Title: 1.5 mile run time and body mass predict 8 mile loaded march performance, irrespective of sex.

Final Approved Version Prior to Typesetting

Coakley SL [1], Myers SD [1], Walker EF [1], Hale B [1], Jackson S [2], Greeves JP [2], Roberts R [3], and Blacker SD [1]

[1] Occupational Performance Research Group, Department of Sport and Exercise Sciences, University of Chichester, UK. [2] Army Personnel Research Capability, Army HQ, UK.

[3] HQ Royal Army Physical Training Corps, UK.

✉Address for correspondence:

Dr Sarah Coakley

Department of Sport and Exercise Sciences,

University of Chichester,

Chichester,

PO19 6PE

England

Tel: +44 (0) 1243 816145

Email: S.Coakley@chi.ac.uk

Abstract

Objectives: To develop a statistical model to predict 8 mile Loaded March (LM) performance and quantify differences in physical characteristics for men and women British Army Personnel**. Design:** 135 trained soldiers (87 men; 48 women) completed two sessions, seven days apart. **Methods**: Session 1: Participants' stature, body mass, Fat Free Mass (FFM) [by dual-energy x-ray absorptiometry], Single Lift (SL), Water Can Carry (WCC), and 1.5 mile run performance were measured. Session 2: Participants completed an 8 mile LM, carrying 25 kg (4 miles paced and 4 miles individual best effort). Sex differences were compared using independent samples t-tests and 8 mile LM performance time was predicted using various multiple linear regression analysis: hierarchical forced entry multiple ordinary least squares, principal component and ordinary least products. **Results:** A combination of 1.5 mile run time and body mass were the strongest predictors of 8 mile LM time (R^2=0.71; SEE=4.17 min; p<0.001). Including stature, FFM, sex, SL score, or WCC score did not further improve predictions (p>0.05). Compared to women, men had faster mean 1.5 mile run and LM times, greater body mass and total FFM and higher SL and WCC scores (p<0.001), however some women outperformed men. **Conclusion:** 1.5 mile run time and body mass predict 8 mile LM performance with no further improvement gained in the model by including sex as a variable.

Keywords: Load Carriage; Military Personnel; Sex; Linear Models; Body Composition

Introduction

Military personnel are required to carry heavy loads (e.g. equipment and food supplies), over mixed terrain, for prolonged durations as part of military training and combat operations [1-3]. Repetitive and prolonged load carriage can place significant strain on the musculoskeletal system, increasing the risk of acute and chronic overuse injuries, in particular for untrained soldiers [3, 4]. In an attempt to reduce this risk, Representative Military Tasks (RMTs) have been developed to assess a soldier's physical status and combat readiness which replicate the physical demands of specific military tasks, but in a more practical and safe manner [5, 6].

A prerequisite for applicants wishing to join the Infantry in the British Army is to complete and pass three RMTs to a required standard before basic training, namely a 1.5 mile run (to best effort), a Single Lift (SL; capped at 40 kg; Powerbag™ from the floor onto a 1.45 m platform), and a bilateral Water Can Carry (WCC; 20 kg on each hand, capped at a distance of 150 m). Body mass and stature are also recorded. From these test scores, statistical models can be used to predict military performance at the end of the 26 week Infantry training course (output standard) for SL (≥40 kg), WCC (≥150 m) and 8 mile Loaded March (LM) (carrying 25 kg, to be completed in <2 h, which also forms part of the British Army Annual Fitness Test (AFT)) [7]. A LM model has been developed to predict 8 mile LM (carrying 25 kg) for men from body mass and 1.5 mile run time [7]. This model is important because it allows for the prediction of LM performance, while protecting an untrained applicant or a trained soldier from the physical demands associated with performing the actual task. However, as women have not previously been permitted to serve in UK Infantry roles (prior to the opening of ground close combat roles to the UK Armed Forces in July 2016) the influence that sex *per se* may have on the prediction of LM performance to a British Army Infantry standard has not been evaluated.

Evidence suggests that an average woman soldier will fatigue earlier and is at greater risk of injury compared to men soldiers when performing physically demanding military tasks [8-11], due to differences in body composition and physiological factors [12]. Men soldiers typically have greater muscle strength, lower percentages of body fat, and higher aerobic and anaerobic capacities when compared to women [12-14]. However, the ability of women to undertake RMTs to a British Army Infantry standard has not previously been quantified.

