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Capability of Fitness Testing to Predict Injury Risk During Initial Tactical Training: A Systematic Review and Meta-Analysis

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Background

- Tactical personnel can be defined as those individuals whose sworn duty it is to protect their country and/or community, and who may place themselves at risk for this purpose [1]
- All tactical personnel require sufficient physical fitness to be able to complete daily occupational tasks safely and effectively [2]
- In order to ensure operational capability under varied and often extreme demands, many tactical organizations have put physical fitness standards in place for initial entry trainees [3]
- The required training, amongst other factors, to meet these standards can place individuals at risk of injury [4,5]
- Therefore, this review sought to identify studies that have investigated associations between fitness measures and injuries, and to synthesize and report key findings to inform tactical organizations

Methods

- A comprehensive literature search within four databases (PubMed, Embase, CINAHL, SPORTDiscus) was performed (Figure 1)
- The Defense Technical Information Center (DTIC) was also searched
- After duplicates were removed, the remaining articles were screened for the following inclusion criteria:

- Evaluated one or more measures of fitness
- Study included data on training injuries and risk of injury
- Study was observational (e.g., not reporting on an intervention)
- Was peer-reviewed, original research, and
- Published after 1997

Articles were excluded under the following criteria (Figure 1):

- No fitness measure correlated with injury risk during initial tactical training
- Single event follow-up
- Sporting injury, or
- Heat injury

- Articles were critically appraised to determine the methodological quality by two authors (CT & SS) using the CASP toolkit [6]
- Cohen's kappa coefficient was used to measure the level of agreement and was calculated by a third author (RO)
- Studies were selected for meta-analysis based on the following criteria:
 - Study investigated a timed running event and injury risk
 - Data were reported categorically with a referent risk ratio
- A random-effects model was used to account for differences in tactical subpopulations, different run lengths and varied sample sizes (Figure 2)
- To account for differences in categorization (quartile, quintile, half), only the fastest and slowest group from each study were included

