Mini-Review/Systematic Review

Physical tests based on combat tasks: a systematic review

WC Botta[1,2], JMMP Santos[1,2], JP Borin[1]

[1]*Universidade Estadual de Campinas, Faculdade de Educação Física, Campinas, SP, Brazil;*
[2]*Academia da Força Aérea, Pirassununga, SP, Brazil.*

Associate Editor: Angelina Zanesco. [1]Universidade Metropolitana de Santos, Faculdade de Medicina, Santos, SP, Brazil; [2]Universidade Estadual Paulista "Júlio de Mesquita Filho", Departamento de Educação Física, Instituto de Biociências, Rio Claro, SP, Brazil. E-mail: angelina.zanesco@unesp.br.

Abstract - Aim: Military personnel needs to develop and maintain the ability to perform specific mechanical actions, under the risk of not fulfilling their assignments and failing in their missions. Considering the importance of being able to evaluate whether the military is ready for their jobs, studies have been conducted to establish assessments based on the requirements of the tasks performed in combat, referred to as Combat Tasks (CTs), giving rise to Simulated Tasks (STs). This study aimed to understand how physical STs have been used among military personnel worldwide. **Methods:** A systematic review was conducted to identify literature published between 2001 and 2021 that investigated STs. The search criteria for articles (keywords, inclusion, and exclusion) were applied to five databases - PubMed, Cochrane, Embase, Scopus, and Web of Science - and the PRISMA recommendations were followed. **Results:** The searches resulted in 2630 documents, in addition to two studies that came from other sources. After the removal of duplicates, 1216 studies were screened by title and abstract, resulting in 71 documents, which were read in full. In the end, 17 studies were selected for the qualitative analysis. **Conclusion:** From the data obtained, the results highlighted that six countries with well-structured Armed Forces have been investing in research to develop physical assessments based on CTs, showing a paradigm break regarding conventional physical tests, which ultimately prove to be adequate to measure general fitness levels and issues related to health, but are not sufficient to ensure readiness for the performance of specific military activities.

Keywords: military healthy, military personnel, physical functional performance, readiness.

Introduction

The military profession is very peculiar, and it can be stated that its members must be permanently able to perform Combat Tasks (CTs), which can be defined as the actions performed during a real mission. When the troops are ready to perform their core activities, the levels of readiness for combat are high, and there is a certainty that the constitutional duties of the Armed Forces will be fulfilled, such as the guarantee of law and order and maintenance of the state of peace, among others[1].

It is known that in real missions, several stressors can arise, such as psychological overload, sleep restriction, energy deficit, and physical exhaustion, which cannot be avoided, but whose negative impact can be minimized through adequate preparation. That said, improving the physical capabilities of the military can significantly increase combat readiness levels and may even develop psychological attributes such as maintenance of mood, cognitive abilities, and pain thresholds[2].

In this context, just as important as investing in training programs is having the ability to reliably evaluate preparation levels. One of the strategies that have emerged for this purpose is Simulated Tasks (STs), developed based on the requirements of the CTs and with high face validity levels[3], which means that this kind of evaluation can reproduce the physical demands of the tasks originally performed in combat. There are basically two types of physical tests: the first focused on simple physical capabilities, and the other focused on task performance[4]. The first type is effective in determining the general health condition of the individual but does not necessarily have a relationship with performance in field activities[3,5]. Conversely, the second is reliable for showing whether the individual will be able to perform satisfactorily in their core combat activities.

Based on this context, the present study aimed to conduct a systematic review without a meta-analysis, following the PRISMA recommendations[6], to answer the following question: how have task-based physical tests been used among military populations from representative Armed Forces worldwide? This systematic review presents the first effort of the Brazilian Air Force to establish a reliable Physical Employment Standard (PES)

for its military personnel, which includes the CTs applicable to a specific branch, the physical demands involved in their performance, and the best assessments for them.

Methods

Search strategy

The searches were conducted between February and September 2021, to identify how STs, based on CTs, have been applied among military populations. The PRISMA recommendations were followed[6], and the review was registered in the PROSPERO platform under code number CRD42021257671.

The following databases were consulted: PubMed, Cochrane, Embase, Scopus, and Web of Science. In addition to these, given that some studies related to the topic of interest may not have been published, individual contacts were also made by email with researchers linked to the laboratories of the United States, Canada, Finland, Sweden, Australia, and the United Kingdom.