The aims of this study were 1) to develop a statistical model to predict 8 mile LM performance for men and women military personnel and 2) to evaluate the differences between men and women military personnel on RMT performances (SL, WCC and LM).

Methods

Out of an initial cohort of 157 serving soldiers, 135 [87 men and 48 women] attempted all testing sessions (Table 1). Participants were provided with a written brief of the purpose and requirements of the study at least 24 h prior to volunteering and gave written informed consent prior to participating. The study was approved by the Ministry of Defence Research Ethics Committee (740/MoDREC/16). The manuscript was reviewed by the funding organisation (The Ministry of Defence) and approved for publication.

Participants completed three RMTs (SL, WCC and LM) and a 1.5 mile run to best effort or until a safety limit was reached. These tests were completed across two sessions, separated by seven days and participants were tested in groups of 40-50. All tests were conducted according to the British Army Test Protocols and overseen by Army Physical Training Instructors (PTIs). Session 1: Stature, body mass, and FFM were measured. Participants completed the SL, WCC, and 1.5 mile run. Session 2, participants completed an 8 mile LM (4 miles paced in 60 min and 4 miles best effort), carrying 25 kg (daysack, weapon and helmet [carried, not worn]). All testing sessions were completed on the same course for all participants. Participants wore t-shirt, shorts and running shoes for all testing sessions except for the LM, which was completed in combat trousers, combat jacket, and boots. Heart rate was recorded every 5 s throughout all tests (Polar Team 2 system, Polar Electro UK, Ltd, Warwick, UK).

Stature was measured to the nearest 0.5 cm and body mass to the nearest 0.1 kg (Seca 770, Seca Ltd, Birmingham, UK). FFM was measured from a whole-body scan using a dual-energy x-ray absorptiometry (DXA) (Lunar, GE Healthcare). For this measurement, participants wore minimal clothing, no jewellery, and were provided 500 ml of water to consume before the scan to ensure euhydration. During the scan participants lay on the bed and remained as still as possible for approximately 5 min. The scan was an automatic procedure where the scan arm moved from the head to the toe scanning the entire body.

The 1.5 mile run was completed on a 400 m athletics track to best effort, with completion time recorded to the nearest second. The SL required participants to lift a Powerbag (Powerbag™; Leisure

Lines GB Ltd, Hinckley, UK) from the ground to a height of 1.45 m. The Powerbag was placed on the ground 1 m away from the platform. The test commenced at 20 kg, and increased by 5 kg until lift failure or an upper safety limit of 60 kg was achieved. Two spotters were available if the participant could not complete the lift, and they returned the Powerbag to the ground after each lift. Participants were instructed to keep their feet on the ground at all times, not to hyper-extend their back, to grip the bag by placing their hands through the handles and maintain this throughout the lift (an overhand grip was not permitted), and to complete the lift in one phase (e.g. the Powerbag could not be purposefully rested on the legs or chest). The maximum load sucessfully lifted to the nearest 5 kg was recorded as the SL score. At least 30 s rest was allowed between lift attempts and participants were allowed a maximum of two failed attempts.

The WCC required participants to walk continuously up and down a 30 m course at a prescribed pace of 1.5 $m{\cdot}s^{-1}$ (set by a PTI) carrying two 20 kg plastic water cans (one in each hand). The end of the test was determined when the participant could no longer hold the water cans or maintain the required pace set by the PTI. Distance covered was recorded to the nearest 7.5 m.

The LM required participants to complete an 8 mile course carrying 25 kg i.e. the Infantry LM standard. The first 4 miles was completed at a pace of 1.79 $m{\cdot}s^{-1}$ (set by a PTI). At the 4 mile point participants had a 3 min water break before completing the remaining 4 miles individually at a maximum self-selected pace that enabled them to complete the distance as fast as possible. Participants were encouraged to adopt a sensible pace that they could sustain for the remaining distance. One PTI acted as a front marker ahead of the fastest participant, and another maintained the prescribed pace of 1.79 $m{\cdot}s^{-1}$ to assist the slower participants in judging the minimum pass time, with others interspersed throughout the group. Time to complete the final 4 miles of the course was added to the 60 min taken to cover the first 4 miles, to constitute the LM time.

