International Journal of Industrial Ergonomics 56 (2016) 9–16

Contents lists available at ScienceDirect

International Journal of Industrial Ergonomics

journal homepage: www.elsevier.com/locate/ergon

Developing physical and physiological employment standards: Translation of job analysis findings to assessments and performance standards – A systematic review

Ben Beck, Daniel C. Billing*, Amelia J. Carr

Land Division, Defence Science and Technology Group, Australia

ARTICLE INFO

Article history:
Received 15 April 2015
Received in revised form
7 June 2016
Accepted 10 August 2016
Available online 10 September 2016

Keywords:
Physical employment standards
Job analysis
Physical aptitude tests
Job-related fitness
Occupational fitness

ABSTRACT

Physical employment standards (PES) are developed with the aim of ensuring that an employee's physical and physiological capacities are commensurate with the demands of their occupation. While previous commentaries and narrative reviews have provided frameworks for the development of PES, this is the first systematic review of the methods used to translate job analysis findings to PES tests and performance standards for physically demanding occupations. A search of PubMed and Google Scholar was conducted for research articles published in English up to and including March 2015. Two authors independently reviewed and extracted data.

The search yielded 87 potentially eligible papers, including 60 peer reviewed journal articles and 17 technical reports. 57 papers were excluded leading to a final data set of 31 papers, representing 22 studies. Job analysis was most commonly conducted through subjective determination of job tasks followed by objective quantification and validation. Determination of criterion tasks was evenly distributed through subjective and objective methods with criterion tasks being defined most commonly as most demanding, critical and/or frequent. Generic predictive and task-related predictive tests were more commonly observed in isolation or in combination when compared to task simulation tests. Performance standards were more commonly criterion-referenced than norm-referenced with a variety of statistical methods utilised. This review provides recommendations for researchers when developing physical employment standards for a variety of occupations.

1. Introduction

The development of physical and physiological employment standards (PES) is based on the premise of matching an employee's physical attributes with the physical demands of their job. The implementation of PES can lead to increased capability and productivity in the workplace (Taylor and Groeller, 2003) and have been shown to significantly reduce injuries across a range of occupations (Harbin and Olsen, 2005; Larsson and Harms-Ringdahl, 2006; Rosenblum and Shankar, 2006).

The development of PES commonly involves two key stages: task observation and analysis, and test development (Constable and Palmer, 2000; Payne and Harvey, 2010; Tipton et al., 2013). A summary of Payne and Harvey (2010) framework is presented in Table 1. The task observation and analysis process has previously been reviewed extensively (Campion, 1983; Constable and Palmer, 2000; Taylor and Groeller, 2003; Larsen and Aisbett, 2012). Task observation and analysis has typically been divided into two components: job task analysis, and physical demands analysis (Rayson, 2000). Job task analysis involves determining a list of physically demanding tasks conducted within an occupation. Common methods in job task analysis include the use of questionnaires, interviews, subject matter expert (SME) consultation and job observation with the aim of ascertaining task details, such as frequency and duration. Physical demands analysis is the process of quantifying the physical elements of the task, such as the equipment used, load movement descriptors and the environment in which the work is conducted, as well as the physiological strain, with measures such as heart rate and oxygen consumption. The quantification of the physical and physiological demands has been

* Corresponding author. Land Division, Defence Science and Technology Group, Melbourne, VIC 3207, Australia.
E-mail address: daniel.billing@dsto.defence.gov.au (D.C. Billing).

http://dx.doi.org/10.1016/j.ergon.2016.08.006
0169-8141/

Table 1
Summary of the development of physical employment standards (summarised from (Payne and Harvey, 2010)) The steps described in this table are the focus of this review.

