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Physical characteristics of New Zealand Army, Navy and Airforce officer trainees' over a 6-week joint officer induction course

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ABSTRACT

Fitness levels of military personnel have been well researched around the world, however limited data exists on the New Zealand Defence Force (NZDF). This study identifies NZDF officer trainees' physical characteristics during a Joint Officer Induction Course (JOIC) and compares differences across groups. 116 participants (Army n = 75; Navy n = 25; Airforce n =16) were tested over 2.4km run, muscular-endurance (press-ups and curl-ups), body-mass and Y-balance musculoskeletal screening, pre and post a 6-week JOIC. Army performed better in the 2.4km run and press-ups compared to other services ($p < 0.05$), Navy performed better in curls-ups. At completion, there were significant improvements in 2.4km run ($p < 0.01$), press-ups ($p < 0.01$) and curl-ups ($p < 0.01$) across all services. Army officers performed better when compared to Navy and Airforce pre-post. Significant improvements were found for aerobic fitness, upper-body and core muscular-endurance across all services, following a 6-week JOIC.

1. Introduction

The physical fitness levels of recruits and officers entering military service is a major area of interest for defence forces worldwide (Knapik et al., 2006; Knapik, Sharp, & Montain, 2018; Robinson et al., 2016; Rosendal, Langberg, Skov-Jensen, & Kjær, 2003; Rudzki & Cunningham, 1999). Optimal levels of fitness are essential for daily task completion and for safe operation during military deployment (Kyröläinen, Pihlainen, Vaara, Ojanen, & Santtila, 2017) as there is still an essential need for physically capable men and women to deploy and fight on ground, sea and air spaces in the modern military world (Friedl et al., 2015). This has been illustrated by Lovalekar et al. (2018) when measuring physical performance/fitness was ranked in the top five of 44 priority research areas identified via survey from attendees at the 2018 International Congress on Soldiers Physical Performance in Melbourne Australia; with eight of the top ten ranked topics focused on physical demands in operational environments and measuring physical performance adaptation (Lovalekar et al., 2018).

While there is research on other forces in the world in relation to physical training and fitness assessment, including the USA (Deuster & Silverman, 2013), Finland (Kyröläinen et al., 2017), Australia (Rudzki & Cunningham, 1999), and Britain (Brock & Legg, 1997), there is limited research on the New Zealand Defence Force (NZDF) and especially new officer trainees. Although it is clear that physical fitness is vital for military forces, the physical characteristics of recruits and officers entering the NZDF has not been fully understood, and as a result an unwanted outcome of certain forms of training is high injury rates (Davidson, Chalmers, Wilson, & McBride, 2008). Such rates have been revealed both internationally (Andersen, Grimshaw, Kelso, & Bentley, 2016) and in New Zealand (Brooks, Fuller, Kemp, & Reddin, 2008). Previous research suggests military recruit physical performance has generally focused on load carriage and physical preparedness, and its effect on the body. Literature has established that four key factors play a major role in contributing to poor physical-condition and physical-state in military recruits: 1) time and distance on feet (Knapik et al., 2006); 2) entry level fitness (Molloy, Feltwell, Scott, & Niebuhr, 2012); 3) lower limb strength (Bullock, Jones, Gilchrist, & Marshall, 2010); and 4) pre-

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existing injuries (Knapik et al., 2001). These four defined areas combined with a lack of research and data in New Zealand has impacted adversely on the success of the NZDF joint officer induction course (JOIC). Furthermore, research suggests physical training approaches for the modern military service person need to focus on a flexible integration of strength, power and aerobic performance training programs (Kraemer & Szivak, 2012). It is of the utmost importance that forces are physically ready for deployment and physical assessments play vital role in ensuring this occurs. It is also internationally accepted that military personnel need to be physically fit to perform their normal duties, which are likely to be more physically demanding than that of the normal civilian population (Lovalekar et al., 2018), and as previously indicated, will substantially vary within the NZDF. Therefore, it is essential that physical training in the military positively facilitates fitness and conditioning improvement from the on-set of recruit and officer training.