Sex differences for physical characteristics and performance scores were compared using an independent samples t-test. Prediction of 8 mile LM performance was undertaken using two different statistical analysis methods. Firstly, a hierarchical forced entry multiple Ordinary Least Squares (OLS) regression was used, in keeping with the development of previous models [7]. Previous research has shown aerobic fitness (e.g. 1.5 mile run), body mass, muscular strength (e.g. SL) and muscular endurance (e.g. WCC) are important variables in determining LM performance [7]. For that reason, these test variables were entered hierarchically into the LM model based on previous knowledge of perceived importance. Secondly, a Principal Component Analysis (PCA) was run to generate a component containing participants' physical characteristics and performance test scores. This component was entered into a simple Ordinary Least Products (OLP) regression to devise a model to predict LM performance. All data were checked for normality and the assumptions of regression, where appropriate, and are expressed as mean ± one standard deviation (SD). The Standard Error of the Estimate (SEE), and correlation coefficient (R^2) were used to assess the accuracy of the predicted values. Time is reported as a decimal minute (min). Statistical significance was set at $p<0.05$.

Results

Eight women participants were unable to complete the 8 mile LM (voluntary withdrawal). Therefore, the linear regression models only included the 40 women who completed the LM. Compared to women, the men were heavier, had a lower percentage body fat, and greater total FFM ($p<0.001$). 1.5 mile run time, SL, WCC distance and LM performance were also significantly better for men compared to the women ($p<0.001$; Table 1).

*** Insert Table 1 near here ***

All men successfully completed the LM in under 2 h. Out of a total of 48 women, 33 successfully completed the LM in under 2 h; seven completed the LM in more than 2 h, while eight did not complete the LM distance. The proportion of participants who achieved the Infantry standards for each of the RMTs are presented in Table 1. These standards were set during the development of the role-related fitness tests for the British Army [15, 16]. Frequency distributions of men and women performances for the WCC, 1.5 mile run, SL and LM are presented in Figure 1.

**** Insert Figure 1 near here ****

Three iterations of predictive Model 1 were evaluated. Iteration 1 contained 1.5 mile run time, body mass, FFM, WCC and stature. Stature was not a significant predictor variable (p=0.277) and was therefore removed. The FFM was also removed as the tolerance statistics indicated possible multicollinearity with one or more of the other variables. Iteration 2 contained 1.5 mile run time, body mass and WCC. The WCC coefficient, whilst significant (p=0.006) only provided a 0.02 change in R^2 and was therefore removed. Iteration 3 contained 1.5 mile run time and body mass as predictors and explained 71% of the variance in LM performance (R^2=0.71; p<0.001; SEE=4.17 min). Categorical variables were then entered into Iteration 3 to determine if they significantly improved its predictive ability. The SL score as a categorical variable (<or≥ 40 kg, p=0.769) and sex (p=0.679) were not significant when forced into the model, so were not included in the final version (Model 1). The regression equation for the final Model 1 can be used to predict 8 mile LM performance time (min).

Model 1: 8 mile LM time (min) =73.466 + (5.167 x run time [min]) – (0.242 x body mass [kg])

R^2=0.71; p<0.001; SEE=4.17 min.

For the OLP regression method, a PCA was initially performed to identify if a large group of variables would form meaningful components for entry into a regression model. The variables ‘1.5 mile run time’ and ‘body mass’ formed the first ‘principal component’. This component explained 56% of the variance in LM performance time and was included in the regression analysis (R^2=0.65; SEE=4.54 min). While the inclusion of WCC, FFM and stature into the PCA increased the percentage of variance explained by 10%, it reduced the model’s ability to predict LM performance (R^2=0.51; SEE=5.35 min). In addition, the model containing 1.5 mile run time and body mass was not improved when the SL score as a categorical variable (<or≥ 40 kg, p=0.611) and sex (p=0.279) were entered. The final principal component model (Model 2) can be used to predict 8 mile LM performance time (min).

