UvA-DARE (Digital Academic Repository)

The concurrent validity of the ERGOS Work Simulator and the Ergo-Kit with respect to maximum lifting capacity

Rustenburg, G.; Kuijer, P.P.F.M.; Frings-Dresen, M.H.W.

DOI

[10.1023/B:JOOR.0000018327.27554.58](https://doi.org/10.1023/B:JOOR.0000018327.27554.58)

Publication date

2004

Published in

Journal of Occupational Rehabilitation

[Link to publication](#)

Citation for published version (APA):

Rustenburg, G., Kuijer, P. P. F. M., & Frings-Dresen, M. H. W. (2004). The concurrent validity of the ERGOS Work Simulator and the Ergo-Kit with respect to maximum lifting capacity. *Journal of Occupational Rehabilitation*, 14(2), 107-118.
<https://doi.org/10.1023/B:JOOR.0000018327.27554.58>

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

The Concurrent Validity of the ERGOSTM Work Simulator and the Ergo-Kit[®] With Respect to Maximum Lifting Capacity

G. Rustenburg,¹ P. P. F. M. Kuijer,^{1,2} and M. H. W. Frings-Dresen¹

*The aim of this study was to investigate the concurrent validity—as regarding maximum lifting capacity—between the Functional Capacity Evaluation (FCE) methods, ERGOSTM Work Simulator and Ergo-Kit[®]. Twenty-five healthy, male fire fighters participated. Dynamic lower and upper lifting capacities were determined using both FCE methods. Paired *t* tests showed the mean maximum lifting capacities to be significantly higher statistically when determined by the Ergo-Kit[®] for lower, as well as, upper lifting. Spearman rank correlation coefficients varied between 0.49 and 0.66. It was concluded that the concurrent validity for lifting between both FCE methods was poor.*

KEY WORDS: concurrent validity; functional capacity evaluation; lifting; ERGOSTM Work Simulator; Ergo-Kit[®].

INTRODUCTION

Functional Capacity Evaluation (FCE) methods are applied in work rehabilitation and disability testing. The aim of FCE methods is to determine objectively functional physical abilities for work. In drafting employee rehabilitation plans, or making return-to-work decisions, the FCE method test results are compared to the physical demands of the individual's job. Most FCE methods make use of the American Dictionary of Occupational Titles (DOT), which contains descriptions of the physical demands of 13,000 jobs (1). One of the activities that can be assessed by FCE methods is lifting. Lifting occurs in many occupations, and work disability due to low-back pain is positively associated with it (2). For that reason, it is extremely important to determine lifting capacity in work rehabilitation and disability testing (3).

Examples of FCE methods are the ERGOSTM Work Simulator and the Ergo-Kit[®]. Several studies on the reliability of different FCE methods are known (4–8). However, no

¹Coronel Institute for Occupational and Environmental Health, AmCOGG (The Amsterdam Center for Research on Health and Health Services), Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands.

²Correspondence should be directed to Paul Kuijer, Coronel Institute for Occupational and Environmental Health, Academic Medical Center, University of Amsterdam P.O. BOX 22700, 1100 DE Amsterdam, The Netherlands; e-mail: p.p.kuijer@amc.uva.nl.

studies were found on the reliability of the Ergo-Kit[®]. Only one study compared the results of different FCE methods (9). Dusik *et al.* (9) demonstrated moderate relationships for the concurrent validity of the ERGOSTM Work Simulator and conventional FCE techniques with respect to dynamic lower and upper lifting.

Considering that the test results of FCE methods are used to make return-to-work decisions, the instrument used in work rehabilitation and disability testing should not influence those results. In light of that, high levels of concurrent validity between different FCE methods are a prerequisite. This study compares the dynamic lower and upper lifting capacity of an employee, using the ERGOSTM Work Simulator and the Ergo-Kit[®].