Successful completion of the JOIC, which is the initial training phase for all new officers joining the NZDF, has been compromised by trainees entering the course at low levels of fitness. These low levels have contributed to a lack of ability to progress in the physical training program (Davidson et al., 2008). However, if initial military training is well structured, fitness can be improved with concurrent reductions in injury (Rudzki & Cunningham, 1999). Although an important wider topic, injury is not the focus of this paper. Brock and Legg (1997), investigated the effects of 6-weeks of physical fitness training in female British Army recruits and found 6-weeks was effective for recruits to respond with significant increases ($p < 0.05$) in mean VO_2 max (45.7 $ml.kg.min^{-1}$ to 46.7 $ml.kg.min^{-1}$). This study showed that aerobic fitness can increase effectively over a 6-week military training period. Also observed in the same 6-week period was a significant reduction in mean percentage body fat by 3.3% ($p < 0.001$), indicating that the training period also influences energy balance.

The purpose of the current study was to characterize and assess the effectiveness of the physical training program prescribed within the NZDF JOIC. A further aim of this study was to compare the entry level physical characteristics of the recruits from different services.

2. Methods

2.1. Participants

A total of 116 newly recruited healthy officer trainees (n = 95 male, n = 21 female, age 24 ± 12 years [mean ± SD]) from the NZDF participated in the current study. Participant demographics for each sex and area of service (Army, Navy and Airforce) are displayed in Table 1. Participation in the study was voluntary and ethical approval for the study was obtained from the institution's Human Research Ethics Committee and the NZDF. Volunteers were all from the same course and no trainees declined to be involved. Volunteers were explained the procedures and requirements, and signed consent was provided.

Table 1: Participant demographics. Data shown as means ± standard deviations.

	n	Age (yr)	Height (cm)	Body Mass (kg)
Male				
Army	65	25 ± 9.2	181 ± 5.5	78 ± 12.6
Navy	18	26 ± 2.6	179 ± 6.5	82 ± 13.2
Airforce	12	24 ± 2.8	178 ± 7.5	74 ± 17.4
Male Mean	**95**	**25 ± 2.8**	**179 ± 7.5**	**78 ± 14.6**
Female				
Army	10	24 ± 12	173 ± 7.5	73 ± 10.3
Navy	7	25 ± 5.2	168 ± 9	72 ± 13.8
Airforce	4	21 ± 2.6	174 ± 7.5	74 ± 5.2
Female Mean	**21**	**23 ± 13**	**171 ± 8**	**73 ± 9.8**
Total Mean	**116**	**24 ± 12**	**175 ± 8**	**75 ± 12.1**

2.2. Experimental Design

The experimental design included a single-group longitudinal study, whereby all participants were tested for physical characteristics and performance pre and post a 6-week JOIC. Fitness and musculoskeletal data were collected in weeks one and six of the JOIC across two 90-minute sessions. These tests were selected as they were standard NZDF protocols in place.

2.3. Physical Training Program

Physical training (PT) comprised a controlled two-week introduction phase of body weight exercises and aerobic conditioning. In weeks three and four, the intensity of PT increased to challenge individuals. Weeks five and six then focused on functional fitness and conditioning. This included increased load carriage with a combination of field packs, day packs, webbing (military load-carrying vest with pouches for ammunition and water bottles), and weapons. There was a specified 10-minute warm-up and 5-minute cool-down period for all PT sessions. A total of 18, 90-minute periods were allocated to physical training over the 6-week period and included a combination of aerobic interval running, strength training, circuits, swimming, and bike-boxing-rowing intervals as outlined in Table 2.

Table 2: Joint Officer Induction Course Physical Training Program.

Note: A ten minute 6am early morning activity (EMA) was also conducted daily including stretching, mobility and cognitive reaction games.