Model 2:

Step 1*:*

Principal Component=0.666 x (z score of run time [min]) – 0.666 x (z score of body mass [kg])

Where;

Z score = (score – mean score)/standard deviation); mean run time=10.19 min; SD run time=1.06 min; mean body mass=74.90 kg; SD body mass=11.15 kg

Step 2:

The component was used to generate a factor for each participant which was entered into a simple OLP regression to devise a model to predict 8 mile LM performance:

8 mile LM time (min) = 107.985 + 7.6145 x Principal Component (from step 1)

R^2=0.65; SEE=4.54 min.

*** Insert Figure 2 near here ***

Discussion

This study showed that 8 mile LM performance to the British Army Infantry standard can be predicted from an individual's 1.5 mile run time and body mass, irrespective of sex. Compared to women, men had faster 1.5 mile run and 8 mile LM performance times, greater body mass, FFM, SL and WCC scores. Although the mean women physical performance scores were lower, some women test scores (as evident in Figure 1) were above the men test scores in the 1.5 mile run, SL, WCC, and LM, with the least overlap in SL (measure of muscular strength). A greater proportion of men compared to women achieved the Infantry pass standard for WCC (150 m standard; 99 vs. 50%), SL (40 kg standard; 97 vs 15%) and LM (<120 min standard; 100 vs. 69%). Whereas, only 6 of the 48 women participants (13%) achieved the Infantry standard across all three RMTs.

Previous research has shown aerobic fitness (e.g. 1.5 mile run time) and body mass to be important predictors of LM performance in men personnel only [7]. As women personnel are now permitted to serve in Infantry roles, but are yet to be directly recruited, it was important to revalidate this model to determine if sex *per se* might influence the prediction of LM performance. Two statistical methods were used to generate LM models from participants' physical characteristics (body mass, FFM, stature) and physical performance test scores (1.5 mile run, SL, WCC). Both methods generated models that contained variables of 1.5 mile run time and body mass to predict LM performance. Sex was not significant in either model when forced into the regression. Figure 2 shows that while men and women LM performances are different, they do follow a similar pattern, further justifying not including sex as a differentiating variable in the derived models. Additionally, the correlation between actual and predicted LM times was marginally stronger when using Model 1 (R=0.84) compared to Model 2 (R=0.81) indicating that Model 1 is a marginally better predictor of 8 mile LM performance (Figure 2). Previous studies have shown muscular strength to be a predictor of LM performance, however, SL did not significantly contribute to the model in the present study. This may be because body mass was a stronger predictor of LM performance and also closely related to whole body strength, therefore, SL provided no additional contribution to the model.

It is understood that there is an association between body mass and aerobic fitness, with favourable changes in body composition associated with improved aerobic performance in military personnel [17]. The LM models developed in this study can be used to determine the minimum 1.5 mile run time required to achieve the 120 min LM Infantry pass time for different body masses. For example, for a 70 kg individual, the required 1.5 mile run time is similar between Models 1 and 2 (12.3 vs. 12.2 min). However, for the lightest participants such as a 60 kg individual using Model 1 would require a slightly slower 1.5 mile run time than Model 2 (11.8 vs. 11.3 min). In contrast for the heaviest participants such as a 110 kg individual using Model 1 would require a considerably faster 1.5 mile run time than Model 2 (14.2 vs. 16.0 min). The relationships between run time, body size and LM performance are common between all of the models. This relationship reinforces the importance of accounting for body mass when predicting LM performance from unloaded tests of maximal aerobic capacity e.g. timed distance runs, shuttle running tests or treadmill-based graded exercise tests [18-20]. It could be speculated that FFM is one of the physiological components underpinning this relationship, with a greater FFM requiring a slower 1.5 mile run time. Changes in 1.5 mile run time and other physical characteristics for men and women recruits during British Army Infantry training and the resultant impact on LM performance should be investigated further when Ground Close Combat Infantry roles are opened to women applicants. These data can be used to guide physical training for load carriage and suggests that increasing aerobic capacity and FFM are likely to lead to improvements in LM performance in both men and women personnel.

