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Effects of Conventional Exercise versus Functional Training on Physical Performance in AJA Students during the Socialization Course: A Quasi-Experimental Study

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ABSTRACT

This study compared the effects of conventional exercise and functional training, implemented during the AJA socialization course, on multiple dimensions of physical performance. A quasi-experimental pre-test–post-test design was employed. Thirty-four male AJA students were randomly assigned to either a conventional exercise group ($n = 17$) or a functional training group ($n = 17$). Physical performance was evaluated using the 1-1-1 Army Physical Fitness Test (one-mile run, push-ups, sit-ups), the Running-based Anaerobic Sprint Test (RAST), and the Y-Balance Test (YBT). Paired-sample t-tests assessed within-group changes, and analysis of covariance (ANCOVA) examined between-group differences while controlling for baseline values. Statistical significance was set at $p \leq 0.05$. Between-group comparisons revealed no significant differences for the one-mile run ($p = 0.385$, $\eta^2 = 0.06$) or the YBT anterior reach ($p = 0.093$, $\eta^2 = 0.07$). The functional training group showed significantly greater improvements in YBT posteromedial ($p = 0.022$, $\eta^2 = 0.16$) and posterolateral ($p = 0.001$, $\eta^2 = 0.27$) reaches, total YBT score ($p = 0.031$, $\eta^2 = 0.34$), peak anaerobic power ($p = 0.001$, $\eta^2 = 0.36$), push-ups ($p = 0.017$, $\eta^2 = 0.18$), and sit-ups ($p = 0.028$, $\eta^2 = 0.16$). Functional training produced greater improvements in anaerobic power, dynamic balance, and muscular endurance compared to conventional exercise during the AJA socialization course. Given its superior performance outcomes and potential to reduce musculoskeletal injury risk, functional training should be prioritized in military induction programs to better prepare recruits for advanced training and operational demands.

Keywords: *Functional Training, Military Fitness, Anaerobic Power, Dynamic Balance, Injury Prevention*

1. Introduction

The primary objective of military training is to develop and sustain optimal physical fitness, a critical determinant of operational efficiency and mission performance in military personnel (1, 2). Maintaining a high level of physical readiness enables service members to meet occupational demands effectively, even under unpredictable and high-stress conditions (3). Military tasks often require a combination of sustained physical exertion and rapid cognitive decision-making, and training programs are specifically designed to prepare recruits for these challenges (4). Activities such as individual combat tactics, drill and ceremony, prone crawling, tactical bounding, obstacle course navigation, running with weapons, and structured morning physical training require robust baseline fitness (5, 6).

The initial phase of training, commonly referred to as the socialization or basic training course, serves to transform civilian recruits into trained military personnel (7). This period presents significant physical and psychological challenges, fostering adaptation to the military environment while building resilience (8). Although basic training offers considerable fitness and mental health benefits (9), it is also associated with an elevated risk of injury, particularly in the early weeks when recruits have not yet reached sufficient conditioning levels (10).

Musculoskeletal injuries classified as cumulative trauma or overuse injuries affecting muscles, tendons, bones, joints, cartilage, or ligaments (11) are particularly prevalent in military contexts. In the U.S. Army, for example, the incidence of such injuries during basic combat training can reach 42% in male recruits (12). These injuries negatively impact immediate performance, hinder daily military duties (13), and are a leading cause of chronic disability, medical discharge, and premature career termination (14). Approximately one in four military personnel is discharged due to musculoskeletal injuries, resulting in significant implications for force readiness and imposing substantial financial burdens on military institutions (15).

Efforts to reduce injury rates in athletic and military populations have explored a range of interventions, including equipment modifications (e.g., shoe insoles, specialized footwear), nutritional strategies (e.g., post-exercise protein supplementation), and programmatic training adjustments such as neuromuscular and resistance training (16). Effective injury prevention requires coordinated efforts among commanders, healthcare providers, researchers, and training authorities to institutionalize evidence-based practices (17). Beyond individual well-being, injury prevention plays a vital role in maintaining operational readiness and sustaining national defense capability (18).

A persistent challenge is identifying recruits at increased risk of injury early in the training cycle and designing programs that simultaneously enhance performance and minimize injury risk. Screening tools such as the modified 1-1-1 Army Physical Fitness Assessment have been employed to evaluate baseline capabilities and inform training strategies (19).