Day	Physical Training Class (PT)	Military Activity	Time On-Feet
		WEEK 1	**Intensity:** High, Med, Low (H-M-L)
Monday	**Arrival**- Walking		4hr - L
Tuesday	Walking		5hr - L
Wednesday	Introduction to physical training	50min Basic Drill	5hr - M
Thursday	**(Pre) Fitness Evaluation**	50min Basic Drill	5hr - H
Friday	30 min Running + 30 min Body weight standing exercises	Class work	4hr - M
Saturday		Class work	6hr - L
Sunday	60min Curcuit: Lift / Push / Pull / Lift	Class work	6hr - H
		WEEK 2	
Monday	60min 200m swim test & water tread + body weight exrcises	Class work	6hr - M
Tuesday	60min Interval running 6x800m	3hr Survival training workshop	6hr - H
Wednesday	90min Aerobic Intervals (Off feet):Bike / Row / Box / Core	Class work	4hr - H
Thursday		16hr Endurance Activity: Leader building, marching, load carring, problem solving, PT Curcuits, Running.	18hr - M
Friday	40min Pool Recovery & Stretch	Class work	3hr - L
Saturday		7hr Weapons training	5hr - M
Sunday	OFF	OFF	
		WEEK 3	
Monday	90min Interval training: Bike / Row / Box / Core (Off Feet)	4hr Weapons training	5hr - M
Tuesday	90min Interval Run 6x 400-800m & body weight standing exercise	4hr Weapons training	5hr - H
Wednesday		4hr Weapons training	5hr - M
Thursday		4hr Weapons range activity	2hr - L
Friday		9hr Weapons range activity	6hr - M
Saturday		9hr Weapons range activity	6hr - M
Sunday		4hr Weapons range activity	2hr - L
		WEEK 4	
Monday	90min Interval Run 8x 400-800m & body weight standing exercise	3hr Land navigation	4hr - H
Tuesday	90min Interval training : Bike / Row / Box / Core (Off Feet)	6hr Land navigation	10hr - M
Wednesday	60min Curcuit: Lift / Push / Pull / Lift	4hr Sea suvival workshop (pool)	6hr - M
Thursday		4hr Land navigation	6hr - L
Friday	60min Interval running 4x800m	Class work	3hr - H
Saturday		8hr Bush craft skills	10hr - L
Sunday	OFF	OFF	
		WEEK 5	
Monday		24hr Sea & bush svrvival activity	18hr - M
Tuesday		Class work	3hr - L
Wednesday	60min Strength & Mobility + 6x 50 'strid outs'	60min Basic drill	4hr - M
Thursday	60min Pool + body weight exercise	60min Basic drill	4hr - M
Friday	**(Post) Fitness Evaluation**	Class work	4hr - H
Saturday		Tactical field exercise living outdoors: Patrolling, Vehicle checkpoints, obstical buulding, navigation	18hr - M
Sunday		Tactical field exercise living outdoors: (As above)	18hr - M
		WEEK 6	
Monday		Tactical field exercise living outdoors: (As above)	18hr - M
Tuesday		Tactical field exercise living outdoors: (As above & including 12km pack march)	14hr -M/H
Wednesday		60min Basic drill	5hr - L
Thursday		60min Basic drill	5hr - M
Friday	Course End	Course End	

2.4. Fitness Testing

The standard NZDF JOIC fitness evaluation was conducted by the same NZDF Physical Training Instructors (PTIs), at 0800 both pre and post course. This evaluation consisted of three key components, 1) 2.4km road run, 2) maximum curl-ups, and 3) maximum press-ups. The 2.4km road run, which has been shown to provide an effective evaluation of aerobic fitness (Booth, Probert, Forbes-Ewan, & Coad, 2006; Burger, Bertram, & Stewart, 1990), was completed on a sealed flat road in two groups of 58. The run was conducted in a similar fashion to that described by Knapik et al. (2006), where participants started together, but individual effort was assessed by participants completing the distance in the quickest time possible in running shoes, shorts and t-shirt. Run times were measured via stopwatch to the nearest second by a designated PTI. There was no wind for each of the tests and they were conducted at approximately (22◦C) before daily temperature increased. No alcohol was consumed during the course and no caffeine or smoking was permitted in the two hours prior to testing.

The Curl-up protocol as used by Vera-Garcia, Grenier, and McGill (2000) provided an evaluation of local muscular-endurance of the core where repetitions were completed until failure (inability to continue). The curl-up was performed with participants in a supine position with knees bent at 90º and feet flat on the floor. Hands were held in a fist with arms straight. Hands slid up the thigh until the wrist met the apex of the knee. Hands then slid back down the thigh until the shoulder blades and shoulders touched the ground. A repetition was counted by a PTI every time the wrist reached the apex of the knee until failure, where the test finished. There was no time limit on repetitions, but they were completed in a continuous fashion with a pause of only 1-2 seconds between reps.