Strength is considered a vital physical fitness component for military performance [21]. In the present study, SL appeared to be the RMT that women found most challenging, with only 15% of the cohort achieving the Infantry pass standard of 40 kg. This difference may be attributed to men having a greater stature (179.0 ± 6.5 vs. 166.5 ± 6.0 cm) and FFM (63.1 ± 6.7 vs. 47.0 ± 5.3 kg) compared to women. Previous research has reported a positive relationship between FFM and lifting capacity in military personnel [22, 23]. We also contend that stature would be an important factor in the SL performance due to the 1.45 m platform height, meaning women typically have to extend their arms further than the men to lift the Powerbag to the height of the platform. In addition, it has been reported that muscular strength does not change in men and women recruits over the duration of current British Army basic training [7]. Therefore, further research is required to investigate methods for optimising the development of muscular strength during British Army training, in particular for women, without negatively impacting on the other key components of fitness (e.g. aerobic endurance, anaerobic endurance, muscular endurance and mobility).

Conclusion

A combination of 1.5 mile run time and body mass predict 8 mile LM performance, irrespective of sex. The mean men RMT performance scores exceeded the mean women scores, but individually some women outperformed men. The greatest sex differences in meeting Infantry pass standards was for SL. Therefore, future physical training programmes that integrate women into Infantry roles should focus on developing muscular strength, without compromising the development of other components of fitness required for military activity.

Practical Implications

- LM performance can be predicted from two different types of statistical models, using simple field test measurements (body mass and 1.5 mile run time), irrespective of sex.
- The greatest sex differences between military personnel can be found in muscular strength.
- Body mass should be taken into account when predicting LM performance from unloaded tests of maximal aerobic capacity.

Acknowledgements: The study was funded by the UK Ministry of Defence, Army Personnel Research Capability. The authors thank the study participants for their participation.

References

1. Beekley M, Alt J, Buckley C et al. Effects of heavy load carriage during constant-speed, simulated road marching. *Mil Med*. 2007; 172(6):592-595.
2. Knapik J, Reynolds M. Load carriage in Military Operations. a review of historical, physiological, biomechanical and medical aspects. In: Friedl KE, Santee WR, eds. *Mil Quant physiol: Problems and Concepts in Mil Operational Med. Fort Sam Houston, TX: The Borden Institute, Ft. Detrick, MD* 2012:303-337.
3. Knapik JJ, Reynolds KL, Harman E. Soldier load carriage: historical, physiological, biomechanical, and medical aspects. *Mil Med.* 2004; 169(1):45-56.
4. Orr RM, Pope, R. Gender differences in load carriage injuries of Australian army soldiers. *BMC Musculoskelet Disord.* 2015; 17(1):488.
5. Payne W, Harvey J. A framework for the design and development of physical employment tests and standards. *Ergonomics.* 2010; 53(7):858-871.
6. Tipton M, Milligan G, Reilly T. Physiological employment standards I. Occupational fitness standards: objectively subjective? *Eur J of Appl Physiol* 2013; 113(10):2435-2446.
7. Blacker S, Wilkinson D, Brown P, et al. Revalidation of Physical Selection Standards for Recruits [PSS(R)] for Junior, Infantry and Soldier Pre-conditioning Courses. *Bristol: Optimal Performance Ltd.* 2011.
8. Cline A, Jansen, GR, Melby, CL. Stress fractures in female army recruits: implications of bone density, calcium intake and exercise. *J Am Coll Nutr.* 1998; 17:128-135.
9. Lipster D, Heled Y, Shapiro Y, et al. Physiological aspects of females in combat. *Harefauh.* 1999; 137:521-525.
10. Kelly E, Jonson SR, Cohen ME, et al. Stress fractures of the pelvis in female navy recruits: an analysis of possible mechanisms of injury. *Mil Med.* 2000; 165:142 - 146.
11. Friedl K. Body composition and military performance - many things to many people. *J Strength Cond Res.* 2012; 26:S87-S100.

12. Epstein Y, Yanovich R, Moran DS, et al. Physiological employment standards IV: integration of women in combat units physiological and medical considerations. *Eur J of Appl Physiol.* 2013; 113(11):2673-2690.

13. Knapik J, Sharp M, Canham-Chervak M, et al. Risk factors for training-related injuries among men and women in basic combat training. *Med Sci Sports Exerc.* 2001; 33(6) :946-954.