Given the high incidence of injury during initial military training and the essential role of physical fitness in operational effectiveness, it is critical to determine the most effective training methods for this formative period. The present study aimed to assess whether functional training, compared with conventional physical training, provides superior improvements in physical performance measures and contributes more effectively to injury risk reduction among AJA students during the socialization course.

2. Methods and Materials

2.1. *Study Design and Participants*

This quasi-experimental study employed a pre-test–post-test design in an applied military training setting. The study population comprised officer cadets enrolled in the initial military training phase. Sample size calculations using G*Power software indicated a minimum of 30 participants to achieve a statistical power of 0.5, a confidence level of 0.8, and a significance level of 0.05 (20). To account for potential attrition, 34 cadets were recruited. Participants were then randomly assigned to either a conventional training group (n = 17) or a functional training group (n = 17) using a simple randomization method. A random number table was employed to generate the allocation sequence, and cadets were assigned sequentially according to this sequence to ensure unbiased group distribution.

2.2. *Ethical Considerations and Supervision*

The study was conducted in accordance with institutional ethical guidelines. All participants provided written informed consent after receiving a full explanation of study aims, procedures, and potential risks. Participant confidentiality was maintained, and withdrawal from the study was permitted at any time without penalty. All training sessions (both conventional and functional) were supervised by certified physical training instructors and the research team to ensure correct technique, safety, and compliance with the protocols. Attendance was recorded at each session. Adherence was calculated as the proportion of attended sessions relative to the total number prescribed, with participants achieving ≥85% attendance considered adherent to the protocol.

2.3. Injury Monitoring

Injury incidence was systematically monitored throughout the study. Musculoskeletal injury was defined as any physical complaint involving muscles, joints, bones, or connective tissues that resulted in (1) medical evaluation, (2) modification or cessation of training, or (3) absence from ≥1 training session. Injuries were identified and documented by a licensed military physician affiliated with the training academy, and all cases were recorded in a standardized injury log.

2.4. Inclusion and Exclusion Criteria

Inclusion criteria were: (1) enrollment in the initial military training course and (2) no pre-existing musculoskeletal injury. Exclusion criteria were:

1. Absence from >3 total training sessions or >2 consecutive sessions;
2. Non-cooperation with study procedures;
3. Voluntary withdrawal;
4. Onset of pain or discomfort during training;
5. Sustaining an injury necessitating discontinuation of training (21).

2.5. Baseline Assessment

Demographic data including age, height, weight, and body mass index (BMI) were collected at baseline. A standardized briefing session was held to ensure participant understanding of the testing protocols and training procedures.

2.6. Physical Performance Assessments

All performance testing was conducted at baseline and post-intervention, following standardized protocols to ensure reliability.

1. Army 1-1-1 Physical Fitness Assessment (19)

- **Push-up test:** Maximum repetitions performed with proper form.
- **Sit-up test:** Maximum repetitions completed with knees at 90°, feet secured, and proper trunk flexion and extension.
- **One-mile run:** Timed 1.6 km run on a flat track under dual-assessor supervision.

2. Y-Balance Test (YBT) (22)

Participants balanced on their dominant leg while reaching in anterior, posteromedial, and posterolateral directions with the non-dominant leg. Three trials per direction were recorded following a warm-up. Dynamic balance scores for each direction were calculated as:

$$\boldsymbol{Normalized\ Reach\ Distance}\ (\%) = \frac{Reach\ Distance\ (cm)}{Leg\ Length\ (cm)} \times 100$$

3. Running-based Anaerobic Sprint Test (RAST)

Participants performed six maximal 35 m sprints separated by 10-second passive rests. Sprint times were recorded using precision stopwatches, and peak, mean, and minimum power outputs, along with fatigue index, were calculated using body mass and sprint performance data.

2.7. Training Protocols

2.7.1. Conventional Training Group

The conventional training program reflected the standard physical training typically employed during initial military education. It consisted of running, and basic bodyweight exercises performed at moderate intensity. Training sessions were conducted five times per week, each lasting approximately 45 minutes. Running sessions included distances ranging from 2 to 4 kilometers with gradual weekly progression. Calisthenics included push-ups, sit-ups, pull-ups, and squats, performed in 3–4 sets of 12–15 repetitions. Intensity and volume were progressively increased over the 8-week program in accordance with standard military conditioning practices.

2.7.2. Functional Training Group

The High-Intensity Functional Resistance Training (HIFRT) program was adapted from Banaszek et al. (23) and designed to mimic military occupational demands by integrating strength, power, balance, and coordination exercises into a single circuit format (Table 1).