This study focuses in on the following question: is there a difference in functional lifting capacity (kg) for dynamic lower and upper lifting between the ERGOSTM Work Simulator and the Ergo-Kit[®]?

METHODS

Subjects

Twenty-five male fire fighters participated voluntarily in this study. We selected fire fighters as subjects because of the heavy lifting involved in their line of work (10). All participants were informed about the aim of the study, and all signed a written informed consent form before the experiment started. To prevent any bias in test results, we restricted participation to fire fighters with no musculoskeletal problems.

Design

All 25 participants were invited to perform the dynamic lifting tests on both the ERGOSTM Work Simulator and the Ergo-Kit[®]. A balanced design was used: 12 fire fighters were first measured using the ERGOSTM Work Simulator, whereas the other 13 were first measured with the Ergo-Kit[®]. Testing occurred on two different days, separated by an interval of 7 days. The time of day was kept constant in order to minimize bias due to the day of the week, or time of day. Since most of the fire fighters were working 24-h shifts on alternate days, we opted for an interval of 6 or 8 days between the two testing days. In addition, the ERGOSTM Work Simulator and the Ergo-Kit[®] were installed in the same room in order to keep the test conditions as constant as possible.

Instruments

To assess dynamic lifting capacity using the ERGOSTM Work Simulator and the Ergo-Kit[®], the participant was required to lift a box from and to several positions for both FCE methods (11,12). These lifting positions are described in Table I. The materials used by the ERGOSTM Work Simulator and the Ergo-Kit[®] are described below.

ERGOSTM Work Simulator

The ERGOSTM Work Simulator consists of five panels, the first of which is used for measuring strength factors, including static and dynamic lifting strength. The dimensions

Table I. Description of the Lifting Tests for Dynamic Lower and Upper Lifting on the ERGOSTM Work Simulator and the Ergo-Kit[®]

FCE method	Lower lifting tests	Contents
ERGOS TM Work Simulator	<ul style="list-style-type: none"> • Bench center lift • Bench left lift • Bench right lift 	Lifting the box from the 0.11 m elevation on the floor to bench height (center, left, or right), and back to the elevation (three times in 120 s)
Ergo-Kit [®]	<ul style="list-style-type: none"> • Lower Lifting Strength (LLS) test • Lower Lifting Endurance (LLE) test 	Lifting the box from the lower shelf to the step (0.20 m) at the right, and back to the lower shelf (one time in 60 s for the LLS test, and four times in 60 s for the LLE test)
Upper lifting tests		
ERGOS TM Work Simulator	<ul style="list-style-type: none"> • Upper shelf center lift • Upper shelf left lift • Upper shelf right lift 	Lifting the box from the 0.11 m elevation on the floor to upper shelf height (center, left, or right), and back to the elevation (three times in 120 s)
Ergo-Kit [®]	<ul style="list-style-type: none"> • Upper Lifting Strength (ULS) test • Upper Lifting Endurance (ULE) test 	Lifting the box from the lower shelf to the upper shelf at the right, and back to the lower shelf (one time in 60 s for the ULS test, and four times in 60 s for the ULE test)

of the box used for dynamic lifting were 0.52 m × 0.34 m × 0.24 m (length × width × height). The box featured handles on the right and left sides. However, the grip was poor according to the NIOSH lifting criteria (13). The box had to be hooked to a bar. The bars are fixed at six standard positions on the ERGOSTM Work Simulator panel: three at bench height (center, left, and right) and three at upper shelf height (center, left, and right). The bars were set at a bench height of 0.83 m, and an upper shelf height of 1.71 m. The bench height bars were used for dynamic lower lifting, and the upper shelf height bars for dynamic upper lifting.

