epidemiology and the characterization of players' anthropometric and physical attributes (3,7,9) and (b) there is a gap in research analyzing longitudinal changes in body composition and physical performance among elite female soccer. In this line, authors (3) showed that fat mass, and sprint and jump qualities, was not affected by the menstrual cycle during the off-season phase of elite female soccer players. Although the latter study made an important contribution to research on female athletes, an investigation in international-level soccer players (i.e., national team players) is still lacking. In one of the few studies that addressed this issue, Villaseca-Vicuña et al. (18) demonstrated that a home-based training regimen implemented during the confinement period (because of the COVID-19 pandemic) provided sufficient stimulus to maintain acceptable levels of body composition (i.e., muscle mass percentage [MM%] and fat mass percentage [FM%]), strength, vertical jump, and sprint performance, but not to preserve intermittent endurance capacity in elite female soccer players. Nevertheless, this study was conducted under unique conditions (given the known restrictions and the lack of competitions during the experimental period), making it impossible to draw conclusions regarding the anthropometric and physical performance adaptations resulting from the players' usual training regimens.

More specifically, research analyzing changes over time in physical performance measures (3,13,18) demonstrated that strength (i.e., squat 1 repetition maximum [squat 1RM]), and jump and sprint capacities (10- to 20-m), could be maintained or even improved after an intervention period in elite female team-sport athletes (i.e., soccer and rugby league). Nevertheless, to date, no research has specifically analyzed how body composition and physical performance change over time in the lead up to major competitions, such as the FIFA Women's World Cup. This information is critical, because the development of these capabilities is a key prerequisite for players' success. Therefore, the aim of this study was to evaluate the impact of a 4-month training period on body composition (i.e., FM% and MM%) and physical performance (i.e., strength, jumping, and sprinting abilities) across 3 testing time points in a national elite soccer team as they prepared for the FIFA Women's World Cup.

Methods

Experimental Approach to the Problem

This case study involved international (i.e., elite-level) soccer players from a single national team to analyze anthropometric and performance changes at 3 different time points (time-point 1 [TP1], time-point 2 [TP2], and time-point 3 [TP3]) in elite female soccer players. The testing and training sessions were conducted during the preparation period leading up to the FIFA Women's World Cup held in France 2019. This quasi-experimental study did not modify or alter the sport-specific training sessions (i.e., technical and tactical training) and matches. A detailed description of a typical weekly training program and competition schedule for the players at this stage is provided in Table 1.

All players underwent a medical assessment before the beginning of the season and completed the tests without any injuries or physical discomfort, as certified by the medical and coaching staff. Moreover, after being informed of the purpose and experimental procedures, and before participation, players signed a written informed consent form. The University of Flores Research Ethics Committee approved the study (Case No. 009/22), which met all ethical standards according to the recommendations of the Declaration of Helsinki.

Subjects

Twenty-seven players (age ranges: 21–29; age: 26 ± 4 years; height: 1.65 ± 0.08 m; body mass: 62 ± 4.5 kg) from the Chilean women's national soccer team volunteered to participate in this study. The subjects had at least 7 years of training and playing experience in national (i.e., Chile, Japan, Brazil, United States, Spain, and France) and international competitions (i.e., FIFA friendly games, World Cup qualifiers). At the time of the assessments, the Chilean women's national soccer team was ranked 36th out of 155 according to the FIFA Women's World Ranking (6).

Procedures

All physical performance tests were completed within the first 4 days of the respective initial weekly training cycle in TP1, TP2, and TP3. All players were required to avoid strenuous exercise 24 hours before the tests to prevent fatigue. The subjects performed a general standardized warm-up led by a certified and experienced strength and conditioning coach, which included

Table 1

Typical weekly training schedule of elite female soccer players during the 4-month training period.*