14. Yanovich R, Evans R, Israeli E, et al. Differences in physical fitness of male and female recruits in gender-integrated army basic training. *Med Sci Sports Exerc.* 2008; 40(11 Suppl):S654-S659.

15. Rayson M, Holliman D, Belyavin A. Development of physical selection procedures for the British Army. Phase 2: relationship between physical performance tests and criterion tasks. *Ergonomics.* 2000; 43(1):73-105.

16. Rayson M. The development of physical selection procedures. Phase 1: Job Analysis. *In Hanson (Ed.), Contemporary Ergonomics, London: Taylor & Francis.* 1998:393 - 397.

17. Mikkola I, Keinanen-Kiukaanniemi S, Jokelainen J, et al. Aerobic performance and body composition changes during military service. *Scand J Prim Health Care.* 2012; 30(2):95-100.

18. Bilzon J, Allsopp AJ, Tipton M. Assessment of physical fitness for occupations encompassing load carriage tasks. *Occup Med. (Lond).* 2001; 51(5):357-361.

19. Blacker SD, Wilkinson DM, Brown PI, et al. Revalidation of Physical Selection Standards for Recruits [PSS(R)] undertaking the Common Military Syllabus (Standard Entry) [CMS(SE)]. Bristol: *Optimal Performance Ltd*; 2011.

20. Blacker SD, Wilkinson DM, Rayson MP. Development of Physical Selection Standards for Officer Cadets [PSS(O)]. Bristol: *Optimal Performance Ltd;* 2012.

21. Nindl BC, Jones BH, Van Arsdale SJ, et al. Operational physical performance and fitness in military women: physiological, musculoskeletal Injury, and optimized physical training Considerations for successfully integrating women into combat-centric military occupations. *Mil Med.* 2016; 181(1 Suppl):50-62.

22. Beckett M, Hodgdon J. Lifting and carrying capacities relative to physical fitness measures. *Naval Health Research Center, San Diego, CA.* 1987; No. NHRC.87.26.

23. Vogel JA, Friedl KE. Army data: body composition and physical capacity. *Body Composition and Physical Perfermance: Applications for Military Services (Wassington, DC: National Academy Press.* 1992; 368.

Table 1: Physical characteristics and performance scores of all participants who attempted the LM and separated for men and women.

	Sample size (n)	Age (y)	Stature (cm)	Body mass (kg)	Fat free mass (kg)	1.5 mile run (min)	SL (kg) IPS 40 kg	WCC (m) 1PS 150 m	8 mile LM (min) IPS 120 min
All	135	26 ± 5	174.5 ± 9.0	74.2 ± 11.3	57.3 ± 10.1	10.3 ± 1.2	45 ± 12	251 ± 140	108.0 ± 7.6
Men	87	25 ± 4	179.0 ± 6.5**	78.7 ± 10.1**	63.1 ± 6.7**	9.7 ± 0.7**	52 ± 7**	302 ± 146**	104.6 ± 5.6**
Women	48	26 ± 5	165.5 ± 6.0	66.0 ± 8.2	46.6 ± 5.3	11.4 ± 1.1	32 ± 6	157 ± 56	115.3 ± 6.1
% men pass IPS							97	99	100
% women pass IPS							15	50	69
Pass									
All	120	26 ± 5	175.5 ± 8.5	75.2 ± 11.2	59.0 ± 9.3	10.0 ± 0.9	47 ± 11	266 ± 140	107.0 ± 6.5
Men	87	25 ± 4*	179.0 ± 6.5**	78.7 ± 10.1**	63.1 ± 6.7**	9.7 ± 0.7**	52 ± 7**	302 ± 146**	104.6 ± 5.6**
Women	33	27 ± 5	166.0 ± 6.0	65.7 ± 8.0	48.0 ± 5.2	10.9 ± 0.9	33 ± 6	170 ± 58	113.3 ± 4.3
Fail									
Women	15	26 ± 5	163.5 ± 6.5	66.6 ± 8.9	43.7 ± 4.2	12.5 ± 0.8	29 ± 5	131 ± 41	125.2 ± 2.8
DNF									
Women	8	28 ± 6	161.0 ± 6.0	63.6 ± 7.1	42.2 ± 3.5	12.2 ± 0.8	28 ± 6	114 ± 31	x

Note: SL = Single Lift; WCC = Water Can Carry; LM = Loaded March; DNF = did not finish loaded march; IPS = Infantry Pass Standard. Significantly different from women * P<0.05; ** P<0.001.

