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Cost-Benefit Analysis of Ergonomic Program for Management of Low back Problems among Office Workers

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Abstract: Low back problems are emerging as important work-related health disorders especially among computer office workers with substantial cost. The most prominent feature, of these conditions, is low back pain (LBP).The present study was designed to investigate low back problems among office workers in relation to ergonomic factors at work and to analyze cost-benefit of a suggested ergonomic program for management of this problem. A cross-sectional study was conducted in the office work department in a petroleum company in the Western desert. The study included 120 office workers. All participants were subjected to a predesigned questionnaire emphasizing occupational history, clinical examination, anthropometric measurements, and ergonomic checklist for subjective assessment. The LBP was defined whether non-specific, radiating, persistent specific, or chronic. A parallel objective assessment of the computer desk workstations (n = 62), which were shared by workers, was carried out by experienced ergonomists with the same previous checklist. Medical records were reviewed for assessment of the cost of low back problems in the years (2007-2009).The cost of a suggested ergonomic program was calculated for 3 years according to the market price in order to calculate cost-benefit ratio of such a program in prevention of LBP. **Results** showed that 61% of the examined workers gave history of LBP within the previous 3 years and clinical signs were detected in 32% of the workers. There were no significant differences between subjective and objective assessments of the different items scores of the ergonomic checklist. The lowest mean scores were reported for the chair and the work habits and training; both were negatively correlated with LBP intensity and duration. The suggested ergonomic program entails correction of the defective items to meet the standard ergonomic healthy criteria, provision of 6 periodic ergonomic training programs and enforcement of healthy work and life style habits. The final cost-benefit ratio of the ergonomic program for management of LBP among office workers of the present study was 1: 3.67 which is considered cost beneficial. Properly designed ergonomic programs are cost beneficial in management of LBP among office workers.

Key words: Cost-benefit analysis, Low back problems, Office workers, Ergonomics, Ergonomic checklist.

INTRODUCTION

With modernization of work systems and increased trends of sedentary office work, low back problems are emerging as important national work-related health disorders. Such problems, which are common reasons for seeking medical care, require collaborative

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studies for prevention among office employees. The low back problems are associated with substantial direct health care cost and indirect employer paid costs due to absenteeism with the subsequent work loss.[1] According to many investigators, low back pain (LBP), localized between the 12th rib and the inferior gluteal folds with or without leg pain, is the most prominent feature for presentation of these problems which may be of muscular, spinal and/or neurological origin.[2,3]

Great variations in diagnostic tests and treatments as well as the resulting costs have been reported previously, but LBP patients seem to experience similar outcomes.[4] On the other hand, many occupational risk factors were identified in relation to the problem of LBP. Office work, with its monotonous tasks and poor ergonomic standards, was emphasized as important area for remedy.[3,5] The ergonomic principals consider primarily fitting the task for the worker in the different workstations.[6] Prolonged sitting, muscle immobilization, poor back posture with loss of lumbar lordosis, uncontrolled bending and twisting are among conditions that influence low back problems in office workers especially those using computers and requiring continuous long daily work hours.[7,8] However, the search for a comprehensive set of etiological explanations and associated cost estimates has remained inconclusive.

Changes in work practice patterns are raised recently as important issue for improving outcome and cost reduction in LBP.[9] Many ergonomic checklists are currently available for use by the worker himself or by the specialist to identify health problematic sources as base-lines for ergonomic programs in office computer workstations.[10-12] Such programs are based on identification of unsuitable equipment and/or work practices by subjective and objective means in order to suggest the corrective actions, which differ from one situation to another.[6]

The present study was designed to

investigate low back problems among office workers in relation to ergonomic factors at work and to analyze cost–benefit of a suggested ergonomic program for management of these problems.

SUBJECTS AND METHODS

Study design and setting

A cross-sectional study was conducted in the office work department in a petroleum company in the Western desert during May 2010. The administrative system of this place requires working for 12 hours daily (from 7 am to 7 pm) for 2 weeks followed by a vacation for 2 weeks.

