A Generic Work Capacity Assessment Tool for Working Conditions In India: Preliminary Results of Development and Standardisation

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ABSTRACT

The Work Capacity Assessment (WCA) tool is a new tool developed specifically to assess worker suitability for working conditions in India. This study presents the preliminary results of reliability (interrater) and internal consistency of the WCA tool. The steps for instrument development were followed stringently. The newly developed tool addressed three categories of work-Heavy Manual labour (HML), Sustained Labour (SuL) and Sedentary work (SeW). Four participants in HML five in SuL and five in SeW performed activities specified by the new scale; videography was done simultaneously. Internal consistency between the items in the scale was ascertained by Cronbach's Alpha. Spearman's Rank Correlation Coefficient was ascertained for inter tester reliability. In all three categories of workers there were some items which had to be omitted due to lack of variance. After omitting these items alpha was 0.65 and 1 in HML, 0.95 and -0.14 in SuL and 0.83 in SeW. Except for Isometric Strength and Posture Sustainability in HML which showed a poor correlation of 0.33, other items in all the categories have shown moderate to excellent correlation with each other. Most of the items have shown acceptable internal consistency and reliability, but a larger sample size and heterogeneous worker population needs to be tested. This is just a preliminary report and the tool needs to be further validated before clinical use.

Key words: Manual labour, sedentary work, sustained postures, internal consistency

INTRODUCTION

With increasing affluence, there is a concomitant increase in employment. Work related injuries and dysfunctions are on the rise especially in the unorganized sector due to lack of adequate controls and policies. The Indian Ministry of Labor acknowledges that the informal sector comprises the bulk of the workforce [1] in the country. To thwart the public health burden of work related injuries, it is essential that workers are screened/ evaluated for their ability to perform the tasks required of them at their workplace. In case of injury, this evaluation becomes doubly important, prior to return to work. India has a population of approximately 500 million who are in the working age group, but less than 10% of workers are covered by existing health and safety legislation [2]. Due to these factors, there is a dire need to assess job specific fitness of workers before placement, and after rehabilitation, using functional capacity evaluation batteries.

Functional Capacity Assessment, (FCA), has been defined, by Key G L, as "the process of measuring, recording and analyzing a person's ability to safely perform a number of job related functions, such as lifting, lowering, pushing, pulling and carrying weights, climbing ladders and stairs, sitting, standing, bending, stooping, crouching, kneeling, crawling and grasping. The interpreted results determine a worker's safe level for job placement, prevention of injury and ability to return to work" [3]

FCA's were developed as a joint venture of Physiotherapists and Occupational therapists by compiling specific tests meant to assess an individual 's capabilities [3].

The components of an FCA model are as follows. The first process is to gather information about the patient's medical history. Some examiners also obtain the psychosocial information [3]. In the second stage the measurement of a person's ability to perform a number of job related functions, are done. The activities are categorized under three headings [3]: Weighted activities, Posture and tolerance and Upper extremity activities.

There are a variety of FCA tools available, but there is a dearth of research on most, with the exception of Blankenship FCA system and Isernhagen FCA work system.

Isernhagen model

This is one of the commonly used batteries. A study by Kuijer W et al [4] reported that all work related activities could not be matched with Isernhagen Work Systems (IWS) activities. The authors stated that seven activities could be directly matched with work demands (carrying, pushing, pulling, crouching, kneeling, static forward bending, and dynamic bending and rotating). They further opined that not all observed work demands could be matched with activities in eighteen occupations studied. In a study by Gross DP [5] the author pointed out that better FCA performance was mildly associated with indicators of faster return-to-work. Fewer failed tasks (HRR 0.94 (0.91-0.98) and higher floor-to-waist lift (HRR 1.38 (1.17-1.62) were associated with faster return-to-work. Another observation was that FCA is not related to recurrent back problems, future pain intensity, or self reported disability. Brouwer S et al [6] reported on the test-retest reliability of the IWS FCE on chronic low back pain patients, and found that fifteen tests (79%) showed an acceptable test-retest reliability based on Kappa values and percentage of absolute agreement and that eleven tests (61%) showed an acceptable test-retest reliability based on ICC values.

Reneman MF et al [7] studied the test-retest reliability of IWS FCA on healthy adults. He concluded that acceptable reliability was demonstrated for seven out of nine tests (78%). Sixteen out of 17 criteria and ceiling tests (94%) showed acceptable reliability based on Kappa values and percentage of agreement. Of these 17 tests, 8 were eligible for further analysis, and of those 8 tests the reliability of one test was acceptable based on ICC analyses (13%).