The following search equation, with the terms and their variations, was adapted to the standards of each database: {military OR military personnel OR soldier OR armed force OR army OR navy OR air force OR marines} AND {soldiering task OR physically demanding task OR military task OR occupational task OR job task OR combat task OR physical employment test OR task performance OR task simulation OR performance test OR tier II OR critical task OR physical employment standard OR warrior task}.

The inclusion criteria adopted were as follows: 1) complete original articles from the last 20 years; 2) samples consisting of apparently healthy military personnel; 3) the subjects should wear clothing and equipment similar to those used in real situations; 4) the combat tasks that influenced the development of the assessment tests should be relevant to the Brazilian Air Force; 5) there should be a relationship between the tests applied and combat tasks; 6) the results and evaluation protocols should be clearly presented, and 7) the tests should allow for individual assessment. In addition, an article was excluded when: 1) the main objective was to evaluate physical training programs or the efficacy of drugs and medications, and 2) a retrospective data analysis was performed. The search results, as well as the study selection process, are presented in the flow chart in Figure 1.

Data extraction

Two researchers conducted the database searches separately, eliminating duplicates, reading the titles and abstracts, and reading the articles in full. The last two steps were performed using the Mendeley® software, and the text boxes were used to elucidate the reasons why the studies were included in or excluded from the systematic review, as well as highlighting the main points of the articles selected for qualitative analysis.

Results

A total of 2630 articles were identified in the first searches, in addition to two documents sent by other sources. After the removal of duplicates, which was performed in the Rayyan® software, a total of 1216 articles were obtained, which were then analyzed by title/abstract. A total of 71 records were considered eligible and were read in full by the researchers, and then 17 articles were included for the qualitative analysis phase, according to established criteria. It should be noted that among the reasons for exclusion, the four that most influenced the results were as follows: 1) incomplete articles; 2) samples consisting of non-military people; 3) studies that evaluated the effectiveness of training programs; and 4) the inexistence of Simulated Tasks within the study. A summary of the data extraction from the articles can be seen in Table 1.

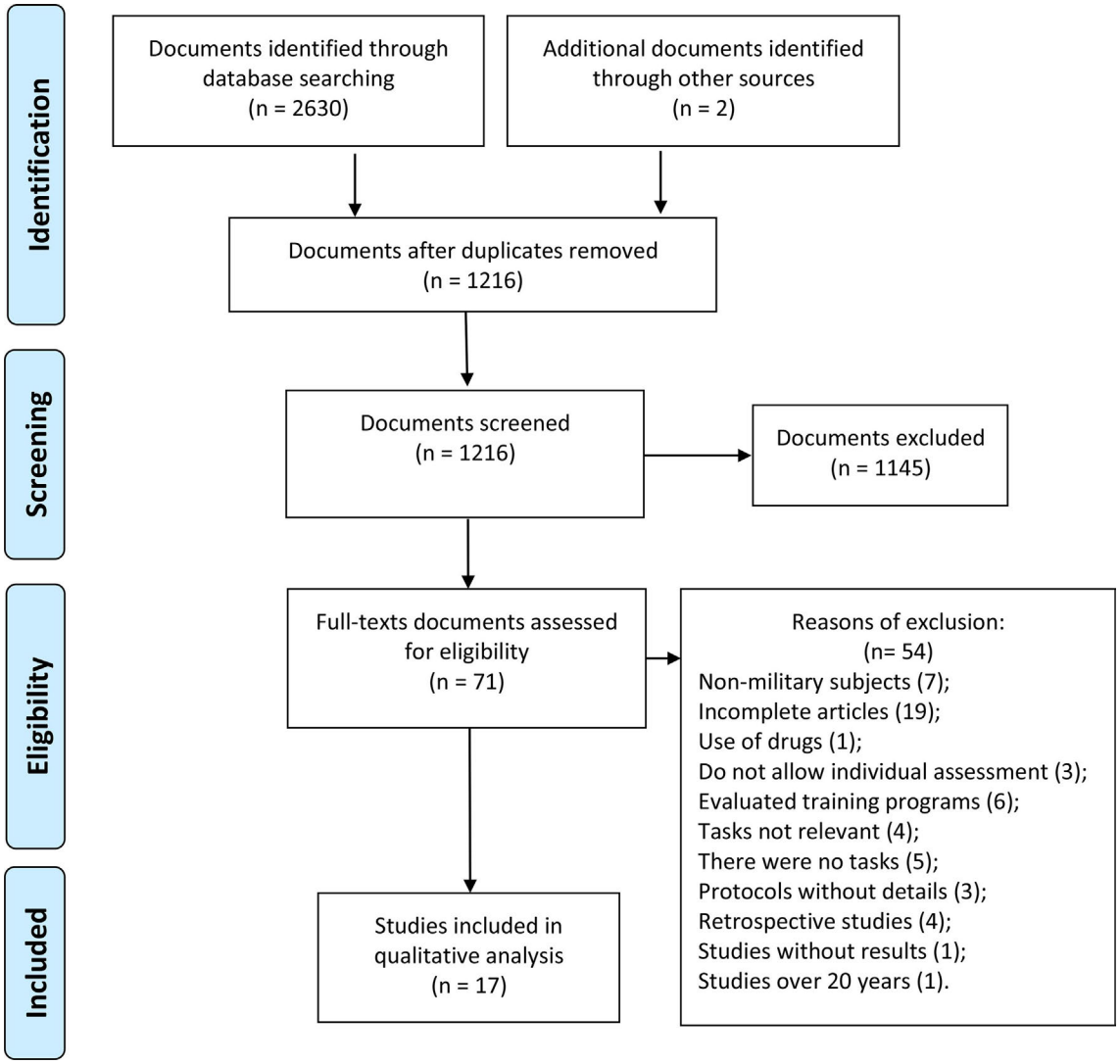
Of the 17 studies selected for qualitative analysis, three were from the United Kingdom, four were from Australia, seven were from the United States, one was from Finland, one was from Canada, and one was from Brazil.