Ergo-Kit[®]

The Ergo-Kit[®] uses a stand with two vertically adjustable shelves, a step, and a box to evaluate dynamic lifting capacity. For dynamic lower lifting, the lower shelf on the stand was used in combination with the step. For dynamic upper lifting, the lower shelf was used in combination with the stand's upper shelf. The shelf heights were dependent on the participant's anthropometry. The lower shelf was set at knuckle height, and the upper shelf was set at 0.12 m below acromion height (12). Step height was set at 0.20 m above the floor for each participant. In keeping with the Ergo-Kit[®] protocol (12), the step was placed at the participant's right side. The dimensions of the box used for dynamic lifting were 0.40 m × 0.30 m × 0.12 m (length × width × height). The box featured appended handles on the right and left sides. The grip on the handles was good according to the NIOSH lifting criteria (13). During the dynamic lifting tests, a Polar T31TM transmitter with a Polar A1TM wrist receiver (Polar Electro Nederland BV, the Netherlands) were used to record the heart rate.

Lifting Tests

Standardized protocols of the ERGOSTM Work Simulator and the Ergo-Kit[®] were used (11,12). The testing time for dynamic lifting was roughly 40–50 min for both the ERGOSTM Work Simulator and the Ergo-Kit[®], and depended on the participant's lifting capacity. During dynamic lifting, the test leader informed the participants when they reached the NIOSH guideline of 25 kg (13). At that point, the participant was free to decide whether or not to continue the dynamic lifting test. The lifting tests for the ERGOSTM Work Simulator and the Ergo-Kit[®] are described below.

Lifting Tests for the ERGOSTM Work Simulator

In keeping with the ERGOSTM Work Simulator protocol (11), four maximum static lifting tests were performed prior to the dynamic lifting test. In this way, the ERGOSTM Work Simulator determines the initial load for the dynamic lifting test. Six dynamic lifting subtests were performed by the ERGOSTM Work Simulator, namely: bench center, left, and right lift, and upper shelf center, left, and right lift (Table I). Figure 1 presents an example of a participant performing the bench left lift. For each sub-test, one of the six bars was used. The subtests were performed to determine: the so-called sporadic lifting capacity (i.e. the maximum load that can be lifted for less than 33% of the day); the frequent lifting capacity (i.e. the maximum load that can be lifted for 33 to 67% of the day), and the constant lifting capacity (i.e. the maximum load that can be lifted for over 67% of the day).

Determining the Sporadic Lifting Capacity. To determine the sporadic lifting capacity, the participant was required to perform the six subtests, during which the box was lifted from an elevation of 0.11 m above the floor to one of the six bars, and back to the elevation on the floor (Table I). Three repetitions of each of the six dynamic lifting subtests were performed. The tempo was set by the ERGOSTM Work Simulator. The maximum time for performing one repetition of a sub-test was 40 s. This means that a sub-test lasted no more than 120 s. After performing the six subtests, the load was increased by 4.5 kg, and the same six subtests were performed. This procedure was repeated until the participant reached his maximum lifting capacity for all six subtests.

The criteria for reaching the maximum sporadic lifting capacity were:

- the participant's inability to hook the box to the bar; or
- a request from the participant to end the subtest because the load was too heavy to lift.

The maximum sporadic lifting capacity for a subtest was defined as the maximum load that the participant lifted in that subtest. Values for center, left, and right existed for sporadic lower and upper lifting. These values were averaged; what remained was one outcome measure for sporadic lower lifting and one outcome measure for sporadic upper lifting.

Determining the Frequent and Constant Lifting Capacity. On the basis of the results of the maximum sporadic lower and upper lifting capacity, the ERGOSTM Work Simulator instrument estimated the maximum frequent and constant lower and upper lifting capacity. Similar to the sporadic lifting capacity, values for center, left, and right existed for frequent and constant lower and upper lifting. Again, these values were averaged for lower and upper lifting.

Fig. 1. Lower lifting test (bench left lift) on the ERGOS™ Work Simulator.