Blankenship model

This is the second FCA model in frequency of use. Brubaker PN et al [8] studied its sensitivity and specificity. They reported a sensitivity of 80% and a specificity of 84.2%. The positive likelihood ratio was 5 and the negative likelihood ratio was 0.2. A systematic review done by Gouttebarge V [9], revealed the lack of studies on the reliability and validity of Blankenship system.

Common limitations

Douglas P Gross [10] compared the time taken to perfrom FCA and the short form FCA and he reported a 43% reduction in assessment time for the latter. The same author tested the reliability of safe maximum lifting determination of FCA. He found the interrater reliability to be 0.95 to 0.98 and the intrarater 0.78 to 0.74 [9].

A critical review by PM King [12] of functional capacity evaluations revealed that the use of evaluation via observation of visual movement (biomechanics) as well as the client self-report and physiological measures (eg, heart rate, blood pressure) are necessary for a safe, objective, and valid report. Tuckwell NL [13] assessed the test-retest reliability on nine tasks of the physical work performance evaluation and he inferred that the Kappa scores ranged from 0.19 (error) to 0.77 and percentage agreement from 66.7% to 87.5%.

A systematic review of all commonly used FCEs by Gouttebarge V [9] resulted in 77 potentially relevant references but only 12 papers were identified for inclusion and assessed for their methodological quality. The interrater reliability and predictive validity of the IWS (Isernhagen work system) were evaluated as good, while the procedure used in the intrarater reliability (test-retest) studies was considered not rigorous enough to allow any conclusion. The concurrent validity of the EWS (ERGOS work stimulator) and EK (ERGO-kit) was not demonstrated while no study was found on their reliability. No study was found on the reliability and validity of the BS (Blankenship system).

Short form FCA

Lechner DE [14] tested the interrater reliability and validity of a newly constructed test of physical work abilities. They reported a Kappa coefficient between the two therapists on the level of work as 0.83. The author opined that the test can be used in making decisions regarding return to work after injury, preemployment placement, and vocational exploration.

Fishbain et al [15] developed a functional capacity battery based on the Dictionary of Occupational Titles (DOT). The advantage of this battery was that it partially circumvented the “demand minimum capacity functional capacity” problem. Although the DOT functional capacity battery was found to yield reliable measurements, predictive validity was not tested. In a recent study, the first of its kind, Fishbain et al [15] tested this battery for predictive validity for actual return to work in patients with chronic pain. They found that the DOT functional capacity battery could not predict employment levels.

Most of the FCA's availability is commercial, require specific training, and have been developed essentially in the USA. They are long and time consuming, requiring on an average 24-48 hours to complete. The activities which are tested in the existing FCAs may not actually mimic the demand of the repetitive job activities [16]. Moreover no FCA has been developed for application to unique working conditions in India and similar countries. By conventional definition, FCEs use mathematical calculations. Since we needed a versatile on-site tool, we decided to develop a WCA (Work Capacity Assessment) tool that did not require calculations.

The objectives of the study were:

1. To develop a new short form WCA battery, which is applicable, to a variety of working conditions and jobs in India and similar countires.
2. To validate the WCA for content and construct.
3. To assess the reliability of the new WCA.

METHODOLOGY

Study design

The study was an observational study.

Participants

Seven Physiotherapists (PTs) and Occupational Therapists (OTs) took part in the validity and reliability phases of the study. This included two PTs for item generation, three PTs for item reduction, and two PTs and one OT for content validity.

Clearance from the institutional research committee and consent from the individual participants were obtained prior to undertaking the study. Seventy four normal participants took part in the pilot testing, which included 20 heavy manual labourers for standardization of prone plank test for Indian population, 50 students (post graduates, interns and undergraduates) for standardization of reaction time for Indian population and four post graduate physiotherapy students for pilot testing.

Fourteen asymptomatic participants fitting the work categories were recruited for reliability testing which included, four participants for heavy manual labour, and five participants each for sustained labour and sedentary jobs.

Sampling method

The sampling strategy was purposive.

Inclusion criteria

PT's and OT's: participants with a minimum of two years experience were considered for participation in the tool development stage. Participants who were engaged in the specified category of job for a minimum of the preceding 1 year were recruited for reliability testing and participants with no reported morbidity were recruited for pilot testing.

Exclusion criteria

Participants who had non work related co-morbidity and/or who were non co-operative were excluded for the final part of the study.