Elements	Step
Task observation and analysis	1. Identification and confirmation of job tasks
	2. Observation and measurement of selected job tasks
	3. Analysis of physical demands of selected job tasks
	4. Identification and review of criterion job tasks on which to base physical employment tests
Test development and determination of physical employment standards	5. Development of a set of potential physical employment tests
	6. Establish relationship between potential test and task performance
	7. Identification of provisional physical employment standards for potential physical employment tests
	8. Selection of the final battery of physical employment tests and confirmation of physical employment standards

described in detail previously (Taylor and Groeller, 2003; Tipton et al., 2013). As part of the job task analysis phase or the physical demands analysis, criterion, or critical, tasks are determined and form the basis of PES development. Factors involved in determining criterion tasks include task frequency, importance, criticality, duration and the physical demands (Jamnik and Gledhill, 1992; Taylor and Groeller, 2003; Payne and Harvey, 2010; Tipton et al., 2013).

After the physically demanding job tasks have been quantified, PES tests are developed. These tests aim to replicate or induce an equivalent physical and physiological demand to the criterion job task being assessed. PES tests are commonly divided into generic-predictive, task-related predictive, and task simulation tests (Payne and Harvey, 2010; Gumieniak et al., 2011). Generic-predictive tests (or basic physical ability tests) are, as the definition suggests, generic in nature and do not have specific job-related characteristics. Task simulation tests are those that directly replicate criterion job tasks. Task-related predictive tests incorporate elements of the two aforementioned assessments to develop a test that is more generic than a task simulation, but retains elements of job-related tasks (Payne and Harvey, 2010).

Performance standards (or cut-scores) are required on these PES tests to classify an employee's ability to conduct criterion job tasks. Generally, the development of performance standards is based around referencing measures of the physical requirements of the job (criterion-referencing) or standardising test scores relative to a relevant group (norm-referencing) (Constable and Palmer, 2000). Specific statistical methods to achieve this will be analysed in this review.

Existing frameworks provide a comprehensive methodological overview and commentary on the development of PES (Constable and Palmer, 2000; Payne and Harvey, 2010; Jamnik et al., 2013; Tipton et al., 2013). However, the intensive examination of the translation of job task analysis findings to physical employment standards and assessments has not previously been conducted. Furthermore, existing reviews are narrative in nature, and there has been no previous review that has analysed existing literature using systematic methods, incorporating the extraction of objective information from individual studies such as the number of participants, test characteristics and validation procedures used. Performing a more objective analysis of existing literature in this area may elucidate to researchers and practitioners the components of PES development where there are consistencies and established techniques, as well as areas where further improvements are required.

As such, the aim of this paper was to systematically review relevant published literature to examine the procedures and methods applied in the translation of job analysis findings PES tests and performance standards.

2. Methods

2.1. Eligibility criteria

Studies that met the inclusion criteria were those focussed on detailing the development of PES from a job analysis for physically demanding occupations. Studies were included if they were published open-literature manuscripts or publically-available technical reports. Potentially eligible papers met the inclusion criteria either as an isolated document, or as part of a series of papers or reports that met the inclusion criteria. Studies that did not detail job analyses, develop PES tests or were developed for occupations that were not physically demanding occupations were excluded. Due to the very specific nature of our eligibility criteria, there were several articles on PES development that could not be included in the results of this review.

2.2. Information sources

A search of PubMed and Google Scholar was conducted for research articles published in English up to and including March 2015. It was necessary to use a large number of keywords due to the broad range of occupations and the associated differences in terminology applied. Keywords were divided into five headings (job terms, fitness terms, test terms, other, and occupation) and are presented in Table 2. Google Scholar was used to ensure that we had complete capture of all publically-available internal reports; occupations such as the military and emergency services often generate publically available reports that are not available in the peer reviewed literature.

2.3. Study selection

Authors used pre-defined inclusion criteria to decide on whether each article would be included or excluded. Two authors (BB and AC) screened citations in an independent manner by title, abstract and then full article for relevance. At each stage of the

Table 2
Keywords used in the literature search.

Job terms	Fitness terms	Test terms	Other	Occupations
Work	Physical	Standard	Meiorin decision	Military
Job	Performance	Simulated	Safety margin	Fire fighters
Job-related	Fitness	Test	Content validity	Ambulance
Job-specific	Demanding	Predictive	Construct validity	Police
Occupation	Criterion		Face validity	Correction
Operational	Valid			Security
Employment	Bona fide			
Pre-employment	Defensible			