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Original article

Manual material handling assessment and repetitive tasks with two methods MAC and ART in a subsidiary of a manufacturer of cleaning products

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ABSTRACT

Due to the limitations of each method of posture evaluation; the results from the comparison and evaluation of combined methods in order to complete and assess a comprehensive list of risk factors of activities is important. The purpose of this study was evaluated risk factors of manual handling, repetitive tasks and to determine the correlation between the results from two MAC and ART techniques. In this descriptive-analytical study, 50 workers who were working in 25 jobs were studied. In each task, after interviewing workers and observing their work cycles, a video was produced and the risk factors related to each activity were evaluated separately in accordance with both MAC and ART techniques. The correlations two techniques were examined by spss16 using Pearson correlation test. In accordance with the ART and MAC, 16% of the work stations are at high risk level ART and MAC techniques showed that in stations of manual handling and repetitive movements are carried out, ratings of the two techniques are different. Also, a significant positive correlation

(R=0.725) in the evaluation of musculoskeletal disorders were observed with the aforementioned methods. The findings of this study confirm the agreement between the two techniques of risk assessments that can be lowered by designing, modification of workplace, planning and implementation of ergonomic on the job training and establishing the appropriate work-rest cycle, musculoskeletal disorders.

1. Introduction

Musculoskeletal disorders are considered as one of the most widespread and costly job injuries(HP FA 2000). These disorders are the main reason of the harms and disabilities caused by working in the developed and developing countries(Chobineh A TR 2004). Musculoskeletal disorders are the major cause of loss of time, rising costs and human injuries of the labor force, and the main reason for staff's absences from work(Choobineh A TS 2007). Although the outbreak of these disorders has decreased in recent years, yet they account for a high percentage of a variety of job injuries in major industries(Choobineh A TS 2009). and include more than 85% of the laborers' compensation claims(Choobineh A RA 2006). The Bureau of Labor Statistics in the USA has declared that 44% of all the reported job injuries in America are related to musculoskeletal disorders(BB 1996). Based on a report by the Medical Committee of Social Security Organization of Tehran Province, these disorders account for 14.4% of the disablement diseases(Pransky G 2009). Nowadays, manual handling of the loads forms a large part of the laborers' tasks in most industries of the country(AJIM 2000). This physical activity is considered as one of the risk factors of the musculoskeletal disorders(Kanavos and Mossialos 1999, Kanavos Panos 2000, Karwowski W 2000).

Manual handling of the loads refers to lifting, lowering, pushing, pulling, and carrying loads manually which may lead to work-related musculoskeletal disorders(S 2005). It is the major cause of laborers' injuries in the USA, and 4 out of 5 injuries are related to the Low Back Pains (LBP) caused by manual handling of the loads (Takala 2008). Statistical findings revealed that about 50% of LBPs are caused by lifting the loads, 10% are due to pushing and 6% are related to carrying them(Choobineh A TS 2007). Of the studies based on MAC (Manual-handling Assessment Charts) method the comparison between the MAC and NIOSH (National Institute of Safety and Health) can be noted; the results of this research indicated that the risk level in the studied units are high, and both methods are in total agreement about risk assessment(A. Dormohammadi MM 2013). Based on the results of another research based on the mentioned methods, no significant relationship between NIOSH lifting equation and MAC method was detected(z panj ali 2011). Using the ART (Assessment of Repetitive Tasks) method, the results revealed that 35% of the tasks are in a high risk level (Abbaszahed R 2013). According to another research based on ART aiming to assess body condition, the risk rate of the right hand was determined higher than the left hand(Jafari rodband 2014). Comparing the risk rate of upper-extremity disorders related to manual and automatic tasks, results revealed that the manual tasks risk rate is higher(McLeod, Zochowska et al. 2012). In some industries such as hygiene products in Qazvin most of the tasks are done manually due to the traditional system; thus, activities like manual handling of the loads and repetitive movements are frequently observed in these industries. Hence, their staffs are faced with many ergonomic detrimental factors. Considering that some tasks include repetitive movements as well as manual handling of the loads, using these two methods is essential to determine all the job-related risk factors. Therefore, this study aims to assess manual load-handling tasks (lifting and carrying the loads) and repetitive movement tasks using MAC and ART methods, compare the results of these two methods, determine the relation between them and presenting reform suggestions(Choobineh A TS 2007).

