Adapted Progressive Isoinertial Lifting Evaluation for determining Lifting capacity

Girish Nandakumar¹, Rauf Iqbal², Vivek Khanzode³

¹* Assistant Professor, Department of Physiotherapy, School of Allied Health Sciences, Manipal University, India.  
²,³ Assistant Professor, National Institute of Industrial Engineering, Mumbai, India.

Weight of the load and its characteristics is considered to be the important risk factor for low back disorders (LBD) among manual materials handlers. Determining weight of the load and the amount of load a person can lift is important in minimizing the incidence of LBD. Among various methods like isometric, isoinertial and isokinetic, isoinertial approach of lifting evaluation is best as it is safe, inexpensive, simple and dynamically represents real world lifting. The objective of this study was to evaluate the feasibility of adapted progressive isoinertial lifting evaluation (PILE) for determining maximum acceptable weight of lift (MAWL). This experimental study was conducted among 30 adult male participants recruited from a university community. Adaptation was done to the box dimensions and the weights used for PILE. The subjects were instructed to perform the PILE protocol using adapted box and weights using free lifting technique at two vertical distances and lifting capacity was determined. Heart rate was monitored throughout the trial and the participants were asked to rate their discomfort in a six point likert scale. All the participants were comfortable in performing adapted PILE and no untoward incident was noticed during the procedure. It may be feasible to adapt PILE for determining lifting capacity.

Key words: Lifting capacity, manual materials handling, physical work, progressive isoinertial lifting evaluation, maximum acceptable weight of lift

INTRODUCTION

World Health Organisation (2005) has recognised low back related disorders (LBDs) as one of the top three occupational related health problems. An important contributor to the etiology of back disorder is manual materials handling (MMH) activities (Judith et al., 1999). Various risk factors for LBDs like frequent bending (Garg and Moore., 1992), twisting (Elders and Burdorf., 2001), poor physical fitness levels (Alvinia et al., 2009), and psychosocial issues (Widanarko et al., 2012) have been identified. The amount of load a person can lift and its characteristics plays an important role in the causation of low back disorders (Dempsey., 2003) hence determining lifting capacity or maximum acceptable weight of load is important in the prevention of LBDs (Jager et al., 2000). Isoinertial approach is considered to be best method for determining lifting capacity compared to the isometric and isokinetic approach, as it dynamically represents the real world lifting (Girish, Iqbal, Khanzode and De., 2015).

Progressive Isoinertial Lifting Evaluation (PILE) is simple, easy to administer, valid and reliable method (Lygren et al.,2005, Hazard et al.,1992, Hattori et al., 1998). As standardised equipment for administering PILE is not available in India or is prohibitively expensive there is a need to adapt devices used for PILE. Hence an adapted version of PILE was developed in the Department of Physiotherapy, SOAHS, Manipal University, India. The aim of this study was to evaluate the feasibility of adapted progressive isoinertial lifting evaluation.

*Corresponding Author: Girish Nandakumar, Assistant Professor, Department of Physiotherapy, School of Allied Health Sciences, Manipal University, India. Tel.: +91 9886782114/ +91 820 2922533, Fax no. +91 820 2595758, Email: girish.n@manipal.edu or girish_darsana@yahoo.co.in  
²Tel.: +91 9869030986. Email id: rauf_iq@yahoo.com  
³Tel.: +91 8698193486. Email: vivek.v.khanzode@gmail.com
Table 1. Anthropometric and physiological characteristics of the participants (n=30)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>23.4 ± 2.41</td>
</tr>
<tr>
<td>Height in centimetres</td>
<td>166.23 ± 5.26</td>
</tr>
<tr>
<td>Weight in kilograms</td>
<td>60.05 ± 8.92</td>
</tr>
<tr>
<td>Resting heart rate (beats/minute)</td>
<td>72.97 ± 9.57</td>
</tr>
</tbody>
</table>

Table 2. MAWL using adapted PILE in floor to waist and floor to shoulder category

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor to waist category</td>
<td>25.20 ± 2.46 Kg</td>
</tr>
<tr>
<td>Floor to shoulder category</td>
<td>15.75 ± 2.59 Kg</td>
</tr>
</tbody>
</table>

MATERIALS AND METHODS

Participants

This pilot study was conducted among 30 adult male participants recruited from a university community. After obtaining the ethical clearance from the institutional ethical committee of Manipal University, subjects were recruited. This research complied with the American Psychological Association Code of Ethics and informed consent was obtained from each participant. The inclusion criteria were 1) the participants should be healthy men above 18 years; 2) the participants should be free of any musculoskeletal injuries or health problems or disorders that could have affected the overall performance in this study.