Study population

Ethical considerations were applied after getting permission from concerned authorities. All male office workers in this facility (n = 140) were invited for participation in this study. Those, who accepted to participate in the current study (n=120), were introduced to detailed explanation of the study procedures and all of them gave a written consent to participate in the study. Others refused to participate in the study (n=20) due to causes irrelevant to any health problem. Confidentiality was ensured.

Study methods

The study was performed through the following:

- A predesigned questionnaire was administered including: data about personal particulars, education, monthly total income, and occupational history especially duration of employment and actual office work daily hours. Also data on medical history of low back problems before applying for the present job, pre-placement and periodic medical examination of workers and history of LBP within the last 3 years was inquired about.
- The LBP was classified in terms of duration (weeks) and presentation pattern according to Krismer and van Tulder 2007;[3] into the following categories:1-non-specific LBP; for LBP lasting more than 2 weeks that is symptomatizing causing limitation of activities; 2-

radiculopathy associated LBP; for LBP lasting less than 6 weeks; 3- persistent LBP associated with specific spinal cause; for LBP lasting for a period between 6 and 12 weeks; 4- and chronic LBP; for LBP lasting more than 12 weeks. The intensity of experienced LBP was assessed with a numerical rating scale from 0 to 10 according to Schmidt et al. 2009.[13] In case of experiencing LBP more than once by the same worker, it was counted one time, durations of attacks were added, and final presentation and intensity were considered. The type of management given for each affected worker was described.[5]

- Clinical examination; general and systemic, was performed with particular emphasis on musculoskeletal and neurological examinations according to Deyo et al. 1992.[14] Measurements of height (cm) and weight (kg) were taken by the standard methods. Body mass index was calculated (BMI kg/m2) and classified into normal, overweight and obese (according to the WHO 2006).[15]
- Ergonomic checklist for office computer workstations, according to Gerberding 2002,[11] was administered for subjective assessment by the worker himself as suitable or unsuitable regarding, desk/ workstation (score based on 8 points), chair (score based on 12 points), monitor (score based on 5 points), keyboard and mouse (score based on 5 points), and work habits and training (score based on 5 points). Workstation assessment

The facility of the present study included 62 computer desk workstations which were shared by workers according to work-vacation system; all of them were inspected during real work hours by two experienced ergonomists independently for objective assessment using the same previous ergonomic checklist.[11] They reported on each workstation regarding the different items of the components of the checklist as suitable or unsuitable; in case of

disagreement about any item they were asked to give a final single opinion considering the ergonomic standards.[10]

(Consensus was reached for all answers)

Statistical analysis and calculating cost-benefit

Data entry and analysis were performed using SPSS program version 17. Frequency distribution tables and descriptive analysis (mean and standard deviation) were used. Student t-test and Spearman's correlation analysis were applied. The significance level was set at $p < 0.05$.

The comparator of the present study Is the "status quo" or the do-nothing alternative. This describes a state where no ergonomic program was implemented for prevention of the low back problems and they will continue similar to the current situation in the coming 3 years and even with more severity due to cumulative effect and aging of workers. So, this would have translated into a zero cost, zero benefit (saving) alternative. The prevalence of low back pain may be reduced to 3% only in the low risk population[16], yet this was not considered in the calculations as the workers may transfer the knowledge and practice to some people around; thus compensating for the 3%. The cost/benefit ratio of the ergonomic program was calculated as follows:

- **Cost of the ergonomic program:** Based on the ergonomic checklist items as well as the ergonomists' recommendations, a suggested ergonomic program was proposed. Depending on expert opinion, market price of the different items in Alexandria, and cost of training programs in ergonomics according to Alexandria University training unit, variable cost (according to number of defective or missing ergonomic items), and fixed cost (fixed needs of the program) were calculated for a time interval of 3 years; the durability of items if properly used is 3 years.
- **Benefit: Preventable cost of low back**

problems (saving, after averting cost of illness): Medical records of the currently investigated company were reviewed to obtain data about low back problems among workers in the previous 3 years (2007-2009). The direct cost of low back problems was calculated by multiplying the number of each service provided (outpatient and inpatient) for the presented cases to the medical department by its paid cost by the company according to the ongoing contractors with the different health facilities. The indirect cost was calculated by multiplying the number of sick leaves weeks, given on outpatient basis or for post-surgical convalescence, by the average weekly salary of participating workers.