2. Materials and methods

This descriptive-analytical study is carried out in a hygiene product company in Qazvin in 2014. The statistical population includes 50 laborers working for 25 job tasks chosen through census. Ultimately, 25 job tasks of 6 different units of the company including shampoo manufacturing, laboratory, hygiene gels, baby powder, warehouse and substance-production were studied. To determine the sample size, 10 individuals were randomly chosen based on pilot studies and assessed via the two methods mentioned above. Based on Pearson correlation (r1=0.7), the methods and the corresponding formulas, the sample size of 50 individuals with the confidence level of 95% and the statistical error of 5%. After interviewing each laborer and viewing the type of task they did, MAC and ART assessment methods were individually used for each task. Data final scores were calculated via MAC and ART software. Data was evaluated via SPSS 16.

MAC is a check list for guiding safety and professional health inspectors which is used for assessing common risk factors of lifting, lowering, individual and group lugging(Care B QC 2002, Takala 2008, Tapley 2009). This method studies a collection of 11 risk factors of manual handling according to four color codes and determined scores. Each color code stands for low risk (Grean:G), medium risk (Amber:A), at risk –immediate action demanded- (Red:R), and high risk (Purple:P) (Monnington SC PA 2002, P 2002, E 2012). These risk factors consist of weight/frequency of the load, the distance between the waist and the arms (G/0: arms vertically stretched with body straight, A/3: arms are distant from the body or the body is bending forward, R/6: arms are distant from the body and the body is bending forward), the position of the load being lifted (G/0: above the knees and below the elbow height, A/1: below the knees and above the elbow height, R/3: above the head height), body's rotation or bending to the sides (G/0: no rotation, A/1: bending to the sides, R/2: body's rotation and bending to the sides), the type of grip (G/0: good, A/1: acceptable, R/2: weak), body condition during the task (G/0: no hindrance, A/1: restricted body movement, R/3: highly restricted body movements), floor level regarding its flatness or pollution (G/0: clean and dry floor, A/1: rough floor, R/2: damp and rough floor), other environmental factors (no factor, A/1: one factor, R/2: more than two factors), muscles coordination in lifting, carrying the loads (G/0: good, A/1: acceptable, R/3: weak), load-transferring distance and the barriers in the path. Data-gathering tools in this research are video capture and photography (Care B QC 2002, Tapley 2009, Takala E-P PI 2010). Having determined the risk factor level, color codes and the scores, the total score can be calculated according to which the reforming action in MAC method is clarified, as displayed in Table 1.

Table 1
Determination of the risk level and reforming actions in MAC method.

MAC final score	Reforming Action	Action Class
0-4	No action demanded	1
5-12	Action demanded in near future	2
13-20	Action demanded shortly	3
21-31	Action demanded immediately	4

ART is a useful method for assessing tasks with upper extremity movements such as montage, manufacturing, packaging, and categorizing. This method not only identifies the risks of the tasks with repetitive movements, but also improves the working conditions by prioritizing actions demanded for reducing potential risks. ART divides risk levels into three categories: low risk (G), medium risk –thorough investigation demanded- (A), and high risk –immediate action demanded- (R)(Tapley 2009). These risk factors include the frequency of repetitive movements (A1: arms movements, A2: repetitive movements of arms and hands), the demanded strength (light, without requiring any effort; medium weight, for which the laborers do not need much effort; heavy and extremely heavy loads for which the laborers need to use their maximum strength), poor postures (C1: head and neck posture, C2: back posture, C3: arm posture, C4: wrist posture and C5: hands/fingers grip), and additional factors (D1: working gaps, D2: working rapidity, D3: time span and D4: other factors). The Task Score is a total of repetitive movements' frequency, strength, poor posture and additional factors for the right and left hand individually.

Task Score =A1+A2+B+C1+C2+C3+C4+C5+D1+D2+D3

Task Score multiply the time span of the task will result in the Exposure Score (Exposure Score = task x D4)

As displayed in Table 2, having calculated the Exposure Score, proper reforming action are taken.

Table 2

Reforming-action class determination based on ART

Action Class	Reforming action	ART Final Score
1	The condition of the vulnerable groups – pregnant women, new laborers, and laborers with heavy repetitive movement tasks- must be considered.	0-11
2	Working conditions demands more examination.	12-21
3	Further investigation is essential.	Over 22