Press-ups were used to assess upper-body muscular-endurance similar to the protocol outlined by Booth et al. (2006) and Knapik et al. (2006). They were performed on a flat wooden gymnasium surface. Hands were placed on a line in the prone press position just slightly wider than shoulder width. A 'ready' cue was then given where the body position was adjusted up to the start position of arms straight, feet shoulder width apart and the head looking downward. From the start position the body was lowered eccentrically with a straight-line maintained between the shoulders and heels, until the elbows were at 90º or until the chest was approximately 3-5cm from the ground. During the concentric phase arms were extended until straight while maintaining the back and head positions. A repetition was counted by a PTI every time the full range of motion was completed until failure. For both the press-ups and curl-ups, one warning was given for an incomplete repetition, prior to participants being stopped by the PTI.

Body mass was recorded at each assessment at 0800hr (two hours after breakfast) prior to the fitness assessments on a set of digital scales (SOEHNLE, Style Sense Safe 200, Germany) to the nearest 100g, while participants wore a t-shirt and shorts with shoes removed.

2.5. The Y-Balance Musculoskeletal Screening Test

To determine musculoskeletal asymmetry, the Y-balance test (YBT) was used for both the Lower (YBT-LQ) and Upper Quartiles (YBT-UQ) (Shaffer, 2013). The YBT-LQ examines unilateral reach in three different directions, anterior, posteromedial, and posterolateral. Differences in the maximum reach distance for left and right leg were compared to examine reach asymmetry for each direction, with lower limb reach normalised to leg length (anterior superior iliac spine to the most distal portion of the medial malleolus). The YBT-UQ test is designed to obtain a quantitative measure of trunk and upper extremity functional symmetry, core stability, strength and mobility. It is shown to be a reliable predictor of upper body musculoskeletal injuries, particularly in the shoulder girdle (Butler, Arms, et al., 2014; Butler, Myers, et al., 2014; Gorman, Butler, Plisky, & Kiesel, 2012). For YBT-UQ participants reach in three directions; medial, inferomedial, and superomedial to determine percentage of functional symmetry and potential injury risk. Scores are also normalised to participant's arm length (spinous process of the cervical vertebrae C7 to the tip of the longest finger of the right arm). Individuals with asymmetries greater than 4cm are more likely to sustain injury (Plisky, Rauh, Kaminski, & Underwood, 2006).

Composite scores of less than88% for males and 85% for females (UQ), and 98% for males and 92% for female for (LQ), is a strong indicator of injury (Butler, Arms, et al., 2014; Butler, Myers, et al., 2014; Gorman et al., 2012; Plisky et al., 2006).

2.6. Statistical Analysis

Simple group scores are shown as mean ± SD values unless stated otherwise. All statistical analyses were performed using the Statistical Package for Social Science (V. 22.0, SPSS Inc., Chicago, IL), with statistical significance set at $p \leq 0.05$. A Student's paired T-test was used to compare pre to post performance measures for the entire group, for each sex (male, female), and for each service (Army, Navy, Airforce). To examine whether there were any differences between subgroups, Group (e.g., male vs female, service comparisons) x Time (pre and post) two-way multivariate analysis of variance (MANOVA's) were performed. A Bonferroni adjustment was applied if significant main effects were detected. Analysis of the distribution of residuals was verified visually with histograms and also using the Shapiro-Wilk test of normality. Magnitudes of the standardized effects between pre and post were calculated using Cohen's *d* (Cohen, 1988) and interpreted using thresholds of 0.2, 0.5, and 0.8 for *small, moderate* and *large*, respectively.

3. Results

A total of 119 officer trainees started the JOIC with 116 completing the course, representing a drop-out rate of 2.5%. Those that dropped out were not injured but left due to personal choice. At baseline, Army trainees performed significantly better in the 2.4km run and press-ups than their Navy and Army counterparts ($p < 0.05$) (table 3), however Navy trainees at baseline performed significantly better in curls ups than both Army and Airforce (p = 0.01).