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Physical training	Physical training	Physical training	Physical training	Physical training	Competition	Recovery
Recovery block (15′)	*Core training* (10′)	*Core training* (10)	*Core training* (10′)	*Coordination drills* (15′)		
Lower limbs stretching and foam roller	LB RT	*UB RT*	*Speed Block* (20′)	Individual and group technical drills		
Core training (10′)	3–5 sets/3–6 *r*	3–5 sets/3–6 r	Unresisted linear sprints from 10 m to 30 m	TEC/TAC (60′)		
UB RT (30′)	30–60% 1RM (i.e., squat, deadlift, hip thrust)	30–60% 1RM (i.e., bench press, pull-ups, TRX pull-ups, shoulder press, etc.)	COD and agility training from 10 m to 20 m	Activities aiming to few number of players in shorter playing spaces (i.e., <60 m^2 per player)		
3 sets/3–6 r	TEC/TAC (60′)	TEC/TAC (75–90′)	*Conditioning* (10′)	Specific to tactical attacking actions/drills		
30–60% 1RM (i.e., bench press, pull-ups, TRX pull-ups, shoulder press, etc.)	Varying technical and tactical activities including SSG, shooting, passing, pressing, etc.	Activities aiming to large number of players in large playing spaces (i.e., >60 m^2 per player)	1–2 sets × 6–8 rep 100 m at 90–120% YYIRT-L1	Cool down (10′)		
Conditioning (10′) 2 sets × 5-min 60–70% YYIRT-L1	Cool down (10′)	Cool down (10′)	TEC/TAC (60–70′) Activities aiming to few number of players in large playing spaces (i.e., >90 m^2 per player)			
TEC/TAC (30–45′)			Specific to defensive actions/drills			
Actions more tactically oriented without opposition Cool down (10′)			Cool down (10′)			

*LB = lower body; RT = resistance training; TEC/TAC = technical and tactical training; UB = upper body; YYIRT-L1 = level 1 of the Yo-Yo intermittent fitness recovery tests; 1RM = 1 repetition maximum.

jogging, rapid multidirectional motor tasks, and dynamic stretching, followed by a specific warm-up for each test. The complete warm-up lasted approximately 15 to 20 minutes.

Pre-, mid-, and post-tests were organized as follows: (a) first day: anthropometric measurements and squat 1RM, (b) second day: 10-m sprint speed test (T10), and (c) third day: countermovement jump (CMJ) test. Additional information (e.g., competitions, dates, and tests) is depicted in Figure 1. These tests were selected because they are commonly performed by women's soccer teams (17,18) and provide valid and reliable data. All players were familiar with the tests and were verbally encouraged to give their maximal effort on each one.

Anthropometric Assessment. The sum of 6 skinfolds (Σ6SF: triceps, subscapular, supraspinal, abdominal, medial thigh, maximum calf) was used to estimate FM% and MM%. These procedures have been validated by the International Society for the Advancement of Kinanthropometry (ISAK). All measurements were recorded by an ISAK II certified and experienced practitioner, who is a member of the coaching staff of the Chilean Soccer Federation. The skinfolds were measured using a slim guide caliper (Rosscraft, British Columbia, Canada) with 0.2 mm precision. Owing to time constraints, only 1 measurement was taken for each skinfold.

Maximal Dynamic Strength. Maximal dynamic strength was assessed with the squat test, which has been validated to evaluate the levels of muscular strength in the lower limbs of soccer players (17,18). The assessment was conducted using a linear position transducer (Chronojump, Boscosystem, Barcelona, Spain) attached to the barbell to record movement velocity, in line with recent recommendations (19). The squat exercise was performed on a squat rack with a 20-kg Olympic barbell.

Before the test, each subject performed a specific warm-up consisting of 3 sets of 3 repetitions with a 20-kg load. Subsequently, they completed 5 sets of 3 repetitions with progressively increasing loads of 20, 30, 40, 50, and 60 kg, with 3-minute recovery periods between sets. Subjects were required to perform the concentric phase of the lift at maximal velocity on every repetition. Squat 1RM was then estimated using a previously proposed equation (11) based on the mean propulsive velocity (MPV) of the heaviest load lifted. In addition to absolute 1RM, relative strength (RS) (calculated by dividing squat 1RM by body mass) and the MPV achieved against each absolute load were also analyzed.