Lifting Tests for the Ergo-Kit®

Four dynamic lifting tests were performed by the Ergo-Kit®: Lower Lifting Strength (LLS); Upper Lifting Strength (ULS); Lower Lifting Endurance (LLE); and Upper Lifting Endurance (ULE) (Table I). The LLS and ULS tests were performed to determine the

Fig. 2. Lower lifting test (Lower Lifting Strength or Lower Lifting Endurance test) on the Ergo-Kit[®].

sporadic lifting capacity, and the LLE and ULE tests were performed to determine the frequent and the constant lifting capacity. The LLS and LLE tests consisted of lifting a box from the lower shelf to the step at the right, and back to the lower shelf (Fig. 2). The ULS and ULE tests consisted of lifting the box from the lower shelf to the upper shelf, and back to the lower shelf (Table I) (12).

Determining the Sporadic Lifting Capacity. The LLS and ULS tests were conducted to determine the sporadic lifting capacity. The participant performed the lifting test every 60 s. The initial box load was 5 kg. The lifting test had to be performed within the first 10 s of each 60-s period. The test leader monitored the time. The remaining 50 s were used to rate the level of discomfort experienced in the body regions, and to rate the level of heaviness experienced from the load. Both discomfort and the heaviness of the load were rated on a scale of 0–10, where 0 = “no discomfort experienced whatsoever,” or “heaviness of load was less than very light”, and 10 = “maximum discomfort experienced” or “maximum heaviness of load”. The load was increased, held constant, or decreased depending on the results for the level of discomfort and the level of heaviness experienced from the load, as well as on whether the lifting test was performed in a coordinated manner. An uncoordinated lifting test was defined as one in which: 1) the box fell a few centimeters when it was shoved from a shelf; 2) the box was placed with a thud on one of the shelves or on the step; or 3) the participant was out of balance during the lifting test (12).

The following criteria were used for increasing, decreasing, or keeping the load of the box constant. The load was increased by 10 kg (LLS test), or by 5 kg (ULS test), when the level of discomfort, or the level of heaviness experienced from the load was 2 (light) or less. The load was increased by 5 kg (LLS test), or by 2.5 kg (ULS test), when the level of discomfort, or the level of heaviness experienced from the load was 3 (medium) or more. The load was held constant when the lifting test was performed in an uncoordinated manner. When the participant met one of the criteria outlined below for reaching the maximum sporadic lifting capacity, the load was decreased by 2.5 kg for the LLS. The ULS test was ended immediately when one of the criteria was met. The criteria for reaching the maximum sporadic lifting capacity were (12):

- the performance of two consecutive uncoordinated lifting tests;
- a rating of 7 (i.e. very high/ very difficult) or more from the participant for the level of discomfort or level of heaviness experienced from the load; or
- a request from the participant to end the test because the load was too heavy to lift.

Participants were considered to reach their maximum sporadic lifting capacity upon: lifting their heaviest load (kg); rating the corresponding level of discomfort and heaviness experienced from the load at less than 7; and performing the lifting test in a coordinated manner. The maximum load was a multiple of 2.5 kg.

Determining the Frequent Lifting Capacity. Both the LLE and ULE tests had a total testing time of at least 10—but no more than 15—minutes. The initial box load was 5 kg. The participant performed four lifting tests every 60 s. Each lifting test was started every 10 s in the 60-s period. Again, the test leader supervised the time. In this way, the four lifting tests lasted 40 s in total. The remaining 20 s were used to read the heart rate from the Polar A1TM wrist receiver, to rate the level of discomfort experienced in the body regions, and to rate the level of heaviness experienced from the load, all with respect to the four lifting tests performed. The load was increased, held constant, or decreased depending on the results for these variables and on whether the lifting tests were performed in a coordinated manner. An uncoordinated lifting test was defined as one in which: 1) the box fell a few centimeters when it was shoved from a shelf; 2) the box was lifted with a jerk; 3) the box was tipped over during a lifting test; or 4) the participant was leaning backwards during a lifting test (12). For both the LLE and ULE tests, an age dependent target heart rate