Following 6-weeks of JOIC training, there was statistically significant decreases in body mass for Army males (78 ± 10.1 to 76.1 ± 9.2, $p < 0.01$, $d = -0.18$), Navy males (81.1 ± 13.8 to 79.3 ± 12.4, $p < 0.01$, $d = -0.20$), and all females collectively (73 ± 13.0 to 71.4 ± 11.8, $p < 0.01$, $d = -0.120$, Table 3). The total mean across all groups also showed a decrease in body mass from (75.5 ± 11 to 73.7 ± 10, $p < 0.01$, $d = -0.20$).

Performance improvement was evident (Table 3, Figure 1) over the duration of the JOIC with statistically significant decreases in 2.4km run time for all males (644 ± 83 to 589 ± 82, $p < 0.01$, $d = -0.57$), all females (708 ± 48 to 661 ± 42, $p < 0.01$, $d = -0.86$), and for all JOIC participants collectively (676 ± 83 to 625 ± 82, $p < 0.01$, $d = -0.57$). Following the 6-weeks of training there were also significant increases in maximum repetitions for press-ups (26 ± 12 to 33 ± 11, $p < 0.01$, $d = 0.48$), and curl-ups (42 ± 21 to 56 ± 39, $p < 0.01$, $d = 0.67$) for all JOIC participants (Table 3).

The MANOVA resulted in a significant difference when comparing gender for pre-post 2.4km run time ($p < 0.01$), and press-ups ($p < 0.01$). However, there were no significant differences found for curl-ups ($p > 0.05$). There was a significant group interaction for service pre press-ups for Army vs Navy ($p < 0.01$) and Army vs Airforce ($p = 0.01$). There was a significant interaction for post press-ups for Navy vs Army ($p = 0.01$). No significant interaction was found for any other measures.

YBT musculoskeletal screening following 6-weeks of JOIC showed no significant mean improvement, with only *small* to *moderate* improvements in some limb scores (Table 4).

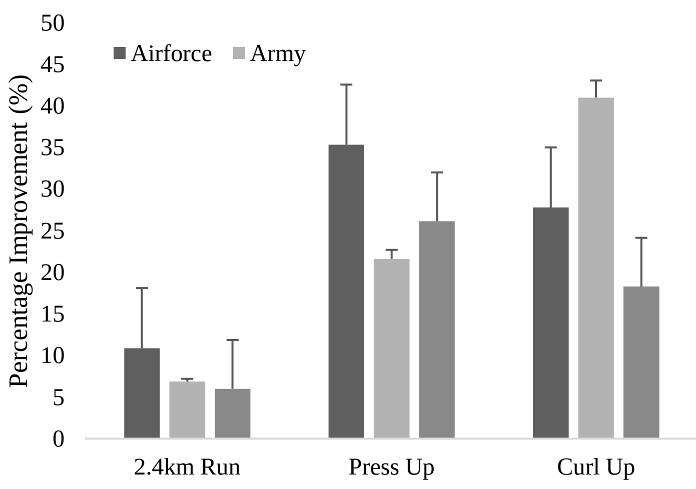

Figure 1: Percentage improvement pre to post for fitness testing scores for 2.4km run, press-ups and curl-ups for all trainee officers of the 6-week JOIC.

4. Discussion

The purpose of the current study was to compare and characterize New Zealand Army, Navy and Airforce officer trainees' pre and post a 6-week joint officer induction course. The 6-weeks of military training resulted in improved physical fitness markers as seen by significant improvements ($p < 0.01$) in all three measures; 2.4km run, press-ups and curl-ups. Although Army and Navy trainees performed better at baseline, Airforce percentage improvement for 2.4km run (11%) and press-ups (36%) was better than both other services. For curl-ups, the greatest improvement was seen in the Army trainee's (41%). Other international military studies have also shown comparable changes in aerobic fitness and strength-endurance over similar durations (Brock & Legg, 1997; Hendrickson et al., 2010; Hoffman, Chapnik, Shamis, Givon, & Davidson, 1999; Hofstetter, Mäder, & Wyss, 2012).
The current study demonstrated similar findings as Brock and Legg (1997) and Hofstetter et al. (2012), with the transition from civilian daily routine to a physically more demanding military routine leads to significant improvements in muscular-endurance and aerobic fitness (Hofstetter et al., 2012). This effect was particularly evident in Airforce recruits who had the lowest fitness level pre JOIC, but made the best overall improvements. Hendrickson et al. (2010) and Hoffman et al. (1999), also found similar outcomes in aerobic fitness and muscular-endurance with college athletes and new recruits joining the Israeli military respectively.