3. Results

Table 3 displays the results of the assessment based on MAC and ART methods. As the results revealed, based on MAC method assessment reforming action is demanded in near future for one-starred cells and for two-starred ones reforming action must take place within a short time. Based on ART assessment, the risk level is medium for grey cells which require more examination for the task represented in them. As the results of MAC assessment revealed, the highest score belongs to the manufacturing unit (relocating the casks), and then storage and manufacturing units (filling the tanks) with the score of 14 and transformation of the bags by pallet jack with the score of 13; the risk level of all of the mentioned factors belong to the third reforming-action class. All other tasks own the risk level of 2 or less. Based on ART results, the highest scores in both left and rights hands are in the range of 12.5-14.5, related to the packaging and handling the boxes, baby body oils lid-replacing, lifting and squeezing the hygiene gel tubes and injection of hairspray into its container; the risk level of all belong to the second reforming-action class. Table 4 displays the results of assessing the risk level of each activity base on MAC and ART methods. As the results revealed, mean and standard deviation in MAC and ART methods are 7.7+3.8 and 7.8+3.3, respectively. The examination of the two methods' correlation indicated that the two methods have a relatively good ($r=0.725$) and significant ($P<0.001$) correlation.

4. Discussion and conclusion

Manual handling of load is one of the causes of musculoskeletal disorders in the employees. So, the ergonomics assessment of this physical activity could be help to identification of problems and provide control solutions. The results this study showed that according to the score of MAC method, in 16% of the workstation is a high level of risk and correction action is needed soon. As well as in 44% of the workstation is a medium level of risk and correction action is needed in the closely future. The reasons of the relatively high level of risk in workstations of handling of bags by jack pallets, storage units, and the construction unit (carrying barrels) can be overweight of load, increase the hand distance to low back, torso bending forward and poor grip on the load .The most important risk factors in this study can be mentioned to the weight load, hands grip when closing the lid containers, manual handling barrels and the reach distance to remove products. In the study of the Abaszadeh and colleague (2012) in the assembly industry also how the grip and the lack of rest was considered as one of the most important factors in the increase level of risk(Abbaszahed R 2013). Therefore, to reduce musculoskeletal disorders in these activities can be mentioned to decrease of load weight, loss of reach region, increase lifting height of load, assembling handles on the load, measuring body dimensions of employee and design of workstation based on anthropometric characteristics. Planning and implementation of ergonomics training on the job, appropriate work and rest cycles are corrective actions in such workstations.

Table 3

The results of the assessment of the laborers' activities in a hygiene product company based on MAC and ART methods.

Stage	Type of the task	Final mac score	Risk level	Final ART score			
				Right hand score	Right hand risk level	Left hand score	Left hand risk level
1	Injecting baby shampoo into the container	4	1	3.5	1	3.5	1
2	Shampoo lid-replacing	4	1	3.5	1	3.5	1
3	Shampoo packaging	9	2*	8	1	7.5	1
4	Coding and labeling	4	1	4.5	1	4	1
5	Packaging and handling the boxes	11	2*	13	2	12.5	2
6	Labeling 500 ml shampoo container	4	1	4	1	3.5	1
7	Hairspray, shampoo coding, and baby body oil units	4	1	6	1	5	1
8	Labeling baby shampoo and body oil	4	1	5	1	4	1
9	Packaging and handling baby oil boxes	9	2*	8	1	7.5	1
10	Hair conditioner spray labeling	4	1	6	1	5	1
11	Injecting hairspray into the container	8	2*	13	2	11	1
12	Baby body oil lid-replacing	8	2*	14	2	12.5	2
13	Lifting and squeezing hygiene gel tubes	8	2*	14.5	2	13.5	2
14	Packaging hygiene gels in boxes	10	2*	9.5	1	9	1
15	To domino the products	4	1	4	1	4	1
16	Lifting and transferring the boxes by the pallet jack	13	3**	10.5	1	9	1
17	Shrink-wrapping the shampoo	8	2*	9	1	9	1
18	Packaging the shampoo after being shrink-wrapped	10	2*	9.5	1	9	1
19	Packaging bags filled with containers	10	2*	8	1	8.5	1
20	Labeling baby powder containers	4	1	5	1	4.5	1
21	Transferring and examining the materials (laboratory unit)	6	2*	8.5	1	7.5	1
22	Control room (sorting, handling and replacing unit)	4	1	4	1	4	1
23	Storage unit (packaging,, sorting and replacing)	14	3**	10	1	9.5	1
24	Manufacturing unit (filling	14	3**	11	1	10	1

	the tanks)						
25	Manufacturing unit (relocating the casks)	14	3**	11	1	10	1

Table 4
Risk Level Percentage in ART and MAC methods.