Experimental procedure and protocol

All the subjects were instructed to perform progressive isoinertial lifting evaluation (PILE) from floor to waist (FW) and floor to shoulder (FS). The protocol for PILE was developed by Mayer et al (1988). The weight of the load and its characteristics is important in determining the lifting capacity but the authors of PILE have not given any specification related to the box dimensions. So a wooden box was prepared after reviewing the literature, using compressed wood with a dimension of 48 x 36 x 24 cm and weight of 4.5 kg. The PILE protocol for men consists of lifting and lowering a weight of 4.5 kg at a rate of four lifts in 20 second intervals. As 4.5 kg weight is not available as a single unit in India, it has been adjusted using 4 kg weight disc and half kg sand bag. A load increment of 4.5 kg (4 kg weight disc and half kg sand bag) was added every time they completed the stage. The demographic characteristics of the participants collected were age, height, weight and resting heart rate. After explaining about the study they were asked to wear a polar heart rate monitor (FY1, Finland). Heart rate (HR) was the physiological parameter monitored as it is the easiest response to measure the intensity of physical activity also it is an indirect measure to predict the stroke volume and oxygen consumption (Johnson., 2016). The participants were instructed to lie down in supine position for minimum 5 minutes before starting the procedure and the resting heart rate was recorded.

They were free to use the technique of lift they prefer (squat, stoop/ semi-squat). The distance of lift (FW or FS) was decided using the fish bowl method without replacement in order to minimise the influence of fatigue (Kremier, 2016). The lifting evaluation was continued until they terminated the protocol because of any of the following reasons- fatigue, discomfort, and shortness of breath, inability to complete 4 lifts, lifting a load of 60% of their body weight or achieving 85% of their age determined body weight (Mayer et al; 1988).

All the participants were instructed to report the reason for terminating the protocol. All the participants were asked to rate their discomfort while performing the protocol on a six-point Likert-scale prepared by the authors, consisting of the following options: no discomfort, mild discomfort, moderate discomfort, severe discomfort, very severe discomfort and worst possible discomfort. A rest period of minimum ten minutes was given in between the trials and the total duration of lifting evaluation lasted for approximately 30 minutes for each participant and the trials were performed on the same day in a single session.

Data analysis

The data was analysed using SPSS version 14 for windows (SPSS Inc. in Chicago). Descriptive statistics were used to summarize the data.

RESULTS

A total of 30 men participated in this study. The anthropometric and physiological characteristics of the participants are shown in Table 1.

MAWL in kilogram using adapted PILE is represented in Table 2.

As depicted in table 2, the lifting capacity has shown to reduce with the increase in vertical distance of lift. A decline of 62.50% has been noticed in the lifting capacity when the vertical distance of lift is increased from waist to shoulder. Heart rate response during PILE is represented in Figure 1.
As can be seen from Figure 1 the HR increased logarithmically from the resting HR (72.97 ± 9.57). Maximum rise in HR was noticed in the first increment i.e. from stage 0 to stage 1. The participants were able to reach up to level 8 in floor to waist category whereas in floor to shoulder category they could reach up to stage 6 only. All the participants were comfortable in performing adapted PILE and no untoward incident was noticed during the procedure. None of the participants rated the discomfort as severe, very severe or worst possible.

DISCUSSION

This study was intended to evaluate the feasibility of adapted PILE for determining MAWL. PILE protocol developed by Mayer et al (1988) describes it as lifting of weight in a box from floor to waist (lumbar test) or from floor to shoulder height (cervical test) at a rate of four lifts in a 20 second interval. The test began with 4.5 kg and was incremented upwards by 4.5 kg in each 20- second interval till they terminate the protocol. The developers of this protocol have not mentioned any box dimension as size of the box, presence of handles, stability of the contents inside and so on can affect the lifting capacity; hence the box and free weight increments were adapted.

The earlier studies which determined MAWL has used psychophysical methodology, which has limitations like subjects perception, size weight illusion, moment arm distance and various other perceptual and judgmental factors that affect persons performance (Davis and...
Marras., 2000 and Remko et al., 2006). Various authors have recommended an objective performance based evaluation method like PILE for determining MAWL (Girish et al., 2015, Lygren et al., 2005 and Hazard et al., 1992). This study was conducted on male subjects from a university community, who have not received any formal training for lifting nor are they adopting lifting activities during their daily routine. Two categories of lifting were evaluated and it was found that the participants could lift more weight in floor to waist category compared to floor to shoulder category. The heart rate response during PILE showed a logarithmic rise and at each stage the HR was more for floor to shoulder category of lift when compared to floor to waist category. The numbers of participants who completed PILE reduced with each stage of PILE after stage 3 for floor to shoulder and after stage 5 for floor to waist category (Table 3). Inability to complete four lifts in 20 second interval was the reason for terminating the protocol for majority of the subjects during floor to shoulder lift (due to increased distance of lift) where as fatigue was the reason for termination during floor to waist lift. All the participants were comfortable in performing adapted PILE and no untoward health events were noticed during the procedure.

CONCLUSION

It is feasible to adapt progressive isoinertial lifting evaluation for determining the lifting capacity and no untoward health events were noticed during lifting capacity evaluation.

ACKNOWLEDGMENTS

The authors acknowledge Mr. Sarosh, Ms. Jovy and Ms. Tenzin, Interns, Department of Physiotherapy, SOAHS for their support in adapting PILE and their assistance in data collection.

REFERENCES


World health organisation (2005). Estimating the global burden of low back pain attributable to combined

Adapted Progressive Isoinertial Lifting Evaluation for determining Lifting capacity

Accepted 01 August, 2016.


Copyright: © 2016 Girish et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are cited.