Regardless of service and initial aerobic fitness level, all officer trainees in the current study made notable increases in aerobic fitness over the 6-week duration. The mean improvement observed is comparable with Brock and Legg (1997), who found an increase in aerobic fitness when measuring VO_{2max} and strength in female recruits in the British army over a 6-week period. Brock and Legg (1997), also found a statistically significant ($p < 0.05$) increase in aerobic fitness occurred (45.7 $ml.kg.^{-1}min^{-1}$ to 46.7 $ml.kg.^{-1}min^{-1}$) and was reflected in a 6.1% improvement in maximal cycling time in a cycle ergometer test. In a study by Hofstetter et al. (2012), at the Fusilier Infantry Training School in Switzerland, recruits completing 7-weeks of infantry training displayed similar aerobic fitness improvement to the trainees in the current study regardless of starting level of fitness. Hofstetter et al. (2012) outlined that over 7-weeks, results showed there was significant improvement in the distance and velocity covered in the Conconi Progressive Endurance Run Test (Conconi et al., 1996).

Of the three services in the current study, Army trainees performed better in the 2.4km run at baseline and showed significant improvement pre-post JOIC for both males and females. Regardless of initial aerobic fitness, results show that all trainees improved in the current study. It has previously been found that recruit trainees who possess low levels of fitness will often make considerable physical performance gains due to having more room for improvement (Orr, Pope, Johnston, & Coyle, 2010). This finding was supported in the current study.

Table 3: Joint Officer Induction Course Pre-Post Scores.

	Body Mass (kg)				**2.4km Run (sec)**				**Press-Ups (Repetitions)**				**Curl-Ups (Repetitions)**			
	Pre	**Post**	**p-value**	**Effect Size**	**Pre**	**Post**	**p-value**	**Effect Size**	**Pre**	**Post**	**p-value**	**Effect Size**	**Pre**	**Post**	**p-value**	**Effect Size**
Male																
Army	78 ± 10.1	76.1 ± 9.2	<0.01*	-0.18	681 ± 68	567 ± 82	<0.01*	-0.71○	39 ± 9	43 ± 10	<0.01*	0.31■	43 ± 16	76 ± 40	<0.01*	1.02+
Navy	81.1 ± 13.8	79.3 ± 12.4	<0.01*	-0.20■	648 ± 76	623 ± 70	0.14	-0.32■	30 ± 10	35 ± 10	<0.01*	0.51○	36 ± 14	42 ± 10	0.04*	0.56○
Airforce	74 ± 5.2	72.8 ± 4.3	0.08	-0.32■	667 ± 157	577 ± 79	0.08	-0.69○	32 ± 10	39 ± 10	<0.01*	0.78○	42 ± 36	49 ± 33	0.02*	0.18
Male Mean	**77.9 ± 10.6**	**76.1 ± 9.6**	**0.08**	**-0.23■**	**644 ± 83**	**589 ± 82**	**<0.01***	**-0.57○**	**34 ± 10**	**39 ± 11**	**<0.01***	**0.53○**	**40 ± 19**	**56 ± 38**	**<0.01***	**0.02**
Female																
Army	72.8 ± 12.6	71.3 ± 11.3	0.06	-0.13	694 ± 30	655 ± 24	<0.01*	-1.09+	21 ± 6	30 ± 7	0.05*	0.68○	32 ± 9	44 ± 15	0.02*	0.77○
Navy	71.9 ± 13.1	70.5 ± 12.8	0.18	-0.11	681 ± 45	642 ± 28	0.15	-0.88+	21 ± 9	29 ± 7	<0.01*	0.95+	58 ± 46	69 ± 7	0.17	0.26■
Airforce	74.4 ± 17.4	72.5 ± 15.0	0.22	-0.13	750 ± 118	686 ± 127	0.06	-0.60○	12 ± 5	21 ± 8	0.02*	1.12+	40 ± 25	56 ± 30	0.38	0.15
Female Mean	**73 ± 13.0**	**71.4 ± 11.8**	**<0.01***	**-0.12**	**708 ± 48**	**661 ± 42**	**<0.01***	**-0.86+**	**18 ± 7**	**27 ± 7**	**<0.01***	**0.91+**	**43 ± 28**	**56 ± 41**	**0.01***	**0.39■**
Service Mean																
Army	74.5 ± 13	73.7 ± 10	<0.01*	-0.17	656 ± 49^	611 ± 54	<0.01*	-0.68○	30 ± 8^	37 ± 9	<0.01*	0.32■	37 ± 13^	60 ± 27	<0.01*	0.89+
Navy	76.8 ± 13	74.9 ± 13	<0.01*	-0.17	665 ± 61#	633 ± 50	0.07	-0.37■	25 ± 9#	32 ± 9	<0.01*	0.54○	47 ± 30#	56 ± 43	0.01*	0.28■
Airforce	74.2 ± 11	72.6 ± 10	0.02*	-0.27■	708 ± 138	631 ± 104	0.04*	-0.66○	22 ± 8	30 ± 9	<0.01*	0.58○	41 ± 31	52 ± 31	0.01*	0.17
Total Mean	**75.5 ± 11**	**73.7 ± 10**	**<0.01***	**-0.20■**	**676 ± 83**	**625 ± 82**	**<0.01***	**-0.57○**	**26 ± 12**	**33 ± 11**	**<0.01***	**0.48■**	**42 ± 21**	**56 ± 39**	**<0.01***	**0.67○**