- A discount rate of zero percent was used in the primary analysis, and only the denominator of the cost/benefit ratio was discounted by a derived rate, from discounting tables,[17] equal to (0.03) and multiplied by years of the ergonomic program to yield 0.91 as a discounting factor. $PV=FV/(1+i)^n$ [this is assuming that prices (cost of LBP) will stay stable] PV=present value, FV=future value, i= inflation rate and n= number of years discounting factor= $1/(1+i)^n$

RESULTS

Table 1 describes the profile of the studied office workers. The mean age of the studied group was 42.18±9.79 years, and 71.7% of them had university education. The mean duration of employment was 16 ± 7.31 years, with mean actual office work hours of 8.33±1.79 hours daily. The mean monthly income of the participants was divided by 4 to indicate an average weekly salary of about 500 L.E.

None of the studied workers gave the history of LBP before applying for the present job. All the workers stated that they had pre-placement and periodic medical examinations. Clinical examination and/or plain X-ray of low back were performed to

42.5% of the participants during periodic medical examination, while none of these tests was done during the pre-placement medical examination.

About 61% of the examined office workers gave history of LBP that was symptomatizing for more than 2 weeks within the previous 3 years. Non-specific LBP represented 40% of all LBP cases; meanwhile, radiculopathy with LBP, persistent specific LBP and chronic LBP represented 22.9%, 25.7% and 11.4 % of cases respectively. The median intensity of LBP score was 4 (score 0/10) among complaining workers. The average (median) duration of LBP was 5.36 weeks, and about 57% of the complaining cases had LBP duration between 2 and less than 6 weeks. Eight LBP cases (11.4% of the complainers) did not seek specialized medical advice; meanwhile, the remaining cases received variable services; including medical advice, medical treatment, investigations (laboratory analyses, plain X-ray &/or magnetic resonance imaging (MRI)), and/or physiotherapy. Four cases (5.7% of the complainers) required surgery for their LBP. Table 1b

Regarding the workers' opinion about the cause of their LBP, 60% of cases attributed LBP to uncomfortable posture and/or chair, 27.1% of cases blamed the prolonged sitting hours, 8.6% of cases gave history of trauma during work, and only a minority, 4.3% of cases, gave history of trauma outside work. Most of the workers participating in the study were overweight (43.4%) and 20.8% were obese. Clinical signs were detected in 31.7% of the examined workers in terms of tenderness of low back region (16.7%), positive straight leg raising test (SLR 10%), sensory deficit (3.3%), and motor deficit (1.7%).

Table 2 shows the results of the subjective assessment, of the different items of the ergonomic checklist, by the worker himself; as well as, the objective assessment of the workstations by the ergonomist using the same ergonomic checklist. There were no

significant differences for the mean scores given subjectively or objectively for the different items; including desk/ workstation, chair, monitor, and keyboard and mouse. The lowest mean scores were reported by workers for the chair (5.12/ 10) and the work habits and training (2.88/ 5).