Table 1

Structure of the High-Intensity Functional Resistance Training Program

Parameter	Description
Training modality	Integrated resistance training incorporating concurrent upper- and lower-extremity exercises, multi-planar movement patterns, core stability training, neuromuscular coordination drills, and balance-oriented activities.
Training intensity	Program duration: 8 weeks; prescribed at a moderate-to-vigorous effort corresponding to a Rating of Perceived Exertion (RPE) of 6–7 on the Borg CR10 scale
Training structure and volume	Circuit training with 8 exercise stations; 40 s work / 20 s rest per station; 3 complete circuits per session; total session duration ≈ 25 min.
Program duration	8 weeks

Table 2

High-Intensity Functional Resistance Training Protocol, Categorized by Primary Movement Focus

Functional Category	Exercise Description	Equipment Type	Week(s) Performed
Lower Body Strength & Power	sit-to-stand with elbow flexion	Body weight	1, 5
	Sumo squat	Body weight	
	Squat thruster	Body weight	3, 7
	Stiff-leg deadlift	Free weight	
	Front pulldown with squat	Elastic bands	
	Upright row with sumo squat	Body weight	2, 6
	Hip extension	Body weight	
	Side lateral raise with lunge	Body weight	
	Front raise with side lunge	Free weight	
Upper Body Strength & Pulling Movements	Push-ups	Body weight	
	Suspended row	Body weight	
	Horizontal row	Elastic bands	
	Horizontal row	Body weight	
	Bench press	Body weight	
	Standing bench press	Body weight	4, 8
Upper Body Strength & Pushing Movements	Push forward	Body weight	
	Shoulder abduction/adduction	Body weight	
	Dumbbell fly with pelvic elevation	Free weight	
Core Stability & Trunk Control	Crunches with rotation	Body weigh	
	Ball crunch	Body weigh	
	Crunch	Body weigh	
	Trunk lateral flexion	Body weigh	
	Trunk rotation	Body weigh	
	Elastic trunk rotation	Elastic bands	
	Good morning	Free weight	
Balance & Coordination	Side-lying hip abduction	Body weight	
	Airplane (single-leg T-position balance)	Body weight	
	Single-leg balance with eyes closed	Body weight	
	Single-leg balance with eyes closed (duplicate entry)	Body weight	
	Knee flexion with elbow flexion	Body weight	
	Dumbbell swing	Free weight	
	Hip flexion with elbow flexion	Elastic bands	

2.8. Statistical Analysis

Descriptive statistics (mean ± standard deviation) were computed for all demographic and performance variables. Data distribution normality was assessed with the Shapiro–Wilk test. Within-group pre–post differences were analyzed using Paired-samples *t*-tests. Between-group post-test comparisons, controlling for baseline scores, were performed using analysis of covariance (ANCOVA). Statistical analyses were conducted in SPSS version 26, with significance set at $p < 0.05$.

3. Findings and Results

Thirty-four cadets ($n = 34$) completed the training program without attrition. Baseline demographic characteristics are presented in Table 3. Independent-samples t tests revealed no significant differences between the conventional exercise and functional training groups at baseline ($p > .05$), indicating comparable starting conditions.

Table 3

Descriptive Characteristics of Participants (Mean ± SD)

Variable	Conventional Exercise	Functional Training
Height (cm)	178.14 ± 6.43	179.66 ± 7.26
Weight (kg)	71.52 ± 4.13	71.90 ± 5.17
Age (years)	20.19 ± 2.16	19.23 ± 2.30
BMI (kg/m^2)	21.98 ± 1.04	22.13 ± 1.39

Note. BMI = body mass index, calculated as weight (kg) ÷ height^2 (m^2).

Paired-samples t tests (Table 4) indicated statistically significant improvements from pre-test to post-test in push-ups ($p = .023$), sit-ups ($p = .035$), one-mile run time ($p = .047$), and peak anaerobic power ($p = .027$). Changes in dynamic balance were not statistically significant ($p > .05$).