Results

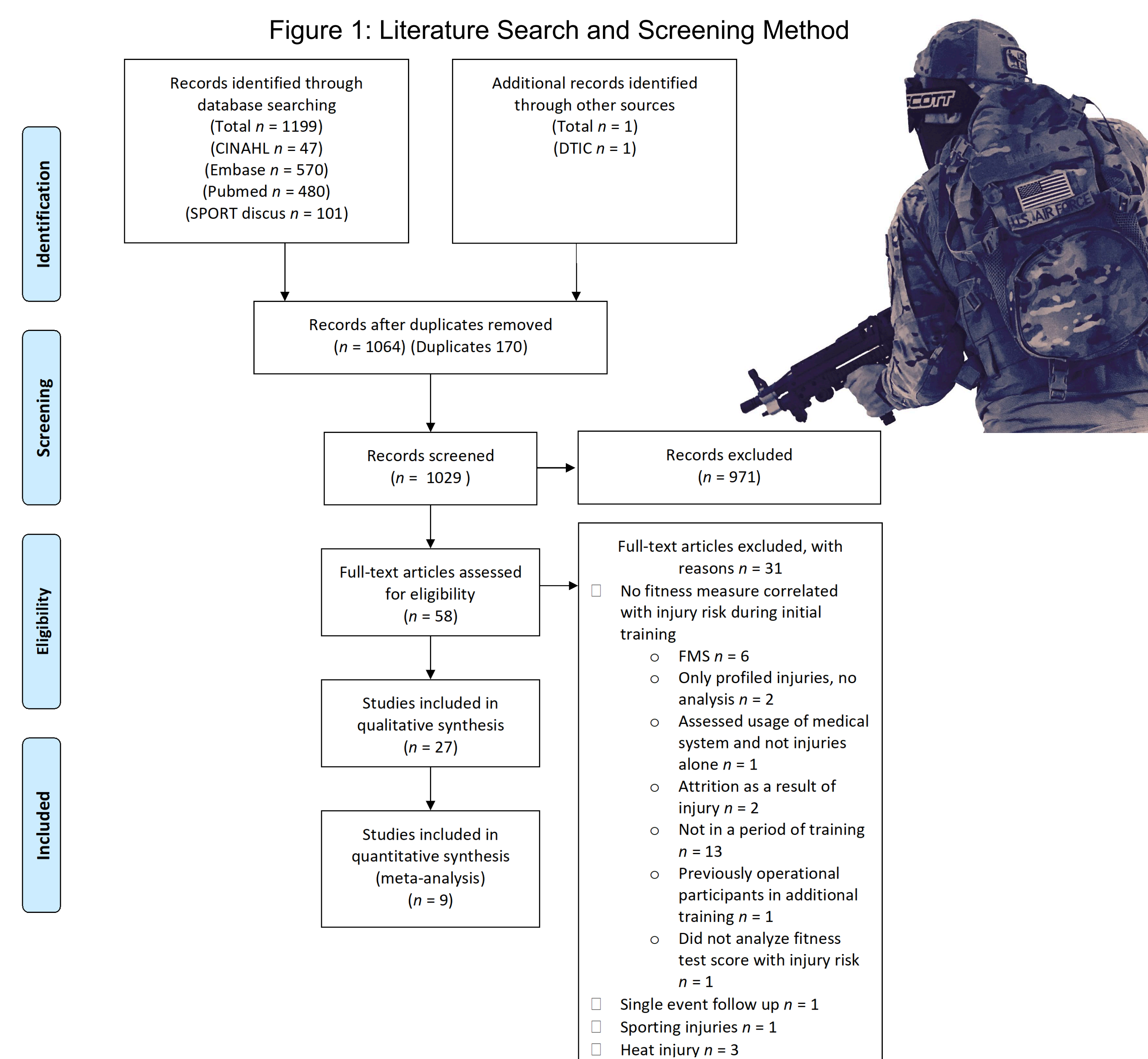
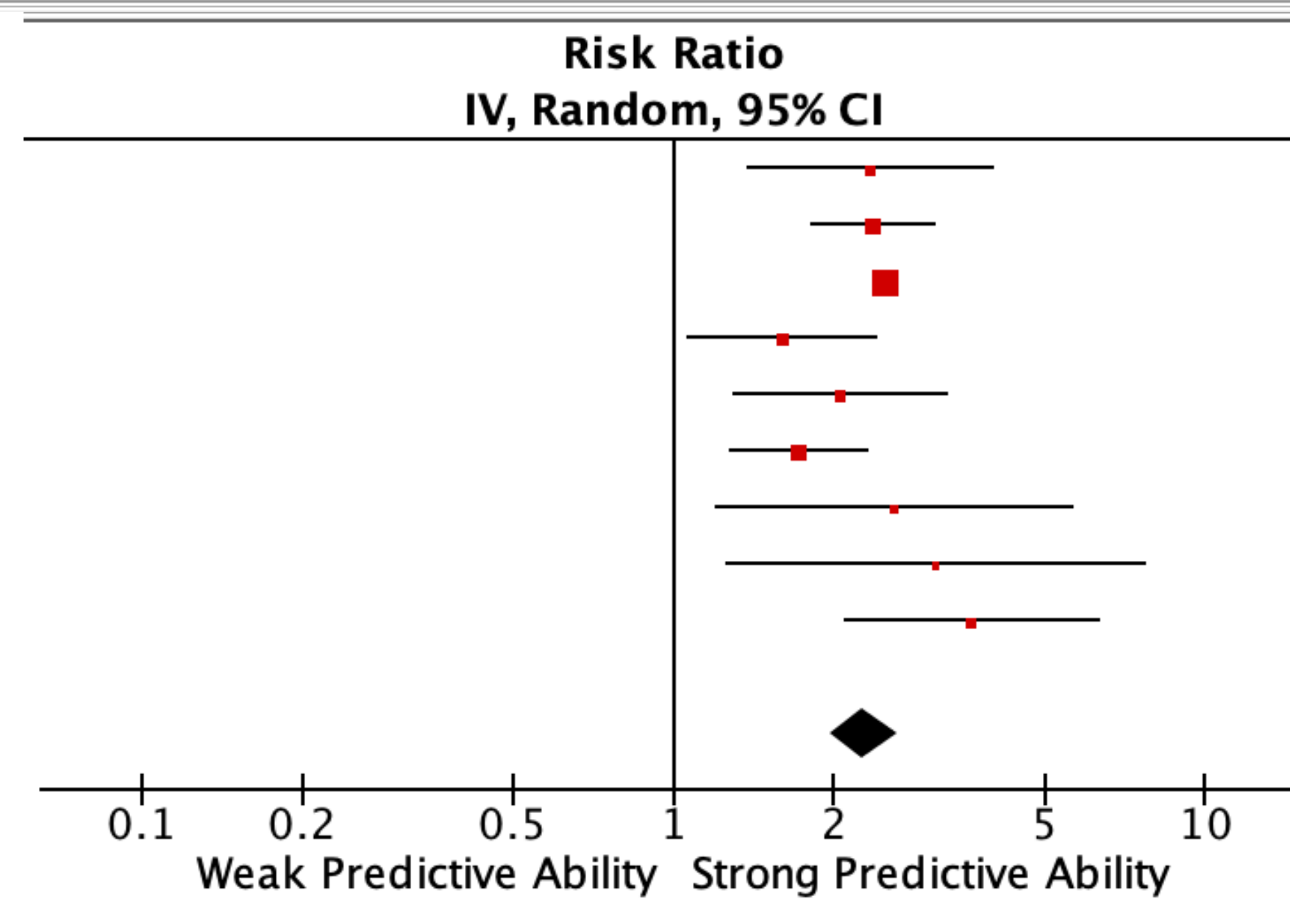