(THR) and an age dependent maximum heart rate (MHR) were defined, using the following equations (12):

1. LLE test: $\text{THR} = (220 - \text{age}) \times 0.85$ and $\text{MHR} = (220 - \text{age}) \times 0.70$
2. ULE test: $\text{THR} = (220 - \text{age}) \times 0.75$ and $\text{MHR} = (220 - \text{age}) \times 0.60$

The following criteria were used for increasing, decreasing, or keeping the load of the box constant. During the first 10 min of the test, the load was increased by 5 kg when the level of discomfort and the level of heaviness experienced from the load were 3 (medium) or less, and the heart rate did not exceed the MHR. After 10 min of testing, the load was increased by 2.5 kg, using the same criteria. The load was held constant when the level of discomfort and the level of heaviness experienced from it were 4 (somewhat high/ somewhat difficult-heavy), and the heart rate did not exceed the MHR. The following criteria were used for decreasing the load by 5 kg (in the first 10 min of the test) or by 2.5 kg (after 10 min of testing). The first criterion for decreasing the load was a rating of 5 (high/ difficult-heavy) or more for the level of discomfort or heaviness experienced from the load after a set of four lifting tests. The second criterion was uncoordinated performance of at least three of the four lifting tests within a 60-s period. The third criterion was a heart rate: 1) exceeding the MHR after a set of four lifting tests; 2) exceeding the THR when the load was held constant as compared to the preceding set of four lifting tests; or 3) increased by 10% or more when the load was held constant as compared to the preceding set of four lifting tests (12).

Participants were considered to reach their maximum frequent lifting capacity upon:

- lifting the same load in the last three sets of four lifting tests after performing at least ten sets of four lifting tests (i.e. with a minimum lifting time of 10 min);
- requesting to end the test because the load was too heavy to lift; or
- completing fifteen sets of four lifting tests (i.e. with a maximum lifting time of fifteen minutes).

The lifting test was ended when one of these criteria was met. In cases where the first criterion applied, the maximum frequent lifting capacity was defined as the load the participant lifted in the last three sets of four lifting tests. For the other two criteria, the maximum frequent lifting capacity was defined as the heaviest load lifted in a set of four lifting tests, during which the level of discomfort and heaviness experienced from the load fell under 5 (i.e. high/ difficult-heavy). The heart rate was not a criterion for ending an LLE or ULE test. The maximum load was a multiple of 2.5 kg.

Determining the Constant Lifting Capacity. The constant lower and upper lifting capacities were defined as 50% of the frequent lower and upper lifting capacity (kg), respectively (12).

Data Analysis and Statistics

Concurrent validity was determined by comparing the mean values for frequent, and constant lower and sporadic, frequent and constant upper lifting capacity for the ERGOSTM Work Simulator and the Ergo-Kit[®]. Statistical analysis was performed, using a paired *t* test and a Spearman rank correlation analysis (two-sided) in SPSS 10.0 for Windows. In this study, concurrent validity was defined as being indicated by: the absence of statistically

Table II. Mean, Standard Deviation (SD), and Minimum and Maximum Age (years), Body Weight (kg), and Body Height (m) of the Participating Fire Fighters ($N = 24$)

Characteristics	Mean	SD	Minimum	Maximum
Age (years)	34.8	9.5	21	53
Weight (kg)	85.2	8.5	72	99
Height (m)	1.82	0.06	1.74	1.98

significant differences in test results (p value > 0.05) and correlation coefficients higher than 0.75 (14).

RESULTS

Subjects

The participants' mean and standard deviations (SD) for age (years), body weight (kg), and body height (m) are presented in Table II. Of the 25 subjects, one participant did not perform the dynamic lifting test on the ERGOSTM Work Simulator because of musculoskeletal problems. For that reason, this person was not included in Table II ($N = 24$). None of the participants wished to end a dynamic lifting test on reaching the NIOSH guideline of 25 kg.