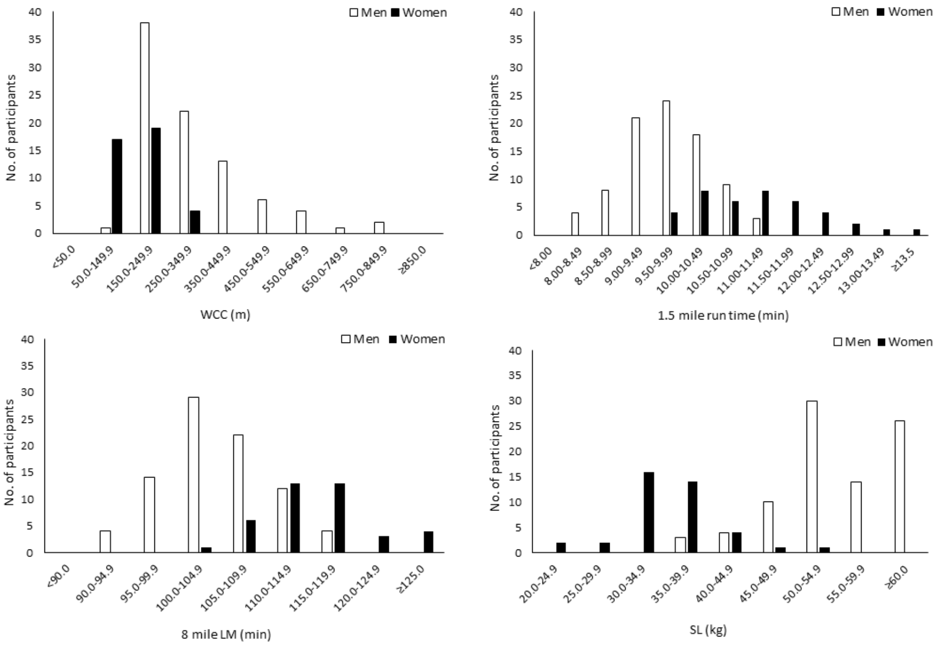

Figure 1: Frequency distributions of men and women performances on the Water Can Carry (WCC), 1.5 mile run, Single lift (SL) and 8 mile Loaded March (LM)

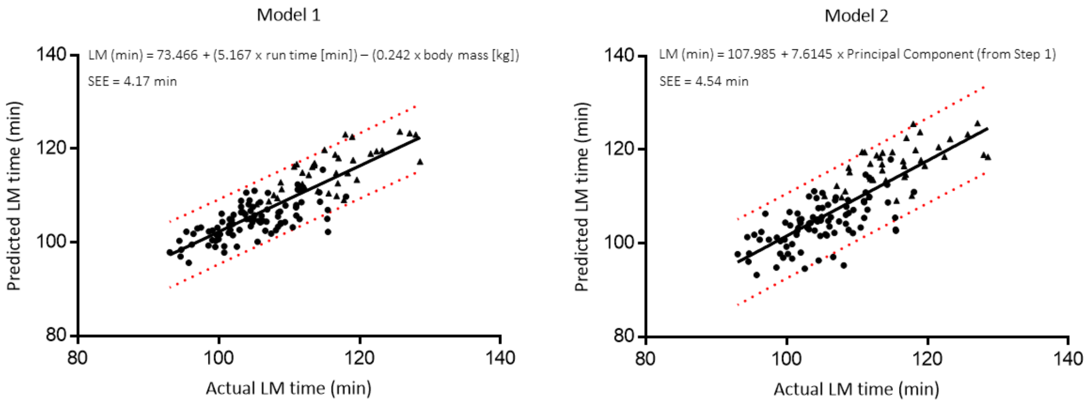

Figure 2: Actual versus predicted Loaded March (LM) performance times for Model 1 and Model 2, with the dashed lines representing 95% confidence intervals. Circle symbols represent men and triangles represent women (n = 127). *Note: Model 2: Principal Component = 0.666 x (z score of run time [min]) – 0.666 x (z score of body mass [kg]).*