Table (1): Profile of the studied office workers

Characteristics	No.	(%)
Age(years)		
20-	26	(21.7)
30-	53	(44.2)
40-	24	(20.0)
50-60	17	(14.1)
Mean± SD	**42.18 ±9.79**	
Education		
Technical diploma	34	(28.3)
University degree in engineering	50	(41.7)
University degree in Chemistry	20	(16.7)
University degree in commerce	16	(13.3)
Duration of employment (years)		
<5	22	(18.3)
5-	40	(33.3)
10-	46	(38.4)
20+	12	(10.0)
Mean ±SD	**16.03 ± 7.31**	
Actual office work daily hours		
<6	23	(19.2
6-8	42	(35.0)
8-	43	(35.8)
10+	12	(10.0)
Mean ±SD	**8.33 ± 1.79**	
Monthly total income (L.E):		
1000-	18	(15.0)
1500-	36	(30.0)
2000-	44	(36.7)
2500-	14	(11.7)
3000+	8	(6.6)
Mean ±SD	**2000.8 ± 1501.3**	
History of LBP before applying for the present job (No**)**	120	(100.0)
Performance of pre-placement medical examination (Yes)	120	(100.0)
Clinical and/or plain radiological examination of low back during pre-placement medical examination (No)	120	(100.0)
Performance of periodic medical examination		
Every two years	120	(100.0)
Clinical and/or plain radiological examination of low back during periodic medical examination (Yes)	51	(42.5)

Continue: Table (1b)

Characteristics	No.	(%)
History of LBP within the last 3 years (Yes)	70	(60.8)
Presentation of LBP (n=70)		
Non-specific LBP	28	(40.0)
Radiculopathy with LBP	16	(22.9)
Persistent specific LBP	18	(25.7)
Chronic LBP	8	(11.4)
Intensity of LBP (score 0/10) (n=70)		
1-	32	(45.7)
4-	20	(28.6)
7-10	18	(25.7)
median	**4**	
Duration of LBP (weeks) (n=70)		
2-	40	(57.1)
6-	12	(17.2)
8-	10	(14.3)
12+	8	(11.4)
median	**5.36**	
Type of management given for LBP (n=70)		
No specialized medical advice	8	(11.4)
Medical advice, laboratory analyses and treatment	18	(25.7)
Plain X-ray, sick leave+ above	18	(25.7)
MRI + above	12	(17.1)
Physiotherapy + above	10	(14.3)
Surgery + above	4	(5.7)
Cause of LBP (worker's opinion) (n=70)		
Uncomfortable posture and/or chair	42	(60.0)
Prolonged sitting hours	19	(27.1)
History of trauma during work	6	(8.6)
History of trauma outside work	3	(4.3)
BMI (kg/m^2)		
< 25 Normal	43	(35.8)
25- Overweight	52	(43.4)
≥ 30 Obese	25	(20.8)
Mean ± SD	**28.66 ± 6.03**	
Clinical examination		
No clinically detectable findings	82	(68.3)
Tenderness of low back region	20	(16.7)
Positive SLR test	12	(10.0)
Sensory deficit	4	(3.3)
Motor deficit	2	(1.7)

Table (2): Ergonomic checklist of office work by subjective (workers' opinion) and objective (ergonomist's opinion) assessment.