Short-Sprint Ability. Short-sprint ability was assessed using the 10-m sprint test. Before the test, each player performed a specific warm-up consisting of 5 progressive 10-m sprints. Subjects then completed three 10-m attempts, with a 3-minute rest intervals between trials. The test was conducted on a natural grass soccer pitch in the morning (i.e., 10 AM), under mild weather conditions (15 °C, no wind). Subjects started in a split stance position, with the front foot positioned 0.5-m behind the starting line. Sprint times were recorded using timing gates (Microgate Bolzano, Italy), and the best time was considered for further analysis. Intraclass Correlation Coefficients (ICCs) of 0.904, 0.875, and 0.874 and Coefficients of Variation (CVs) of 4.4, 4.1, and 4% were obtained for TP1, TP2, and TP3, respectively.

Vertical Jumping Ability. Vertical jumping ability was assessed using the CMJ test, performed after a specific warm-up consisting of 5 submaximal CMJs. Players completed three attempts, with 3-minute recovery periods between each attempt. Countermovement jump height was measured using an infrared device (Optojump, Microgate, Bolzano, Italy). The highest jump was selected for further analysis. Intraclass Correlation Coefficients were 0.974, 0.902, and 0.981, while CVs were 14, 15, and 15% for TP1, TP2, and TP3, respectively.

Statistical Analyses

Data are reported as mean ± *SD*. The Shapiro–Wilk test was used to determine whether all measures followed a normal distribution, while Levene's test verified the homogeneity of variances. Intraclass Correlation Coefficients and CVs were calculated to assess relative and absolute reliability, respectively. Differences between the 3 time points (TP1 vs. TP2 vs. TP3) were analyzed using a 1-way ANOVA for repeated measures. In the event of a significant effect, Bonferroni post hoc tests were conducted to identify pairwise differences. Effect sizes (ESs) for the ANOVA outputs were calculated using partial Eta-squared, with thresholds defined as 0.01 (small), 0.06 (medium), and 0.14 (large). For post hoc pairwise comparisons, Cohen's *d* ES and their respective 95% confidence intervals were calculated. Threshold values for Cohen's ES were as follows: >0.2 (small), >0.6 (moderate), >1.2 (large), >2.0 (very large), and >4.0 (nearly perfect) (5). The significance level was set at $p \leq 0.05$. Statistical analyses were performed using JASP Team (Version 0.16; JASP Team, 2021) for Microsoft Windows.

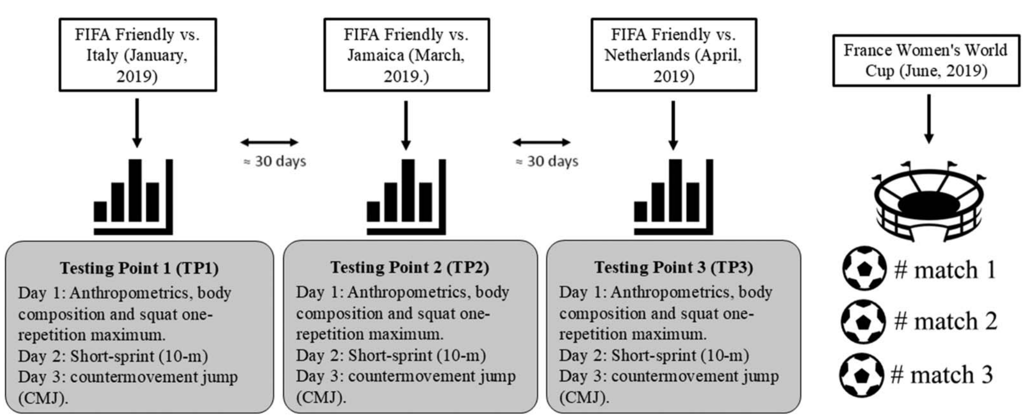

Figure 1. Brief description of the preparation period and the tests completed at pre-, mid-, and post-test phases.

Results

The differences in body composition measures across the 3 time points are depicted in Figure 2. Significant differences (p: 0.006 to <0.001) were observed for ∑6SF, FM% (ES: −0.37 to −1.04; percentage changes [Δ%]: −5.3% to −15.8%), and MM% (ES: 0.66 to 0.69; Δ%: 4.6–5.6%), indicating that all measured parameters varied significantly from TP1 to TP2 and TP3, except for MM% between TP1 and TP2 (p: 1.00; ES: −0.12) and BM values, which remained unchanged across all 3 TPs.