Procedure

Planning

The participants reviewed exisitng literature independently. Each reviewer noted limitations of existing tools. Thereafter a consensus meeting was arranged and a comprehensive list of items to be included in the new tool was formulated based on literature. Applicability to Indian conditions was emphasized upon.

Item generation

Apart from feedback from the reviewers, visual observation of the target population was done to outline important aspects of FCA's. Special care was taken to assess unique tasks heretofore not included in FCA's.

Following this, items were generated by participants involved in this part of the study. Only those suggestions which were feasible and seemed realistic were taken into consideration. After the items were generated, the assessment form and scoring information were generated. The items and scoring criteria were given to three physiotherapists for item reduction.

Face validity

Following tool construction, face validity was assessed. This was done by giving the questionnaires to three experts (2 physiotherapists / 1 occupational therapist) not involved in the item generation phase. The suggestions included modifications to improve the understandability of scoring. Appropriate changes were made. The content validity was assessed based on theoretical constructs.

Pilot testing

A pilot study was conducted on four normal participants for applicability, feasibility and clarity. The participants recruited were normal university students, with no apparent morbidities. The procedure of testing was standardised including rest breaks and order of assessment.

Standardization of reaction time was done on 50 normal students. Standardization of prone plank test, to ascertain hold time, was done on 20 labourers.

Reliability

The final scale was applied to five participants in categories two and three, and four participants in category one. The risk categories were:

1. Heavy manual labour (appendix-I)
2. Sustained manual labour (appendix-II)
3. Sedentary worker (appendix-III)

The scoring was done using the scoring sheet (appendix-IV). Participants were videotaped while performing the activities specified in the scale. Intertester reliability was estimated by two therapists, one of whom was naïve to the study details. Both testers evaluated the same video independent of each other.

DATA ANALYSIS

SPSS version 11.5 was used for analysis. Descriptives were used for normative data on reaction time, prone plank and Beiring Sorenson test.

INTERNAL CONSISTENCY

Internal consistency of the individual category of workers was estimated using Cronbach's alpha. Factor analysis was performed to divide the scale into components measuring different constructs of the scale. Cronbach's alpha was calculated for individual components. An of $\leq$ 0.70 was considered acceptable.

RELIABILITY

Reliability was estimated using Spearman's rank correlation coefficient . P value was kept at $\leq$ 0.05.

RESULTS

Planning

Literature review of all the existing FCE protocols, revealed that there was no tool that considered all the job requirements of Indian workers. Components of exisitng FCE's that were relevant to Indian workers, were adopted or adapted with modifications, and new items were added to mimic all situations that were foreseen.

Item generation/item reduction

Items which were generated, focussed on the present working conditions in India. Carrying loads on the head, and floor to overhead lifting were incorporated in the scale. Consensus was sought at a reconciliation meeting of the therapists. Those items not having 75% concurrence were omitted from the scale resulting in four items being removed. These were goniometric measurement of spinal rotations, dynamometric measurement of trunk muscle strength, and cognitive evaluation. Pain measurement was changed to RPD (Rate of Perceived Discomfort). An indigenous tool was constructed for testing reaction time. Since normal values were not available for Indian population, standardization was done using 50 students. The standard timing was found to be 385.97±56.42 milliseconds.

Face validity

The scoring criteria was haphazard in the beginning. The scoring criteria was changed universally from 0-5, 0 being maximal risk, or unable to do a task, and 5 being minimal risk, or able to do a task to maximum potential.

Pilot testing

After pilot testing, the following procedural changes were incorporated. A rest period of 5-6 mins between the testing of muscular strength of extremities, the functional and biomechanical analysis, the instrumented activitiy and the spinal muscular endurance in the heavy manual labour category. A rest period of at least 2-3mins between the isometric, isotonic, and eccentric control of the spinal muscular endurance in all the categories of workers. The grading of the prone plank test of muscular endurance was changed and is presented in table 1.

Table 1: Grading of the prone plank test of muscular endurance

Score	Description
5	Able to hold with plantar flexion and shoulders flexed greater than 90°.
4	Able to hold with dorsiflexion and shoulders flexed greater than 90°
3	Able to hold with plantar flexion and shoulders at 90°
2	Able to hold with dorsiflexion and shoulders at 90°
1	Able to hold for at least 30 secs
0	Unable to hold

Test: Ability to sustain position for 1 minute is the test

The aerobic fitness test was changed from 1 mile run to submaximal exercise test using Astrand Rhyming protocol for ease of performance. The results according to the stages of construction of the scale are given in table 2.