All studies presented STs involving weight loading: ammunition boxes, sandbags, fire extinguishing equipment, or others. In addition, 15 records presented tasks with anaerobic demands, such as short runs, displacements in obstacle courses, and weight bearing in short stretches. The STs that appeared most, in terms of several occurrences (11), were those related to the rescue and transport of casualties, either using stretchers or through direct contact.

Regarding the use of STs, six studies sought to understand and quantify the metabolic and physiological demands of the tasks[7,8,9,11,20,22]. Four studies applied STs to determine their reliability and learning effect indices[16,13,18,19]. In addition, one study sought to compare performance between two groups of military personnel with different experience times[10]; five studies investigated the predictive power of specific physical tests in relation to STs[5,12,14,17,19]; two studies focused on understanding how performance can be affected with and without the weight of additional equipment [15,21], and only one study effectively aimed to evaluate the participant's ability to perform CTs[8].

Discussion

This study investigated the literature in order to clarify how Armed Forces around the world have been using STs in their physical evaluation contexts, and the diversity



of nations found highlights the importance of the topic, especially considering that the countries cited have representative Armed Forces on the world stage. General physical fitness tests have been considered insufficient to predict performance in CTs[3,5], which has motivated the development and validation of STs.

The methodological criteria involved in the establishment of a PES are quite complex, and it usually takes several years of research to be ready[4,24]. It can be seen that ten studies highlighted in this systematic review are in different phases of this process; six of them are trying to understand and quantify the metabolic and physiological demands of some tasks[7,8,9,11,20,22], and four studies are aiming to determine the reliability and learning effects levels of some STs[16,13,18,19]. Analyzing this scenario, it can be noted that, although STs have been developed to evaluate the capability to perform CTs, there are few documents ultimately focused only on this aspect. It is understood, however, that the final objective of these Armed Forces will be to use the validated STs to evaluate the combat readiness levels of their troops.

It can also be noted, from the reading of the extracted data contained in Table 1, that there is no worldwide standardization regarding the STs that are applied among each Armed Force, but all have been developed based on the physical demands of CTs that have proven to be relevant to their context. The literature corroborates with this idea because STs that do not have a direct connection with CTs are not useful to assess combat readiness levels[19]. One of the main pillars in the development of STs is the specificity of the actions performed in combat and, although some tasks are common to all military personnel, a lot of them are influenced by the war strategies, the equipment and guns available, and the prevailing environment of the country.

The fact that all the studies presented STs involve weight loading is very interesting because it shows that it is a fundamental skill for military personnel in action,

Table 1 - Summary of selected studies.