* Significant difference between pre and post values ($p < 0.05$).
# Significant difference between Airforce and Navy at baseline.
^ Significant difference between Army and Navy at baseline.
■ Small effect size
○ Moderate effect size
+ Large effect size

Table 4. Joint Officer Induction Course Pre-Post Y-Balance Musculoskeletal Screen Scores.

	Right Upper Limb				**Left Upper Limb**				**Right Lower Limb**				**Left Lower Limb**			
	Pre	**Post**	**p-values**	**Effect Size**	**Pre**	**Post**	**p-values**	**Effect Size**	**Pre**	**Post**	**p-values**	**Effect Size**	**Pre**	**Post**	**p-values**	**Effect Size**
Male																
Army	93 ± 6	95 ± 7	0.80	-0.05	93 ± 4	96 ± 6	0.04*	0.17	96 ± 11	96 ± 11	0.52	-0.08	95 ± 6	96 ± 7	0.80	-0.05
Navy	92 ± 7	94 ± 7	0.09	0.35■	92 ± 8	95 ± 7	0.12	0.23■	94 ± 6	96 ± 7	0.29	0.16	94 ± 10	97 ± 10	0.09	0.35■
Airforce	92 ± 7	94 ± 10	0.07	0.55○	94 ± 4	94 ± 7	0.09	-0.44■	98 ± 11	96 ± 9	0.45	-0.11	99 ± 10	96 ± 11	0.07	0.55○
Male Mean	**92 ± 6**	**94 ± 8**	**0.32**	**0.29■**	**93 ± 7**	**95 ± 7**	**0.08**	**-0.01**	**96 ± 8**	**96 ± 8**	**0.42**	**-0.01**	**95 ± 8**	**96 ± 8**	**0.32**	**0.29■**
Female																
Army	95 ± 6	99 ± 5	0.04*	1.11+	97 ± 4	100 ± 6	0.13	0.22■	98 ± 6	98 ± 10	0.49	0.17	96 ± 8	97 ± 7	0.04*	1.11+
Navy	90 ± 12	93 ± 9	0.48	0.93+	87 ± 8	95 ± 6	0.79	-0.10	98 ± 9	97 ± 7	0.19	0.44■	97 ± 8	98 ± 7	0.48	0.93+
Airforce	88 ± 3	88 ± 9	0.82	-1.37+	90 ± 4	90 ± 6	0.21	0.72○	90 ± 9	96 ± 7	0.15	0.98+	88 ± 5	91 ± 7	0.82	-1.37+
Female Mean	**92 ± 9**	**95 ± 8**	**0.45**	**0.22■**	**92 ± 7**	**96 ± 6**	**0.38**	**0.28■**	**97 ± 8**	**97 ± 7**	**0.28**	**0.53○**	**95 ± 8**	**96 ± 7**	**0.45**	**0.22■**
Service Mean																
Army	94 ± 6	97 ± 6	0.38	0.16	95 ± 4	98 ± 6	0.01*	0.19	97 ± 9	97 ± 11	0.88	0.02	96 ± 7	97 ± 7	0.38	0.16
Navy	91 ± 10	94 ± 8	0.15	0.34■	90 ± 8	95 ± 7	0.15	0.19	96 ± 8	96 ± 7	0.24	0.19	95 ± 9	98 ± 9	0.15	0.34■
Airforce	90 ± 5	91 ± 10	0.29	0.35■	92 ± 4	92 ± 7	0.16	-0.27■	94 ± 10	96 ± 8	0.75	0.06	94 ± 8	93 ± 9	0.29	0.35■
Total Mean	**92 ± 8**	**95 ± 8**	**0.28**	**0.28■**	**93 ± 7**	**96 ± 7**	**0.11**	**0.04**	**96 ± 8**	**96 ± 8**	**0.62**	**0.09**	**95 ± 8**	**96 ± 8**	**0.28**	**0.28■**