Table 2: Results of the different stages of the scale construction

Stages	Results
Planning	Limitations of FCE's noted down
Item generation	1. Floor to overhead lifting 2. Overhead carrying 3. Reaction time standardization 4. Prone plank hold time standardization 5. Aerobic test changed
Item reduction	4 items removed
Pilot testing	1. Breaks needed between components of strength tests 2. Astrand Rhyming protocol not possible for heavy manual labour and sustained labour categories

Internal consistency

Some items in the overall scale did not have variance, so they were omitted. These items, in accordance with the categories they belong to, are given in table 3.

Table 3: Items lacking variance in the different categories

Category	Items omitted
Heavy manual labour	• Balance • Posture • Other job specific tasks • Overall assessment
Sustained labour	• Dynamometric muscle strength
Sedentary job	• Sensation • Aerobic fitness • Other job specific tasks

Heavy Manual Labour:

In the heavy manual labour category, the alpha after removing balance, posture, other job specific tasks, and overall assessment, i.e., the items having no variance was 0 .64. Factor analysis revealed that the components were divided into two constructs. The items in the two constructs and the alpha values are depicted in table 4.

Table 4: Items representing different constructs with their Alpha values in the Heavy Manual Labour category

Construct	Items	Alpha
1	FBA, SME, FLE, PC, NM, RT	0.65
2	MS, IS, PS	1

FBA: Functional and Biomechanical analysis; SME: Spinal Muscular Endurance; FLE: Flexibility; PC: Postural Control; NM: Neural Mobility; RT: Reaction Time; MS: Dynamometric Muscular Strength; IS: Instrumented Activity; PS: Posture Sustainability

Sustained Labour

In this category, the alpha after reducing items having no variance (dynamometric muscular strength) was found to be 0.62. Factor analysis categorised the components into three principal components as given in table 5.

Table 5: Items representing different constructs with their Alpha values in the Sustained Labour category

Construct	Items	Alpha
1	BAL, FLE, PC, NM	0.9565
2	SME, RT, EHFC, OJST	**-.1481**
3	POS	---

BAL: Balance; FLE: Flexibility; PC: Postural Control; NM: Neural Mobility; SME: Spinal Muscular Endurance; RT: Reaction Time; EHFC: Eye Hand/Foot Coordination; OJST: Other Job Specific Tasks; POS: Posture

The alpha for the 1st component was 0.96. For component 2 α was -0.15. Component 3 consisted of only one item. Hence this particular item (posture) was not consistent with other items of the scale.

Sedentary Job

In this category, there were three items having no variance (sensation, aerobic fitness, other job specific tasks), after removing them, alpha for the other items was found to be 0.84.

Reliability

Spearman's rank correlation coefficient was calculated for only those components which had variance in grading. Items having no variance suggested that they had perfect correlation.
In the heavy manual labour group balance, posture, other job specific tasks, and overall

assessment had no variance. Therefore they were not taken into account for reliability. For the other items. correlation was measured within those items that measured different constructs as they were factored. The results are shown in table 6.

Table 6: Spearman's correlation values for Heavy Manual Labour

Category	Items	Spearman's correlation Coefficient
Heavy manual labour	FLE*, PC*, NM*, RT, MS*	1
	FBA	0.83
	SME	0.82
	IS, PS	0.33

FLE: Flexibility; PC: Postural Control; NM: Neural Mobility; RT: Reaction Time; MS: Dynamometric Muscle Strength; FBA: Functional and Biomechanical Analysis; SME: Spinal Muscular Endurance; IS: Instrumented Activity; PS: Posture Sustainability.

In the sustained labour group, there was only one item (dynamometric muscle strength) having no variance. After omitting this item, reliability was recalculated. Results for construct 1 are presented in table 7.

Table 7: Spearman's correlation values for Sustained Labour

Category	Items	Spearman's correlation Coefficient
Sustained labour	BAL*, FLE*, PC*, NM, EHFC*, POS*, RT*	1
	SME**	0.92
	OJST	0.40

BAL: Balance; FLE: Flexibility; PC: Postural Control; NM: Neural Mobility; EHFC: Eye Hand/Foot Coordination; POS: Posture; RT: Reaction Time; SME: Spinal Muscular Endurance; OJST: Other Job Specific Tasks

In the sedentary job category sensation, aerobic fitness, other job specific tasks had no variance so they were excluded for consistency evaluation. Cronbach's alpha was excellent for the other items so factor analysis was not done. Item-wise reliability for this category is given in table 8.

