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# Matching physical work demands with functional capacity in healthy workers: Can it be more efficient?

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ABSTRACT

*Objectives:* To determine if functional capacity (FC) and physical work demands can be matched and to determine the validity of normative values for FC related to physical work demands as a screening instrument for work ability.
*Methods:* Forty healthy working subjects were included in this study. Subjects were categorized into four physical work demand categories (sedentary, light, moderate and heavy). FC was tested with a standardized Functional Capacity Evaluation (FCE) following the WorkWell Protocol and physical work demands were determined with an onsite Work Load Assessment (WLA) according to the Task Recording and Analyses on Computer (TRAC) method. Physical work demands were compared to FC and normative values derived from previous research.
*Results:* 88% of the subjects scored higher on FCE than observed during WLA. The tenth percentile of normative values appeared valid in 98% for sedentary/light work for the subjects tested in this study. For moderate or heavy work, the thirtieth percentile of normative values appeared valid in 78% of all cases.
*Conclusion:* Functional capacity and physical work demands can be matched in most instances, but exceptions should be kept in mind with regards to professions classified as moderate or heavy physical work, especially concerning lifting high. Normative values may be considered as an additional screening tool for balancing workload and capacity. It is recommended to further validate normative values in a broader and more extensive working population.


## 1. Introduction

In health literature, much focus is given to (reduction of) work demands, but the focus on its relation to work capacity is rather limited (Heerkens et al., 2004). Functional capacity (FC), which includes the total of all physical, cognitive and emotional characteristics of the worker (Dijk van et al., 1990), and work demands need to be in balance in order to regain or maintain working successfully (Heerkens et al., 2004). This can be achieved by either increasing capacity or decreasing workload by application of ergonomic interventions. A previous study focused on interventions to reduce musculoskeletal complaints in the nursing profession and described strong effects of ergonomic interventions (Bos et al., 2006). FC can be measured with a Functional Capacity Evaluation (FCE). This is a battery of tests measuring the capacity to perform work-related activities (Soer et al., 2008). FCEs can be job-specific (Frings-Dresen and Sluiter, 2003), pathology-specific (Reneman et al., 2005; Gross et al., 2006) or can be used for the assessment of capacities for activities of daily living (Soer et al., 2009). Physical work demands (PWD) can be measured through standardized questionnaires or onsite measurement (van der Beek et al., 1992; Lindstrom et al., 1994). A disadvantage of questionnaires used for PWD measurement, is ambiguity with respect to the validity. Because in practice, patients and healthy workers estimate their PWD considerably higher than can be objectified by onsite observations (van der Beek et al., 1992; Lindstrom et al., 1994), it is

*Abbreviations:* FC, Functional Capacity; FCE, Functional Capacity Evaluation; WLA, Work Load Assessment; NV, Normative Values; DOT, Dictionary of Occupational Titles; PWD, Physical Work Demands; METS, Metabolic Equivalent.

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recommended to assess PWD, besides by self-report, through observational methods (Winkel and Mathiassen, 1994). To determine if a worker holds sufficient FC to return to or stay at work, it is important that the FC of the worker is equal to or higher than the PWD (Dijk van et al., 1990). This comparison is important in determining whether increasing capacity of the worker or adaptation of the workplace is needed. In the study of Kuijer et al. (2006), FCE activities derived from the Isernhagen Work Systems protocol were matched to the observed PWD in workers with chronic low back pain by video and real life observations (Kuijer et al., 2006). It was concluded that seven FCE activities could directly be matched with the PWD as measured through video observation on an onsite Work Load Assessment (WLA). These activities were carrying, pushing, pulling, crouching, kneeling, static forward bending, and dynamic bending and rotating. Lifting could indirectly be matched. Disadvantages of this method, however, are that WLA are time consuming and expensive and therefore practically impossible to use for each worker or patient.

Better knowledge concerning the relationship between PWD and FC enables practitioners to better advise with respect to return to or stay at work and develop better work rehabilitation programs or apply ergonomics principles more effectively. A more practical and inexpensive method to match FC and PWD is to compare FC with normative values (NVs) which were previously obtained (Soer et al., 2009). In that study, it was assumed that the FC expressed by NVs of healthy workers was sufficient to meet the PWD (Soer et al., 2009), because all subjects were healthy and working in the year prior to the study. To interpret normative values validly, however, it is essential that these NV correspond to direct measurements of PWD for healthy subjects in a broad spectrum of occupations. When the normative values for the FCE are proven valid, FCE may serve as a screening instrument for potential imbalances and WLAs to measure PWD may be redundant, in cases where studying the physical part of the work capacity is needed.