* Significant difference between pre and post values ($p < 0.05$).

■ Small effect size

○ Moderate effect size

+ Large effect size

Findings from the present study show a significant increase in maximal press-ups pre-post for all JOIC officer trainees collectively ($p < 0.01$). This appears to have been achieved through a combination of both daily prescribed PT and daily manual-handling of equipment (field-stores, pack and weapon). Previous research by Williams, Rayson, and Jones (2002) also documented a similar relationship between traditional prescribed PT (6-8 weeks), manual-handling and muscular-endurance improvement. Interestingly however, although Williams et al. (2002) research was focused on lower body, a similar mean improvement of 28% for maximum repetitions during squatting was found. This supports the muscular-endurance improvement observed in the current study from a similar combination of training.

With core muscular-endurance, although not a specifically targeted training modality, the inclusion of 'functional core training' throughout the course (gym circuits, pack walks, running, swimming, log lifts and tyre flips), likely contributed to an increase in core muscular-endurance. Similar to that observed by Haddock, Poston, Heinrich, Jahnke, and Jitnarin (2016), when prescribed strength training is combined with core strength and functional training within the PT program, it can be very effective in addressing the requirement of improving general strength condition and local muscular-endurance. As there was a requirement to lift, carry and manual-handle equipment on a daily basis further to prescribed PT, a functional training effect may have been gained from such activities (Knapik et al., 2003; Kraemer & Szivak, 2012). This also tends to indicate the prescribed volume of PT and functional training improved core muscular-endurance.

The current study is not without its limitations. These include the lack of control around some of the measures, (e.g., the 2.4km run was outside on the road and weather dependent), and there was no metronome for press-ups and curl-ups or standardisation for the height of the press-ups apart from full extension at the elbows. A further limitation is the difficulty to make comparisons between countries for these tests since most countries and individual militaries use different physical tests for fitness assessments. Future research should use standardised tests to make these comparisons in fitness levels across other militaries around the world. Future research should also consider implementing and comparing specific interventions to further increase physical adaptations during the 6-week JOIC, (e.g. nutrition, training, and recovery).

In conclusion, results from this study have demonstrated that regardless of gender, service and starting fitness level, aerobic capacity and muscular-endurance can be positively enhanced from a combination of both prescribed PT and military manual-handling activates over the 6-week JOIC duration. Army officer trainees possessed greater physical characteristics at baseline and post testing compared to the other two services (Navy and Airforce). Collectively, results showed that 6-weeks of JOIC improved aerobic fitness by ~8%, and muscular-endurance by ~31%. In the future, looking at strategies to improve sleep, recovery and adaptation to gain even greater benefits over the 6-week JOIC and New Zealand Defence Force training courses should be given consideration.

Conflict of Interest

The authors declare no conflict of interests.

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