Concurrent Validity

Table III presents the mean differences and Spearman rank correlation coefficients between the maximum lifting capacity (kg) for lower and upper lifting of the ERGOSTM Work Simulator and the Ergo-Kit[®].

Lower Lifting

In the case of one participant, an invalid measurement of the maximum load (kg) was performed for dynamic lower lifting on the ERGOSTM Work Simulator (i.e. the bench lifts).

Table III. Mean Difference, Standard Deviation (SD), and Spearman Rank Correlation Between the Maximum Lower and Upper Lifting Capacity (Sporadic, Frequent, and Constant) (kg) Determined by the ERGOSTM Work Simulator and the Ergo-Kit[®]

		Mean (SD)			
	N	ERGOS TM Work Simulator	Ergo-Kit [®]	Paired difference	Spearman correlation
Lower lifting	Sporadic 23	43.9 (9.0)	45.5 (4.0)	— ^a	— ^a
	Frequent 23	22.0 (4.5)	27.9 (8.8)	5.9 (7.7)**	0.50*
	Constant 23	8.7 (1.9)	14.0 (4.4)	5.2 (3.8)**	0.50*
Upper lifting	Sporadic 24	25.5 (5.5)	35.6 (5.8)	10.1 (5.8)**	0.49*
	Frequent 24	12.7 (2.9)	20.8 (6.3)	8.1 (5.1)**	0.66**
	Constant 24	5.1 (0.9)	10.4 (3.1)	5.3 (2.8)**	0.56**

^aNo valid comparison possible, because a maximum load was imposed by the Ergo-Kit[®].

* $p < 0.05$; ** $p < 0.01$.

For that reason, the results for lower lifting are based on 23 participants. As mentioned, the lifting height for lower lifting using the ERGOSTM Work Simulator was set at 0.83 m. The mean lifting height for lower lifting using the Ergo-Kit[®] was 0.80 m (SD = 0.05 m). For sporadic lower lifting, the mean maximum load was 43.9 kg for the ERGOSTM Work Simulator and 45.5 kg for the Ergo-Kit[®]. However, we were unable to make any valid comparisons for sporadic lower lifting, because 74% of the participants reached the maximum load of 47.5 kg with the Ergo-Kit[®]. For frequent lifting, the mean maximum load was 22 kg for the ERGOSTM Work Simulator and 27.9 kg for the Ergo-Kit[®] ($t = 3.7$, $p < 0.01$). The corresponding values for constant lifting were 8.7 kg and 14.0 kg ($t = 6.5$, $p < 0.01$), respectively. The Spearman rank correlation coefficient for frequent lower lifting was 0.50 ($p < 0.05$), and 0.50 ($p < 0.05$) for constant lower lifting.

Upper Lifting

As mentioned, the lifting height for upper lifting with the ERGOSTM Work Simulator was set at 1.71 m. The mean lifting height for upper lifting with the Ergo-Kit[®] was 1.40 m (SD = 0.06 m). For sporadic upper lifting, the mean maximum load was 25.5 kg for the ERGOSTM Work Simulator and 35.6 kg for the Ergo-Kit[®] ($t = 8.6$, $p < 0.01$). For frequent upper lifting, these values were 12.7 kg and 20.8 kg ($t = 7.9$, $p < 0.01$), and for constant upper lifting 5.1 kg and 10.4 kg ($t = 9.3$, $p < 0.01$), respectively. The Spearman rank correlation coefficients load for sporadic, frequent, and constant upper lifting were 0.49 ($p < 0.05$), 0.66 ($p < 0.01$), and 0.56 ($p < 0.01$), respectively.