Items	Assessment as suitable Subjective (n=120)		Objective (n=62)		t	p
	No.	(%)	No.	(%)		
Desk/ workstation:						
1. Enough room on work surface for all accessories.	72	(60.0)	37	(59.7)		
2. Desk surface provides at least 18" between eyes and screen.	90	(75.0)	50	(80.6)		
3. Accessed items (e.g., phone manuals) easy to reach.	101	(84.2)	49	(79.0)		
4. Keyboard tray adjustable.	83	(69.2)	44	(71.0)		
5. No under-desk obstructions.	96	(80.0)	50	(80.6)		
6. Document holder to prevent frequent bending.	24	(20.0)	15	(24.2)		
7. No contact with any sharp or square edges.	110	(91.7)	56	(90.3)		
8. Source of light on the line of sight.	106	(88.3)	55	(88.7)		
Total score (0/8) Mean ± SD	**6.72 ± 1.03**		**6.57 ± 1.06**		**0.92**	**0.451**
Chair:						
1. Chair back is adjustable.	28	(23.3)	12	(19.4)		
2. Chair height is adjustable up and down.	27	(22.5)	12	(19.4)		
3. Chair back is contoured to support the lower back.	27	(22.5)	12	(19.4)		
4. Backrest large enough to support entire back.	30	(25.0)	14	(22.6)		
5. Lumbar support is a minimum of 12" width.	28	(23.3)	14	(22.6)		
6. Between (2-4") room from front edge of the seat pan to the back of knees.	44	(36.7)	24	(38.7)		
7. Use of a footrest.	37	(30.8)	20	(32.3)		
8. Chair arms don't interfere with getting close to work.	70	(58.3)	40	(64.5)		
9. Chair arms allow to seat with shoulders relaxed.	76	(63.3)	38	(61.3)		
10. The distance between armrests adjustable.	20	(16.7)	12	(19.4)		
11. Knees bent forming approximately a 90◦ or greater.	59	(49.2)	32	(51.6)		
12. The chair has a stable base supported by five legs with casters.	24	(20.0)	12	(19.4)		
Total score (0/12) Mean ± SD	**5.12 ±3.31**		**4.87 ± 3.19**		**0.49**	**0.209**
Monitor:						
Viewing distance somewhere between 18 – 30".	100	(83.3)	52	(83.9)		
The top of screen at or just below eye level.	108	(90.0)	56	(90.3)		
To see monitor without tilting head back.	104	(86.7)	55	(88.7)		
Computer monitor free of glare or reflections.	98	(81.7)	50	(80.7)		
Monitor screen is clean.	109	(90.8)	58	(90.6)		
Total score (0/5) Mean ± SD	**4.11± 0.61**		**4.21± 0.21**		**1.25**	**0.574**
Keyboard and mouse:						
Locate directly in immediate reach zone (elbow level).	101	(84.2)	52	(83.9)		
Mouse positioned next to keyboard.	105	(87.5)	55	(88.7)		
During work forearms and upper arms angles are 90◦ and elbows are close to body.	98	(81.7)	50	(80.7)		
Good wrist positions (in line with forearm) during work.	94	(78.3)	48	(77.4)		
Smooth operating work surface for keyboard and mouse.	96	(80.0)	50	(80.7)		
Total score (0/5) Mean ± SD	**4.31± 0.23**		**4.08± 0.33**		**0.84**	**0.439**

Continue Table (2)

Items	Assessment as suitable			
	Subjective (n=120)		Subjective (n=120)	
	No.	(%)	No.	(%)
Work habits and training:				
Do you take short and frequent breaks every 20-30 minutes?	70	(58.3)	--	--
Do you frequently change body positions while working?	76	(63.3)	--	--
Do you provide your eyes with vision breaks every half hour?	97	(80.8)	--	--
Are you free from experiencing any pain or discomfort while working?	68	(56.6)	--	--
Have you been introduced to a training program for healthy ergonomic work at office?	20	(13.3)	--	--
Total score (0/5) Mean ± SD	**2.88± 0.72**		--	--

Table 3 presents Spearman's correlation between LBP intensity and LBP duration, and ergonomic checklist items scores among the complaining cases (n=70).The higher the scores obtained for adequacy of chair or work habits and training, the lower the intensity and duration of pain experienced (intermediate, indirect significant correlation).

Table (3): Correlation between LBP intensity and LBP duration, and ergonomic checklist items scores among complaining cases (n = 70).

	LBP intensity (Score 0/10)		LBP duration (weeks)	
	r_s	p	r_s	p
Desk / workstation score (0/8)	0.019	0.831	0.022	0.842
Chair score (0/12)	-0.349	0.001*	-0.501	0.001*
Monitor score (0/5)	-0.211	0.091	-0.141	0.299
Key board and mouse score (0/5)	-0.071	0.612	-0.101	0.314
Work habits and training (0/5)	-0.411	0.001*	-0.271	0.041*

* $p<0.05$

Table 4 describes the average cost of low back problems in 3 years interval as obtained from the company's medical records. It was calculated in terms of direct cost derived from outpatient and inpatient costs of the different services given for

cases with low back problems in the facility. The worker may receive a service for more than one time. The indirect cost was calculated by multiplying the average number absenteeism weeks, given as sick leaves for low back problems, by the average weekly salary of workers. The average total cost of the disease was 314230L.E.