Figure 3 depicts the results for maximal strength, MPV from 20 to 60 kg, sprint times, and CMJ height. Results showed that all measured parameters varied significantly from TP1 to TP2 and TP3 ($p < 0.001$), except for CMJ height between TP1 and TP2 ($p > 0.299$). Absolute and relative squat 1RM and MPV from 20 to 60 kg (ES: 0.34 to 1.33; Δ%: 5.1–16.2%) increased significantly across the 3 TPs. Similarly, 10-m sprint times decreased significantly and progressively over the 3 TPs (ES: −0.36 to −1.28; Δ%: −1.6% to −4.9%). Finally, CMJ height improved significantly from TP2 to TP3 and TP1 to TP3 (ES: 0.45 and 0.56; Δ%: 6.9–8.3%, respectively).

Discussion

This study aimed to evaluate the impact of a 4-month training period on body composition (i.e., ∑6SF, BF%, and MM%) and physical performance (i.e., strength, jumping, and sprinting abilities) in female soccer players from a national soccer team in the months leading up to the FIFA Women's World Cup. The main findings showed that (a) positive and very large changes were observed in ∑6SF, FM%, and MM% throughout the preparation period; (b) all physical performance measures improved significantly from TP1 to TP3. These findings confirm the effectiveness of the training program designed to enhance overall player performance, which incorporated resistance training, linear and multidirectional speed-related training, and specific conditioning drills, in preparing the team for the Women's World Cup. Furthermore, it is plausible to suggest that the positive changes observed in the selected body composition variables were driven by the improvements across all physical performance measures. Finally, despite the limitations imposed by this study design (i.e., case study), the novel data reported here may provide normative values to aid in profiling and supporting elite female soccer players and their practitioners.

The urgent need for female-specific research in sports sciences has been highlighted previously (7), although some cross-sectional studies have provided insights into the anthropometric and physical characteristics of women's soccer (15–17). However, to date, no studies have examined in-season longitudinal changes in body composition and physical performance measures among international elite-level female soccer players preparing for major sporting events. In this context, this study demonstrated a reduction in players ∑6SF and FM%, along with an increase in MM%, during the 4-month training period leading up to the FIFA Women's World Cup. Similarly, a recent study (13) examined changes in anthropometric traits (i.e., BM, lean mass), physiologic markers (i.e., blood markers), and physical characteristics (i.e., isometric strength and endurance capacity) across 3 TPs in international women's rugby league players leading up to the 2022 World Cup. The study reported increases in lean mass during the preseason (from TP to TP2), with only the backs demonstrating improvements in endurance capacity across the 3 TPs. Furthermore, in this study, no changes were observed in body mass during this time period, which suggests that a positive interchange between muscle mass (e.g., increased MM%) and fat mass (e.g., reduced FM%) may have occurred. A previous study (18) investigating elite female soccer players reported that both fat and muscle mass remained unaffected after the COVID-19 confinement period, with only body mass showing a significant increase. Notably, in this study, after an extensive, real-world period of training and competition (as opposed to the COVID-19 confinement period), the observed changes in body composition were accompanied by significant improvements in physical performance. These findings suggest that changes in body composition may play a crucial role in competitive and physical performance for elite female soccer players (15).

Of note, the training program applied during the preparatory period—specifically designed to enhance physical performance—included strength–power training sessions, linear and multidirectional sprint speed training, and sport-specific conditioning drills (e.g., small-sided games), resulting in significant and positive adaptations from TP1 to TP3. Specifically, strength levels increased, as evidenced by faster MPV values achieved against all absolute loads (i.e., from 20 to 60 kg), and increases in RS and squat 1RM. Moreover, these improvements were accompanied by increments in CMJ height and reductions in 10-m sprint times ($p < 0.001$; ES: small to large). In this sense, the inclusion of training phases with distinct objectives (i.e., strength, speed, power, technical–tactical development) seems to have positively influenced all physical performance measures. Importantly, resistance training was performed with loads ranging from 30 to 60% 1RM, supporting previous studies that suggest lifting submaximal loads as quickly as possible (e.g., loads close to 1 $m \cdot s^{-1}$ MPV [≈40 kg in our study]) results in positive adaptations