Figure 2: Forest Plot of Timed Run Event Injury Prediction Meta-Analysis

Study or Subgroup	log[Risk Ratio]	SE	Lowest Performers		Highest Performers		Risk Ratio	
			Total	Weight	Total	Weight	IV, Random, 95% CI	
Blacker 2008	0.8502	0.2697	2688	6.3%	2664	6.3%	2.34 [1.38, 3.97]	
Hall 2017	0.8629	0.1347	610	16.3%	302	16.3%	2.37 [1.82, 3.09]	
Jones 2017	0.9163	0.0208	28393	34.1%	28713	34.1%	2.50 [2.40, 2.60]	
Knapik 2001	0.47	0.2069	169	9.5%	161	9.5%	1.60 [1.07, 2.40]	
Knapik 2011	0.7227	0.2349	106	7.8%	108	7.8%	2.06 [1.30, 3.26]	
Lisman 2013	0.5423	0.1505	430	14.4%	428	14.4%	1.72 [1.28, 2.31]	
Rauh 2006	0.9555	0.3945	204	3.2%	204	3.2%	2.60 [1.20, 5.63]	
Shaffer 1999	1.1346	0.4599	272	2.4%	267	2.4%	3.11 [1.26, 7.66]	
Shaffer 2006	1.2892	0.2792	696	5.9%	686	5.9%	3.63 [2.10, 6.27]	
Total (95% CI)			33568	100.0%	33533	100.0%	2.27 [1.96, 2.63]	

Heterogeneity: Tau² = 0.02; Chi² = 13.42, df = 8 (P = 0.10); I² = 40%
 Test for overall effect: Z = 11.01 (P < 0.00001)



Results

- Mean CASP score was 10.6/12 (range 9-12)
 - Level of agreement: $k = 0.750$
- Three tactical subpopulations were represented:
 - Military, Police, and US Federal Bureau of Investigation
- Studies by sex: n=11 included both male and female trainees, n=8 males only; n=5 females only
- Studies by fitness measure: n=21 investigated a measure of aerobic fitness, n=9 investigated a pushup test, n=10 investigated a situp test, n=3 investigated a chinup or pullup test, n=3 investigated a true strength measure
- Studies by injuries: n= 11 reported on any musculoskeletal injury, n=7 examined lower limb stress fractures specifically, n= 2 reported on any injury, n=2 reported any musculoskeletal injury requiring hospitalization, n=2 reported any musculoskeletal injury requiring referral, n=1 examined time-loss injuries, n=1 reported any lower limb injury

Summary

- Meta-analysis indicates that slower run times are unequivocally associated with a substantially higher risk of injury during training: RR 2.27 (CI=1.96-2.63)
- Direct physiological testing of VO_{2max} as performed by Knapik et. al., [7] agrees with the meta-analysis results indicating metabolic fitness is key in mitigating injury risk during tactical training
- True strength tests described significant findings, but only three publications investigated a true strength measure
- Potential differences in findings may be due training environmental specificity where those training environments which perform a high amount of running may find running as a predictor as opposed to those training environments who perform less running.
- Based on the data from this review, tactical organizations may benefit from using fitness testing data to identify personnel in need of intervention to minimize risk of training injury

Conclusion

- Individuals who perform poorly on a timed run, in particular, are at greater risk of injury than fitter peers when undergoing tactical training
- Fitness test results could be used as a reliable means of identifying trainees at greater risk of injury for proactive intervention but further research specific to the training environment is needed

Key References

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