Risk level class	Risk level percentage based on MAC method	Right hand risk level percentage based on ART method	Left hand risk level percentage based on ART method
1	40%	84%	88%
2	44%	16%	12%
3	16%	0%	0%
4	0%	No risk level of class 4 based on ART	

Score of ART method for workstation aforementioned is not required to correction action, because ART method, the factors such as weight load, the hand distance to low back, the mount of bending to lifting of the load and bending to the sideway during the activity not assessed as a risk factor. So, the score obtained from MAC method in workstation with manual handling of load including lifting and carrying bags by jack pallets, storage units, and the construction unit (carrying barrels)provide appropriate score and more acceptable. Workstation with repetitive motion including, close lid canister, tore move the gel tube health, injection of hair spray into the container, according to the score of ART method, more study is needed in working conditions (level of risk two), because ART method with investigation of the factors such as wrist posture, frequency of repetitive motion and duration of activity, a more accurate estimate show compared to MAC method.

In assessing the ART method, the right hand than the left hand is a higher risk due to exertion, more use of it and awkward posture which this result in line with the results Rod bandy and colleague(2013) using the ART method among mosaic workers(Jafari rodband 2014).Also, the results this study indicated that ART and MAC methods in workstations which are require handling of load and repetitive motion (i.e. packaging, manual handling of carton and tore move the gel tube health)simultaneously, show the same level of risk while the activities that done only manual handling or repetitive motion is different scores of two methods. Because many workstations had repetitive motion and handling of load, in total, the findings showed a significant positive correlation between the two methods MAC and ART.

Because of limitations in assessing ART method in manual handling of load and MAC method in evaluation of upper limbs, we recommend that these two methods in manual handling activities with repetitive motion used simultaneously, which the results this study was in line with other similar studies(Graves 2008).In a study to determine the association of ART method with three of OCRA, QEC, SI methods was observed that the ART method is high agreement with these methods and ART method in comparison with these methods, better determined the risk levels for awkward posture in many tasks especially for repetitive tasks(Health 2007, Ferreira J 2009) . In the study of Abaszadeh and colleague in 2012 year, ART method introduced as the most method for assessment upper limb musculoskeletal disorders with repetitive motion(Abbaszahed R 2013). McLeod and colleague in 2012 years ART method used in their study to compare the risk of upper limb disorders in manual and automatic tasks in the pharmaceutical industry, therefore ART method as appropriate and application method introduced for identification of related- risks with upper limbs(McLeod, Zochowska et al. 2012).Another study by Dormohmady and colleagues (2013) in a tile industry done by the MAC method that appropriate assessment introduced to determine the physical stresses of manual handling of load(A. Dormohammadi MM 2013).

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References

A. Dormohammadi MM, H. A. S, E. Zarei, M. Asghari, S. Musavi ,2013. Comparative Assessment of Manual Material Handling Using the TwoNIOSH Lifting Equation in a Tile Manufacturing Methods of MAC and Revised Company. Iran Occupational Health 10(5). http://ioh.iums.ac.ir/browse.php?a_id=850&sid=1&slc_lang=en.

Abbaszahed R, Z. S., 2013. using method ART. Health science 10(6) http://ioh.iums.ac.ir/browse.php?a_id=849&sid=1&slc_lang=en.

AJIM.,2000. upper extremity and low back injuries. results of a retrospective study 37(4): 400. DOI: 10.1002/(SICI)1097-0274(200004)37:4<400::AID-AJIM10>3.0.CO;2-C

BB, H. T. 1996. Epidemiology of work-related musculoskeletal disorders. Orthop Clin North Am 27(4): 679-709. DOI: 10.1002/(SICI)1097-0274(199712)32:6<620::AID-AJIM8>3.0.CO;2-T.

Care B QC, M. S., 2002. Testing and improving the usability of the Manual handling Assessment Chart (MAC). Bootle. Health and Safety Executive) Internal report. DOI: 10.3233/WOR-2011-1189.

Chobineh A TR, A. Z., M D., 2004. Ergonomic intervention in carpet medning operation. Applied Ergonomics 35: 493-496. http://www.researchgate.net/publication/259299479

Choobineh A RA, N. M., 2006. Association between perceived demands and musculoskeletal disorders among hospital nurses of Shiraz University of medical sciences. Int J Occup Saf Ergon 12(4): 409-416 http://ijn.iums.ac.ir/browse.php?a_id=1497&sid=1&slc_lang=en.

Choobineh A TS, B. M. ,2009. Musculoskeletal Problems among Workers of an Iranian Sugar-Producing Factory. Int J Occup Saf Ergon 15(4): 419-425 . DOI: 10.4103/0019-5278.32462.