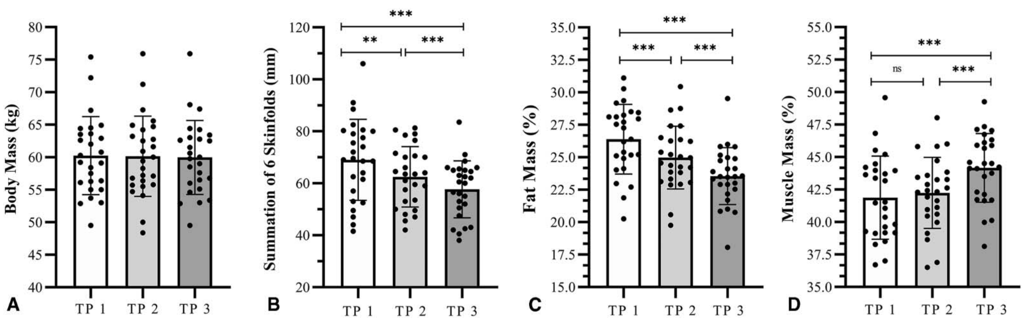

Figure 2. Comparison of body composition variables in female soccer players across the 3 time points (TP 1, TP 2, and TP 3): (A) Body mass; (B) summation of 6-skinfolds; (C) fat mass percentage; and (D) muscle mass percentage. *Denotes a significant difference at $p < 0.05$; ** at $p < 0.01$; *** at $p < 0.001$. ns denotes nonsignificant differences.