Authors	Objectives	Simulated Tasks	Combat Tasks	Main findings
Bilzon et al. (2001)[7]	To quantify the metabolic demand of shipboard fire extinguishing procedures among the U.K. Royal Navy	Boundary cooling; drum carry; extinguisher carry; hose run; ladder climb	Perform shipboard firefighting duties	The metabolic demands of the 5 Simulated Tasks developed were determined, and the "drum carry" was the most demanding one
Bilzon et al. (2002)[8]	To identify the requirements to perform some tasks on board, quantify the metabolic demands of firefighting tasks and identify tests to predict performance on casualty-carrying tasks among the U.K. Royal Navy	Vertical climb through an escape hatch; open and secure a hatch; open and secure a bulkhead door; fire extinguishing tasks; carry a casualty	Perform routine actions on board; fight fires on board; carry a casualty with and without stretcher	The implementation of Simulated Tasks and predictive physical tests can ensure that the subjects have the critical capabilities to perform their functions on board and survive at sea
Burdon et al. (2019)[9]	To identify individual criterion tasks and quantify the physiological demands when the tasks were performed in simulated scenarios among the Australian Navy	Repeatedly handle a 10 to 15 kg crate; simulation of firefighting on board; rescue of a wounded person in a toxic environment; rescue with hose and weight loading	A total of 33 Combat Tasks were listed	Six Combat Tasks were considered critical. In addition, it was shown that a circuit comprising several Simulated Tasks may be the most effective way to find professionals capable to perform their functions
Canino et al. (2019)[10]	To compare physical fitness and occupational task performance between groups of soldiers with different experiences among the U.S. Army	Sandbag carry; casualty drag; move under direct fire	Load and transport equipment; drag a casualty to a safe place; move under enemy threat	Differences on performance between experienced and inexperienced soldiers were evidenced
Canino et al. (2020)[11]	To examine the relationship between total relative oxygen uptake during three soldiering tasks, with two field-expedient measures of training load among the U.S. Army	Sandbag fill; sandbag carry; ammunition can carry	Build a barricade to protect yourself from gunshots; transport ammunition to a combat vehicle	The training load during the execution of Simulated Tasks can be monitored or quantified through heart rate and subjective perception of effort
Carstairs et al. (2016)[12]	To assess the utility of generic predictive tests and a task-related predictive test in predicting performance against four manual handling tasks among the Australian Army	A pack lift and place; artillery loading; bombing up a tank; bridge building simulation	Lift a field pack and place it on a vehicle; participate in a firing mission; stock a battle tank; build a bridge	Push-ups and pull-ups are poor predictors of a soldier's capacity to perform three of the four manual handling tasks
Foulis et al. (2017b)[13]	To determine the reliability of simulated physical soldiering tasks relevant to Combat Arms soldiers the U.S. Army	Sandbag carry; casualty drag; casualty evacuation from a vehicle; move under direct fire; stow ammunition on a tank; load the main gun of a tank; transfer ammunition with a field artillery vehicle; 4-mile foot march	Equipment carries; rescue of casualties; move under enemy threat; transport and store ammunition; travel on foot carrying weapons and equipment	All the Simulated Tasks analyzed in this study showed good reliability indices, which may be useful for evaluation purposes
Foulis et al. (2019)[14]	To determine the accuracy of OPAT (Occupational Physical Assessment Test) cut scores and to determine which events contribute to the individuals that are misclassified among the U.S. Army	Sandbag carry; casualty drag; casualty evacuation from a vehicle; move under direct fire; stow ammunition on a tank; load the main gun of a tank; transfer ammunition with a field artillery vehicle; 4-mile foot march	Equipment carries; rescue of casualties; move under enemy threat; transport and store ammunition; travel on foot carrying weapons and equipment	There was a high classification concordance between success on the OPAT and the Simulated Tasks
Jaworski et al. (2015)[15]	To determine the effects of load on performance of combat-related tasks among the U.S. Marines	Circuit containing short runs, crawling, mannequin dragging, transport of ammunition boxes and grenade toss	Perform a precision gunshot and evade safely; rescue a casualty; transport ammunition; throw grenades	The data showed that loading more than 30% of the body mass in equipment could decrease the performance on Simulated Tasks
Pandorf et al. (2003)[16]	To determine the number of test sessions needed to stabilize performance on two military occupational physical tests and to assess	Indoor 6-station obstacle course; repetitive box-lifting task	Perform displacement under enemy threat; carry equipment to a combat vehicle	Reliability was achieved after the first attempt to the box-lifting task and after two attempts to the obstacle course

(*continued*)