Table 4

Physical Performance in the Conventional Exercise Group (Mean ± SD)

Variable		Pre-Test	Post-Test	*p*-value
Push-ups		3.26 ± 1.50	2.33 ± 2.80	.023*
Sit-ups		5.29 ± 8.60	9.37 ± 2.60	.035*
One-Mile Run (s)		539.20 ± 2.64	491.60 ± 4.10	.047*
Peak Anaerobic Power (W)		602.63 ± 43.15	627.63 ± 17.14	.027*
Dynamic Balance	Anterior	87.37 ± 64.70	91.24 ± 72.60	.136
	Posteromedial	92.26 ± 11.90	96.31 ± 68.30	.096
	Posterolateral	89.47 ± 91.70	92.67 ± 39.60	.258
	Composite Score	91.07 ± 68.70	93.89 ± 61.50	.649

Note. P < .05.

As shown in Table 5, the functional training group demonstrated significant improvements in all measured variables ($p < .05$), including all directions of dynamic balance.

Table 5

Physical Performance in the Functional Training Group (Mean ± SD)

Variable		Pre-Test	Post-Test	*p*-value
Push-ups		27.70 ± 6.80	43.30 ± 1.70	.005*
Sit-ups		30.50 ± 4.60	47.10 ± 3.50	.003*
One-Mile Run (s)		534.30 ± 4.10	472.20 ± 6.92	.009*
Peak Anaerobic Power (W)		599.36 ± 24.13	661.32 ± 14.18	.007*
Dynamic Balance	Anterior	86.24 ± 81.60	94.81 ± 5.09	.019*
	Posteromedial	94.39 ± 53.90	105.17 ± 40.40	.001*
	Posterolateral	90.39 ± 32.70	102.74 ± 92.50	.001*
	Composite Score	90.67 ± 88.70	99.24 ± 13.50	.023*

Analysis of covariance (ANCOVA), controlling for baseline scores, indicated that the functional training group achieved significantly greater improvements than the conventional exercise group in push-ups ($p = .017$, $\eta^2 = .18$), sit-ups ($p = .028$, $\eta^2 = .16$), peak anaerobic power ($p = .001$, $\eta^2 = .36$), and dynamic balance in the posteromedial ($p = .022$, $\eta^2 = .16$) and posterolateral ($p = .001$, $\eta^2 = .27$) directions, as well as in the composite dynamic balance score ($p = .031$, $\eta^2 = .34$). No significant between-group differences were observed for one-mile run time ($p = .385$) or anterior dynamic balance ($p = .093$).

Table 6

ANCOVA Results for Between-Group Comparisons (Mean ± SD)

Variable		Functional Training	Conventional Exercise	*p*-value	*F*-value	η^2
Push-ups		43.30 ± 1.70	33.20 ± 2.80	.017*	0.17	.18
Sit-ups		47.10 ± 3.50	37.90 ± 2.60	.028*	0.11	.16
One-Mile Run (s)		472.20 ± 6.92	491.60 ± 4.10	.385	12.33	.06
Peak Anaerobic Power (W)		661.32 ± 14.18	627.63 ± 17.14	.001*	27.71	.36
Dynamic Balance	Anterior	94.81 ± 5.09	91.24 ± 72.60	.093	2.94	.07
	Posteromedial	105.17 ± 40.40	96.31 ± 68.30	.022*	5.36	.16
	Posterolateral	102.74 ± 92.50	92.67 ± 39.60	.001*	15.86	.27
	Composite Score	99.24 ± 13.50	93.89 ± 61.50	.031*	11.41	.34

Note. $P < .05$. η^2 = partial eta squared.

4. Discussion and Conclusion

The primary objective of this study was to evaluate the effects of two distinct training protocols conventional exercise and functional training on the physical performance of military officer cadets during the initial training phase. Both groups demonstrated significant improvements in most physical fitness parameters from pre-test to post-test. However, dynamic balance improved significantly only in the functional training group, which also showed superior gains across all measured parameters, including balance. Between-group comparisons at post-test revealed no significant differences in one-mile run performance or the anterior direction of the dynamic balance test. In contrast, the functional training group significantly outperformed the conventional exercise group in the posteromedial ($p = .022$) and posterolateral ($p = .001$) dynamic balance directions, composite dynamic balance score ($p = .031$), peak anaerobic power ($p = .001$), push-ups ($p = .017$), and sit-ups ($p = .028$). Notably, the functional training group also reported a lower incidence of musculoskeletal injuries (12%) compared to the conventional exercise group (29%).