This study had two objectives. The first objective was to determine if functional capacity (determined by FCE) can be matched with PWD (measured by a WLA) in healthy working subjects. The second objective was to determine the valid cut-off percentile of the NVs of FCE for healthy workers in jobs with different levels of physical work demands.

## 2. Methods

### 2.1. Subjects

Forty subjects out of a group of 701 who participated in the normative values study of Soer et al. (2009) and whose PWD had not changed since participation were included in the study. Subjects were between 20 and 65 years of age, worked at least 20 h a week and had no sick leave from work higher than 5% in the year preceding this study. After selection and invitation, subjects received written information about the study. Of all forty subjects, 10 subjects per PWD category were randomly selected. These PWD categories were based on the Dictionary of Occupational Titles (DOT) (US Department of Labor, 1991). In the DOT, occupations are classified into five categories of physical work demands, based on the intensity and duration of lifting or carrying and on the number of metabolic equivalents (METS) assumed to be needed for the job. The categories used in this study were sedentary (PWD 1), light (PWD 2), moderate (PWD 3) and heavy/very heavy (PWD4: DOT 4 and DOT 5 combined). All occupations of participants were coded with the DOT and stratified in the according PWD categories. For example in PWD 1, subjects were working as manager, publisher or administration. In PWD 2, subjects worked as waiter, teacher or chauffeur; in PWD 3, subjects worked as nurse or plumber and in PWD 4, subjects worked as farmer or concrete worker. Employers and participants provided informed consent. This study was approved by the medical ethical committee of the University Medical Center Groningen, The Netherlands. After participation, subjects received a gift certificate of €15.

### 2.2. Design

Cross-sectional study design. This study uses cross sectional data of 40 subjects which were compared to normative data retrieved in 2009 (Soer et al., 2009).

### 2.3. Procedures

In the previous study of Soer et al., 701 subjects performed a 12 item FCE, largely based on the FCE following the WorkWell protocol (Soer et al., 2009). Five of these FCE tests were previously found to be directly or indirectly matched to PWD (Kuijer et al., 2006) and were used for this study. These tests were lifting low, lifting high, carrying, overhead working and forward bending stand and formed the protocol. Energetic capacity was added to the protocol. A complete description of these tests is presented in Appendix A. Normative FCE values were established for four PWD categories, based on the DOT.

#### 2.3.1. WLA protocol

A 4 h WLA was performed to determine PWD of the job of each of the subjects. A 4 h duration was reported to be sufficiently valid to determine the PWD of a working day (Hoozemans et al., 2001a,b). The WLA was performed according to the Task Recording and Analyses on Computer (TRAC) method (Hoozemans et al., 2001a). The PalmTRAC consists of a portable computer (Palm Tungsten E2) and a PC-component in which observation on the workplace can be saved and processed. Prior to testing, inter- and intra-observer reliability were tested with video material by two researchers. Inter-observer and intra-observer reliability were calculated using Intraclass Correlation Coefficient (ICC) model 'two-way mixed' and type 'absolute agreement'. Correlations were interpreted according to Portney and Watkins (2008): ICC $\geq$0.50 was interpreted as moderate; ICC $>$0.75 was interpreted as strong. Energetic workload was measured during 4 h with a heart-rate monitor with memory (Polar S610i). The mean and maximum heart rates of a subject during the WLA were collected. The protocol for WLA was constructed according to previous research (Kuijer et al., 2006; Drury, 1995; Kilbom, 1995). For each individual activity, intensity, frequencies, maximum duration and total duration were registered. The forces for lifting low and carrying were measured separately, and categorized into four categories as

**Table 1**
Physical demand characteristics of work.

| Physical work demand category (PWD) | Lifting or carrying* | Average heart rate | Typical energy required |
|---|---|---|---|
| Sedentary (PWD 1) | 4.5 kg. | <90 bpm | 1.1–2.9 METS |
| Light work (PWD 2) | 9.1 kg. | 90–100 bpm | 3–5.9 METS |
| Medium work (PWD 3) | 22.7 kg. | 100–120 bpm | 6–9 METS |
| Very heavy work (PWD 4) | 45.4 kg. | >120 bpm | >9 METS |

NOTE. Given weights are a guideline when lifting and carrying occur occasionally (0–33% of working day). For determining the relation between energetic capacity and energetic workload, average heart rate can be translated into metabolic equivalents (METS) according to this table. Abbreviations: bpm, beats per minute; PWD, physical work demand category which is based on the Dictionary of Occupational Titles (classification scheme of all occupations into four categories of physical workload); kg, kilogram; METS, metabolic equivalent. * Amount of force exerted to lift or carry.