DISCUSSION

The purpose of this study was to compare dynamic (lower and upper) lifting capacity (kg), measured with the ERGOSTM Work Simulator and the Ergo-Kit[®]. The results revealed that dynamic lifting capacity was significantly higher when measured by the Ergo-Kit[®] as compared to the ERGOSTM Work Simulator. Moreover, moderate correlation coefficients, varying between 0.49 and 0.66, were found between the results of both FCE methods. On the basis of these results, we concluded that the ERGOSTM Work Simulator and the Ergo-Kit[®] do not meet the criteria for “good” concurrent validity. What these results signify is that evaluations of functional lifting capacity in work rehabilitation and disability testing will depend on the instrument used, i.e. the ERGOSTM Work Simulator or the Ergo-Kit[®].

The higher outcomes for upper lifting capacity determined by the Ergo-Kit[®] can be explained by the differences in upper shelf height between the ERGOSTM Work Simulator and the Ergo-Kit[®] (with a mean difference of 0.31 m). The ERGOSTM Work Simulator uses standard shelf heights (based on mean values in industrial jobs) for the dynamic lifting tests, while the shelf heights in the Ergo-Kit[®] depend on the participants’ anthropometry. In light of that, it may be more useful to use the ERGOSTM Work Simulator as instrument for determining the *functional* lifting capacity. However, when it comes to evaluating the ergonomic adaptations of an individual workplace, the Ergo-Kit[®] might be more appropriate. A second possible explanation is the difference in lifting frequency as prescribed in the test protocols. In the case of the Ergo-Kit[®], one lifting test lasting no longer than 10 s was performed every 60 s. The ERGOSTM Work Simulator required performance of three lifting

Table IV. Criteria for Classifying an Individual in the Fifth Category (i.e. Very Heavy), Based on Maximum Lifting Capacity (kg) for Both the ERGOSTM Work Simulator and the Ergo-Kit[®]

	ERGOS TM Work Simulator ^a	Ergo-Kit ^{®a}
Lower lifting		
Sporadic	>45.0	>45.4
Frequent	>23.0	>22.7
Constant	>09.0	>11.3
Upper lifting		
Sporadic	>22.5	>31.8
Frequent	>11.5	>13.6
Constant	>04.5	>06.8

^aManuals (11,12) refer to the DOT (1).

tests lasting no longer than 40 s in each subtest. After each lifting test, the participant was allowed to rest for about 10 s; thus, resting time was approximately 30 s in each subtest, which lasted no longer than 120 s. Consequently, the participants had up to 70% less resting time in the test situation with the ERGOSTM Work Simulator.

In work rehabilitation and disability testing, the outcomes of functional capacity tests are compared with categories established in the Dictionary of Occupational Titles (DOT), including: sedentary (1), light (2), medium (3), heavy (4), and very heavy (5) work (1). In the case of fire fighters, an FCE outcome of less than 5 (i.e. very heavy), means “not fit for work” or unable to return to work. Table IV presents, by way of example, the criteria for classifying an individual in category 5 based on his maximum lifting capacity (kg) as measured by the ERGOSTM Work Simulator and the Ergo-Kit[®].

If we were to use the DOT as a reference for determining fitness for work or the ability to return to work, 78% of our participants would fall in category 5 based on the outcome of the Ergo-Kit[®]; the corresponding figure for the ERGOSTM Work Simulator is 61%. As mentioned in the methods section, we restricted participation to fire fighters with no musculoskeletal problems. They all performed the same kind of duties and were not restricted in their work. Therefore, the question remains whether the DOT is an adequate reference for return-to-work decisions. A systematic review of the literature showed that it is unclear whether the DOT is based on accurate descriptions of external exposure in occupations, in terms of frequency, duration, and intensity (15).

Finally, we encountered two other studies that examine the concurrent validity of FCE methods (9,16). One of these found the ERGOSTM Work Simulator and conventional FCE techniques with respect to dynamic lower and upper lifting to have moderate concurrent validity (9). The other study found poor concurrent validity for the Isernhagen Work Systems FCE as compared to several disability questionnaires (16). The task of validating FCE methods in work rehabilitation and disability testing calls for more data concerning the outcomes of FCE methods and the participants’ corresponding work performance and health outcomes.