Table 1 - continued

Authors	Objectives	Simulated Tasks	Combat Tasks	Main findings
	their reliability among the U.S. Army			
Pihlainen et al. (2017)[17]	To evaluate the associations of physical fitness and body composition characteristics with anaerobic endurance performance among military personnel of Finland	A circuit containing short runs with change of direction, crawling, obstacles, weight bearing and mannequin dragging	Escape an ambush situation	Important characteristics of a soldier involved with combat are a high level of muscular power in the lower extremities, endurance capacity, large muscle mass in relation to fat mass as well as the external load carried
Reilly et al. (2019)[18]	To investigate the number of attempts needed to establish reliability of FORCE COMBAT™ tests among the Canadian Army	Short runs assuming firing positions; sandbag lifts; casualty drag; loaded shuttle; foot-march	Tasks during combat or work in urban environments	Subjects who are already familiar with the FORCE evaluation should complete one FORCE COMBAT™ practice trial before being assessed
Silva et al. (2020)[5]	To investigate the relationship between physical and anthropometric parameters with performance on an obstacle course among the Brazilian Air Force	Obstacle course totaling 242.5m	React to an ambush during a mission	A greater distance traveled in the 12-min running test, a heavier free-fat mass and a higher number of sit-ups were correlated with a shorter time on the Obstacle Course
Spiering et al. (2019)[19]	To determine the reliability and construct validity of a battery of tests designed to assess soldier task performance among the U.S. Army	30-m grenade throw; running long jump; 1 repetition maximum box lift; 3.2-km load carriage time trial	Throwing grenades; overcome obstacles; travel on foot carrying weapons and equipment	Performing the tests as a battery had minimal effect on the reliability of the individual tests
Tofari et al. (2013)[20]	To investigate the physical and physiological demands of performing tasks among the Australian Army	Fire suppression; casualty drag; climbing stairs with equipment; access to collapsed structures	Firefighting; rescue in an urban area; climbing stairs carrying equipment; perform rescue in collapsed structure	A battery of tests developed to evaluate combat tasks should involve the clothes and loads that will be used in real missions
Treloar et al. (2011)[21]	To examine the effects of load carriage on performance of an anaerobic military task among the Australian Army	Short sprints assuming firing positions	React to an ambush during a mission; work on urban-based operations	The greatest decrement in performance was observed when loaded soldiers were expected to rise from the prone position and begin sprinting
Treweek et al. (2019)[22]	To develop a Physical Employment Standard (PES) for the British Royal Air Force	Foot-march; react to enemy fire; crawl; casualty drag in different ways; lift; climb over a wall	Tactical advance; react to an ambush; rescue a casualty; transport equipment; overcome obstacles to access places of interest	The physiological demands of the 8 Simulated Tasks proposed by the authors were determined

which has been already highlighted in the literature[23]. A soldier needs to be able to fight, walk, run, swim, and perform several other actions in combat carrying a lot of load[25], and modern warfare demands this kind of capability. It is known that a soldier in the field may be required to carry ammunition boxes, carry heavy weapons, protect themselves from enemy fire by building sandbag barriers, and walk long distances carrying up to 58% of their body weight[15], so it is impossible to think about establishing a PES without considering these tasks.

Just as important as the weight-loading tasks are the ones with anaerobic demands, such as short runs, displacements in obstacle courses, and weight bearing in short stretches. This review found 15 records involving these kinds of tasks, which may be useful when facing an ambush situation in combat or urban operations[21]. Several physical fitness assessments in the military include aerobic tests, but it is unusual to have anaerobic ones[26], which reinforces the urgency of developing a PES and STs in order to guarantee that troops will always be ready to deploy. The anaerobic STs that most appeared in this review, in terms of many occurrences (11), were those related to the rescue and transport of casualties. These tasks are essential in a lot of combat environments[13] because every soldier must have the ability to help wounded people in order to give them the chance to survive or maybe to keep fighting.

This systematic review had two limitations, the first being the fact that only articles in English were included. The second relates to the wide range of different STs pre-

sented in the studies, which made it difficult to perform direct and specific comparisons.

Conclusions

Modern warfare has been demanding from Armed Forces around the world a lot of investigation on physical preparation and evaluation, and it can be seen that several countries have invested in research to develop a PES and physical assessments based on CTs, showing a paradigm break regarding the conventional physical tests, which end up proving to be adequate to measure general fitness levels and issues related to health but are not sufficient to ensure readiness for the performance of specific military activities[12].

Thus, studies on the development and validation of STs should continue to be encouraged in the context of the Armed Forces, under the risk that military personnel will not be adequately prepared to successfully fulfill their professional duties. The authors suggest future studies to improve the PES for Brazilian Air Force personnel.

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Corresponding author

Willian Carrero Botta, Universidade Estadual de Campinas, Faculdade de Educação Física, Campinas, SP, Brazil.
E-mail: al_botta@hotmail.com.

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