Choobineh A TS, M. A., Salehi M., 2007. Mokhtarzadeh A, Salehi M. Musculoskeletal problems among workers of an Iranian rubber factory. J Occup Health 49(5): 418-423. http://eprints.ajums.ac.ir/1607/.

E, H. ,2012. Manual handling assessment charts (the MAC tool). DOI:10.5271/sjweh.2876

Ferreira J, G. M., Hunter L, Birtles M, Riley D. Development of an assessment tool for repetitive tasks of the upper limbs (ART). england: Health and Safety Laboratory for the Health and Safety Executive. ,2009: .. "Development of an assessment tool for repetitive tasks of the upper limbs (ART). england. Health and Safety Laboratory for the Health and Safety Executive: 15-25. DOI: 10.1201/9780203883259.ch73.

Graves, R. J., et al .,2008. repetitive tasks of the upper limbs (ART). england: Health and Safety Executive(HSE). 3-15. http://www.hse.gov.uk/pubns/indg438

Health, a., Safety, Laboratory ., 2007. Development of an assessment tool for repetitive tasks of the upper limbs (ART). england: Health and Safety Executive(HSE).: 3-13. http://www.hse.gov.uk/research/rrpdf/rr707.

HP FA .,2000. The role of physical and psychological feetors in occpatinal law back pain. Ocaupational and Environmental Mediaine. 57: 116-120. DOI:org/10.1037/0033-295X.100.3.363.

Jafari rodband, A., karimi A, mardi H, nadir F, nadir H ., 2014. The Prevalence of Musculoskelet al Disorders and Posture Assessment by ART method in Mosaic art in Kerman city. Journal Of Neyshabur University Of Medical Sciences. 2(2): 38-42. http://journals.nkums.ac.ir/index.php/arcemss8/article/view/2550.

Kanavos, P. and E. Mossialos.,1999. International comparisons of health care expenditures: what we know and what we do not know. Journal of health services research & policy 4(2): 122-126. http://dx.doi.org/10.1590/S0042-96862000000100002

Karwowski W, M. w. ,2000. Occupatoinal Ergonomics Handbook New York.: 447 DOI:10.1080/00140130400029167

McLeod, M., A. Zochowska, D. Leonard, M. Crow, A. Jacklin and B. Franklin .,2012. Comparing the upper limb disorder risks associated with manual and automated cytotoxic compounding: a pilot study.

EUROPEAN JOURNAL OF HOSPITAL PHARMACY-SCIENCE AND PRACTICE 19(3): 293-298. DOI: 10.1056/NEJM200011233432103.

Monnington SC PA, Q. C. ,2002. Development of an inspection tool for manual handling risk assessment. Health and Safety Laboratory. DOI:10.1080/00140130600581041.

P, A.,2002). Benchmarking Manual Handling Assessment Charts (MAC). Health and Safety Laboratory. https://books.google.com/books?hl=en&lr=&id=SCIxOaZTvgIC&oi=fnd&pg=PA14&dq=Benchmarking+Manual+Handling+Assessment+Chart

Pransky G, B. K., Hill-Fotouhi C, Himmelstein J, Fletcher KE, Katz JN, et al .,2009. Outcomes in work-related upper extremity and low back injuries: results of a retrospective study.37(4). DOI: 10.1002/(SICI)1097-0274(200004)37:4<400::AID-AJIM10>3.0.CO;2-C

S, S. (2005). " Exposure Check. Research Report." DOI: 10.1093/occmed/kqi082

Takala, E.-P., et al.,2008. The development of the Quick Exposure Check(QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. Applied Ergonomics 39: 57-69 DOI: 10.3233/WOR-2012-0430-2056.

Takala E-P PI, F. M., Hansson G-Å, Mathiassen SE, Neumann WP, et al .,2010. Systematic evaluation of observational methods assessing biomechanical exposures at work. Scandinavian journal of work. environment & health: 3-24. DOI:10.1007/S00420-007-0180-5.

Tapley, S. E., and Peter Buckle .,2009. Reliability of Manual handling Assessment Charts (MAC) developed for health and safety inspectors in the UK. A field study. Field Operations Directorate: 29. https://books.google.com/books?hl=en&lr=&id=SCIxOaZTvgIC&oi=fnd&pg=PA8&dq=Reliability+of+Manual+handling+Assessment+Charts+(MAC)

Z Panj ali, S. A. z., R abedinlo .,2011. assesment of manual material handlenig using Iranian MMH regulation and comparision MAC and NIOSH method in one of metal casting industries in Tehran.3(1). http://jhsw.tums.ac.ir/browse.php?a_id=5062&sid=1&slc_lang=en.