Table 8: Spearman's correlation values for Sedentary Job

Category	Items	Spearman's correlation
Sedentary job	FLE*, TMS*, POS*, OA*	1
	NM*, SME*	0.90
	PS**	0.76

FLE: Flexibility; TMS: Trunk Muscle Strength; POS: Posture; OA: Overall Assessment; NM: Neural Mobility; SME: Spinal Muscular Endurance; PS: Posture Sustainability

*Correlation is significant at 0.01 level

**Correlation is significant at 0.05 level

DISCUSSION

The process for the development of a new scale and the process for its validation has been described in detail by Jeri Benson [17]. The authors have tried to adhere to the processes described. One method of lift in the Functional and Biomechanical Analysis, commonly encountered in the Indian setup - the head to overhead lift was not included in the scale. The authors realised the significance of this type of lift at the end of the study when they encountered a subject who did this regularly. Participants in the manual work category, were of poor educational background and they were unable to follow the instructions in the Astrand Rhyming protocol. Hence there is a need to incorporate an easier to follow aerobic test. One possible option is the 1 mile walk. This needs to be further studied.

The face validity of the scale was ascertained to be satisfactory. However the therapists involved in the process had had no expereince with FCEs and the knowledge base was purely theoretical. Despite this, most of the items in all the categories have acceptable internal consistency. There were a few items in each category, the consistency of which could not be ascertained because of no variance. This lack of variance can be attributed to the homogeneity in the participants tested, as well as the small numbers. In order to comment conclusively, it would be necessary to test larger numbers of workers performing different tasks.

In the heavy manual labour category, four items had no variance, making them very consistent. They were: balance, posture, other job specific tasks, and overall assessment.

Posture and balance do not fall in the same construct as strength tests. Other job specific tasks would vary from person to person. Hence it is meaningful to delineate this item as well as the overall assessment into the latter part of the scale, dealing with the therapists' recommendation. Both of these would be better as narrative asessments.

In the sustained labour group, only muscular strength had no variance. In this category of workers, further testing should incorporate workers who require to sustain postures for varying amounts of time as this can reflect in the results from the assessment scale. In this category too, participants had the same difficulty with aerobic fitness testing. It is notable that posture, balance and trunk strength were in the same construct in this group lending credibility to the validity of the scale. Extremity strength fell under a different construct which appears logical when the working requirements are considered.

Correlation between most of the items was very good. In construct one, all the items had perfect correlation. In construct two, other job specific tasks had weak correlation between the testers, Apart from that, the other items showed very good correlation. In construct three, posture was the only item and it showed a perfect correlation.

Sedentary job category analysis saw three items with no variance. This finding is again logical and can be considered a strength of the scale. The constructs were sensation, aerobic fitness and other job specific tasks.

After omitting these items, the scale had good consistency. In this category, the participants were able to follow the instructions for the Astrand Rhyming test. We attribute this finding to the fact that the participants were post graduate students. This was the only category, where women were included as participants, as they form a major part of the sedentary workforce. Some of the items could not be tested at all due to lack of applicability. They were aerobic fitness in the heavy manual labour and sustained labour categories; change in direction in the functional and biomechanical analysis of the heavy manual labour category due to the lack of cooperation of the participants and pushing and pulling ability in the heavy manual labour category because none of the participants did significant amounts of these activities.

Longer video clips of workers at work with better clarity, co-operation of the workers for a simulated task analysis, and better work and personal history would have lent greater feasibility to the use of the scale. Although one of the objectives was to construct a scale that could be completed in an hour, this objective could not be met. Further testing and item reduction may enable the fruition of this objective.

Though other researchers have developed and validated short from FCE tools, none of them have been developed for Indian requirements. Hence comparisons cannot be made meaningfully.

While the authors have provided some data in support of use of this tool, the evidence needs to be further examined. The fact that a small sample size was tested is a limitation of this study. Some items seem to have no variance at all, showing them to be very consistent, but this might be attributable to the small sample size and the homogeneity of the workers sampled.

Lastly, it has been postulated that working conditions in India are different to the Western world by many researchers. Maybe it is due to the lack of technological mechanization in the unorganized sector, extreme climatic conditions and lack of stringent occupational health laws and rules for the labourers. Similarly, other FCE tools developed in Western countries find minimal applicability in Indian working conditions. The authors believe this tool to have wide application in the developing world where much of the work continues to be performed by human effort.

FUTURE DIRECTIONS

Time, large numbers, women specific tasks, standardisation of tests, listing of other job specific tasks, many jobs that fall under each category, aerobic testing, predictive validity, norms for Indian population, responsiveness are some of the aspects that need to be ascertained to brand this tool for clinical use.

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