CONCLUSION

The FCE method, Ergo-Kit[®], showed the dynamic lifting capacity for lower and upper lifting to be significantly higher than that measured by the FCE method, ERGOSTM

Work Simulator. Moreover, the correlation coefficients between these FCE methods varied between 0.49 and 0.66. In light of this, we concluded that the concurrent validity for lower and upper lifting between both FCE methods is poor.

ACKNOWLEDGMENTS

The authors thank the participating fire fighters. We also thank Angela de Boer, PhD, for her statistical assistance, and Nathalie Donders, MSc, for her comments on previous drafts of this paper.

REFERENCES

1. *Dictionary of Occupational Titles*. 4th edn., Rev. Washington, DC: U.S. Department of Labor, 1991.
2. Friedrich M, Cermak T, Heiller I. Spinal troubles in sewage workers: Epidemiological data and work disability due to low back pain. *Int Arch Occup Environ Health* 2000; 73(4): 245–254.
3. Isernhagen SJ, Hart DL, Matheson LN. Reliability of independent observer judgments of level of lift effort in a kinesiophysical Functional Capacity Evaluation. *Work* 1999; 12(2): 145–150.
4. Matheson LN, Danner R, Grant J, Mooney V. Effect of computerized instructions on measurement of lift capacity: Safety, reliability, and validity. *J Occup Rehabil* 1993; 3(2): 65–81.
5. Innes E, Straker L. Reliability of work-related assessments. *Work* 1999; 13(2): 107–124.
6. Reneman MF, Dijkstra PU, Westmaas M, Göeken LNH. Test–retest reliability of lifting and carrying in a 2-day Functional Capacity Evaluation. *J Occup Rehabil* 2002; 12(4): 269–275.
7. Reneman MF, Jaegers SMHJ, Westmaas M, Göeken LNH. The reliability of determining effort level of lifting and carrying in a Functional Capacity Evaluation. *Work* 2002; 18(1): 23–27.
8. Gross DP, Battie MC. Reliability of safe maximum lifting determinations of a Functional Capacity Evaluation. *Phys Ther* 2002; 82(4): 364–371.
9. Dusik LA, Menard MR, Cooke C, Fairburn SM, Beach GN. Concurrent validity of the ERGOS Work Simulator versus conventional Functional Capacity Evaluation techniques in a workers' compensation population. *JOM* 1993; 35(8): 759–767.
10. Bos J, Mol E, Frings-Dresen MHW, Visser B. The physical demands upon (Dutch) fire fighters in relation to maximum acceptable energetic workload. *Ergonomics* accepted.
11. *ERGOS Users Guide*. Tucson, Arizona, USA: Work Recovery System Inc., 1987.
12. *Ergo-Kit Functionele Capaciteits Evaluatie. Handleiding. (In Dutch) (Ergo-Kit Functional Capacity Evaluation. Manual.)* Enschede, The Netherlands: Ergo Control, 2002.
13. National Institute for Occupational Safety and Health. *Work Practices Guide for Manual Lifting*. Cincinnati, Ohio: U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, Division of Biomedical and Behavioral Science, NIOSH, 1981.
14. Innes E, Straker L. Validity of work-related assessments. *Work* 1999; 13(2): 125–152.
15. Rustenburg G, Kuijer PPFM, Frings-Dresen MHW. Zijn beperkingen in het werk “evidence-based” vast te stellen? (In Dutch) (Can work disabilities be determined “evidence-based”?). *Werk, Houding en Beweging* 2003;8(2): 6–10.
16. Reneman MF, Jorritsma W, Schellekens JM, Göeken LN. Concurrent validity of questionnaire and performance-based disability measurements in patients with chronic non-specific low back pain. *J Occup Rehabil* 2002; 12(3): 119–129.