Tactical populations including military personnel, law enforcement officers, firefighters, and combat athletes require high levels of physical fitness to meet occupational demands. The specific fitness requirements vary across populations (24), but for military personnel, physical readiness is a critical determinant of mission success, complementing advancements in weaponry and technology (25). Military duties require sustained physical effort, rapid recovery, and completion of task-specific activities, combat skill execution, and confidence in diverse operational settings (26). Accordingly, military academies place substantial emphasis on physical conditioning, often through rigorous early-morning training sessions prior to academic instruction (27).

Military fitness programs typically aim to improve body composition, aerobic capacity, and muscular endurance (28). However, musculoskeletal injuries remain a significant concern, especially among officer cadets (29). Higher training volumes have been linked to increased lower extremity injury risk (30), with younger, less experienced cadets particularly vulnerable due to the combined effects of high training demands and insufficient adaptation. Kucera et al. (31) documented over 3,000 musculoskeletal injuries among cadets at three military academies over four years, highlighting the substantial injury burden in this population. Injury incidence is consistently higher among new recruits compared to experienced personnel (32, 33), likely due to abrupt increases in training load (17). Despite global efforts to reduce training-related injuries, many interventions have proven ineffective (34), often due to their generic design and lack of alignment with the occupational demands of military service.

Evidence suggests that physical fitness data are essential for evaluating training effectiveness and minimizing injury risk in military settings (35). The present findings indicate that functional training may simultaneously improve performance and reduce musculoskeletal injury rates. Such injuries diminish the benefits of training while increasing costs (36). Prior research demonstrates an association between higher performances in standard fitness tests such as the U.S. Army Physical Fitness Test and lower injury rates during basic combat training (37). Balance, a critical component of both athletic and military performance, is also an important predictor of injury risk (38). Functional training, by enhancing neuromuscular coordination, proprioception, and core stability, can improve balance and thereby mitigate injury risk. For example, Nagai et al. (39) found that functional training improved proprioception and balance in recruits, contributing to reduced injury rates.

Although the optimal training model for tactical populations remains debated, growing evidence supports high-intensity functional training as an effective means of improving multiple domains of fitness (40). While various training methods can improve balance (41), functional training has gained particular attention in recent years (42). Heinrich et al. (43) reported that functional training yielded greater improvements in strength, aerobic capacity, and flexibility than traditional training in active-duty personnel. Similarly, Helen et al. (44) found significant gains in strength and endurance following functional training compared to traditional military training. Collectively, these findings suggest that functional training can more effectively address the broad physical demands of military service than traditional endurance-focused methods (45, 46).

Recent reviews (46, 47) further highlight that programs integrating resistance, aerobic, and bodyweight training can enhance anaerobic and aerobic performance more efficiently than conventional approaches. Concerns about traditional training models include: (1) overemphasis on aerobic conditioning, particularly long-distance running; (2) limited focus on the diverse physical demands of tactical work; (3) insufficient preparation for unpredictable operational requirements; and (4) higher injury risk associated with high-volume running (48).

This study demonstrated that both conventional and functional training protocols improved the physical performance of military officer cadets during the initial training phase. However, functional training was more effective in enhancing multiple fitness domains, particularly dynamic balance, muscular endurance, and anaerobic power, while also being associated with a lower incidence of musculoskeletal injuries. These findings underscore the superiority of functional training as a safer and more comprehensive approach to preparing cadets for the diverse physical demands of military service. Integrating functional training into early military training curricula may optimize physical readiness, reduce injury-related attrition, and support the development of sustainable fitness strategies tailored to the unique requirements of tactical populations. Future research should explore the long-term impacts of functional training and its applicability across different branches and levels of military training.

This study was limited to the initial training phase of officer cadets, and the long-term effects of functional training on performance and injury prevention were not assessed. Future studies should examine longitudinal outcomes, scalability across diverse military contexts, and potential adaptations for subpopulations with varying fitness baselines or injury histories.

Authors’ Contributions

All authors contributed substantially to the conception and design of the study, data collection, data analysis, and interpretation of results. Each author participated in drafting and critically revising the manuscript for important intellectual content, and all authors approved the final version for publication.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

This study was reviewed and approved by the Ethics Committee of the University of Tehran, Faculty of Sport Sciences (approval code: IR.UT.SPORT.REC.1404.136). All procedures were conducted in accordance with the ethical standards of the institutional and national research committees and the principles outlined in the Declaration of Helsinki. Participants provided written informed consent before enrollment, were informed of their right to withdraw at any time without penalty, and were assured of the confidentiality of their personal information.

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