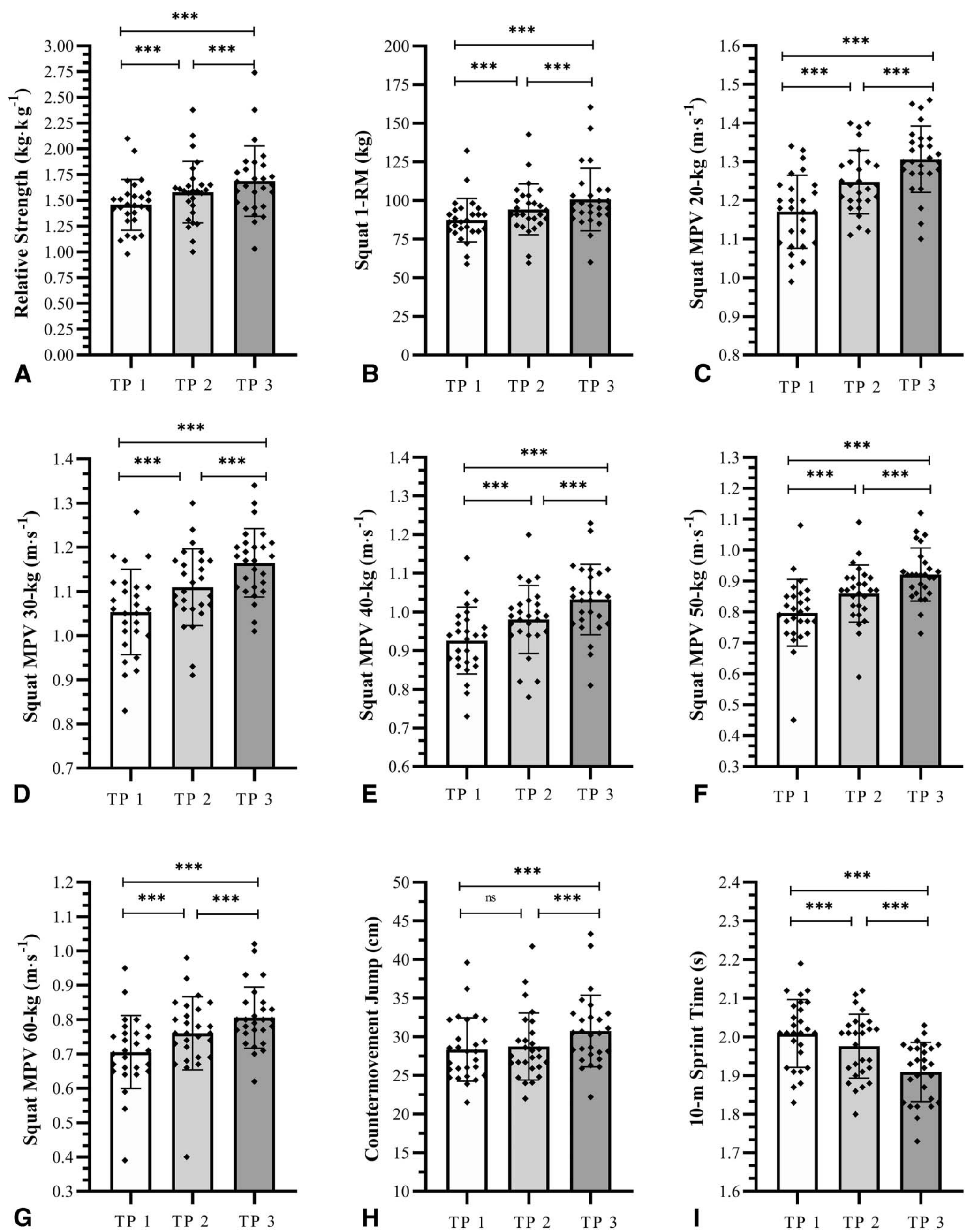

Figure 3. Comparison of physical performance measures in female soccer players across the 3 time points (TP 1, TP 2, and TP 3): (A) Relative strength in the squat exercise; (B) 1 repetition maximum (1RM) in the squat exercise; (C, D, E, F, G) mean propulsive velocity (MPV) at 20–60 kg loads during the squat exercise; (H) countermovement jump (CMJ) height; and (I) 10-m sprint time. *Denotes a significant difference at $p < 0.05$; ** at $p < 0.01$; *** at $p < 0.001$. ns denotes nonsignificant differences.

in jumping, agility, and sprinting abilities (10,12). From an applied perspective, practitioners should consider that heavier loads (e.g., >80% 1RM) may not be necessary to improve strength–power–speed qualities in elite female soccer players.

This study has some limitations: (a) the quasi-experimental design and lack of a control group do not allow for definitive conclusions regarding, for example, the influence of technical–tactical training sessions on the body composition and performance adaptations observed; (b) the absence of an endurance assessment (i.e., maximal oxygen uptake), which might have provided a more comprehensive understanding of the overall training effects; (c) the use of ∑6SF technique instead of the gold standard dual-energy X-ray absorptiometry to assess body composition; (d) the focus on a single team, which limits the generalizability of the findings. Nevertheless, it is important to note that these assessments were not performed because of time constraints, a common challenge in applied research at the elite level (8). Despite these limitations and given the clear need for research on elite female soccer players, coaches are encouraged to regularly assess changes in body composition using other valid and less time-consuming methods (i.e., ∑6SF or bioelectric impedance vector analysis) instead of DXA (4). Likewise, physical performance measures (e.g., strength, power, and speed-related abilities) need to implement comprehensive strength and conditioning programs as part of their preparation for major international competitions. Future interventions should also incorporate endurance capacity assessments to provide a more comprehensive analysis of physical performance variations in elite female soccer players throughout the season, thereby complementing the current results.

Practical Applications

When working with elite female soccer players, the results of this study highlight the importance of (a) assessing changes in body mass and body composition in conjunction with traditional physical performance tests; (b) complementing technical–tactical training sessions with physical training programs that include moderate-intensity resistance training sessions (i.e., 30–60% 1RM), linear and multidirectional sprint speed training, and specific conditioning drills during the preparatory period leading up to major soccer competitions (e.g., FIFA World Cup). The appropriate balance between soccer-specific training and strength and conditioning sessions can promote positive adaptations in body composition and physical performance measures in elite female soccer players. Moreover, when designing training programs to preserve or improve anthropometric traits, body composition, and physical performance, strength and conditioning coaches should focus not only on creating effective training programs but also on regularly testing their athletes (e.g., every 3 to 4 weeks). Regular testing can help detect any negative effects early, enabling rapid adjustments to various training components (e.g., training volume, frequency, and intensity, absolute and relative loads, exercise types, training strategies).

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