Calculating cost-benefit ratio

The suggested ergonomic program entails correction of the defective items, such as chairs, that were shown from the ergonomic checklist to be related to the present health problem (50 chairs, 47 document holders and 42 foot rest). Also to start a periodic training program, each of 20 credit hours, on 6 months basis throughout the coming 3 years (one credit hour costs 150L.E, assuming maximum cost) with enforcement of knowledge about healthy work habits and practices through posters and flyers. Therefore, the cost of this ergonomic program includes:

Variable cost:

- Ergonomic chairs (1000L.E.*50)

= 50000 L.E

- Document holders (50L.E.* 47)

= 2350 L.E

- Footrest (60 L.E. * 42)

= 2520 L.E.

Fixed cost:

- Ergonomic training program (3000L.E * 2*3)

= 18000 L.E.

- Posters and flyers

= 5000 L.E.

Total cost: = 77870 L.E.

Cost/benefit ratio (zero % discount rate**)** = 77870 / 314230 = 1: 4.04

Cost/benefit ratio (3% discount rate**)** = 77870 / 314230 * 0.91 = 1: 3.67

Saving (in 3 years duration**)** =236360 L.E.

Table (4): Average cost of low back pain in 3 years interval.

Item	Cost/item (L.E.)	Duration needed	No. of workers	Cost (L.E.)
Direct cost:				
Outpatient cost				
Medical consultation	40	-	88	3520
Plain X-ray	40	-	68	2720
MRI	600	-	36	21600
Lab investigations	100 L.E/week	-	68	6800
Medical treatment	150 L.E/week	4 weeks	77	46200
Physiotherapy	20 L.E/ session	12 sessions	26	6240
Subtotal				**87080**
Inpatient cost				
Plain X-ray	40	-	5	200
MRI	600	-	5	3000
Lab investigations	150	-	5	750
Surgery	20000	-	5	100000
Medication	500	-	5	2500
Post-surgical medication	200 L.E/week	5 weeks	5	5000
Post-surgical physiotherapy	20 L.E/ session	12 sessions	5	1200
Subtotal				**112650**
Indirect cost:				
Sick leave	500 L.E/week	3 weeks	68	102000
Post-surgical sick leave	500 L.E/week	5 weeks	5	12500
Subtotal				**114500**
Grand total				**314230**

DISCUSSION

The reported rate of low back problems in the present study, within the previous 3 years, was about 61% in the studied office workers and most of them were presented as non-specific, radiating and persistent LBP, with a minority of cases presenting as chronic LBP (11.4%). Those who showed positive clinical signs during examination were 31.7% indicating that they were currently active cases. One other study,[18] reported a similar rate of LBP of more than 60% but as a lifetime prevalence. The rate of the present study was higher than rates reported in other studies for a similar period (12-30%),[19,20] and even for the percent of cases with chronic LBP (6.9%).[16] The prevalence in most studies was determined as LBP

whether specific or non-specific since they share common risk factors that influence its occurrence rate in the different population groups.

The defined risk factors for LBP in the current study were based on questionnaire, measurements, and ergonomic checklist that showed nearly equal results for the subjective assessment by the worker himself and the objective assessment by the ergonomist. The uncomfortable chair as indicated by the lowest given ergonomic score may be the first risk factor for LBP in the present setting, since workers have to perform office work for a long time daily for a mean of about 8 hours on 14 successive days monthly with about 16 years mean duration of work. It was stated that defective and poorly designed office chairs not matching the standard healthy ergonomic criteria is a major risk factor for LBP.[10,6] The most important criteria of a healthy chair were mentioned in the checklist applied in the current study.[11] Also, it is stated that other items in the computer office workstation checklist such as desk, monitor, keyboard and mouse may indirectly affect posture and abnormal movements such as twisting and bending that will indirectly influence the problem of LBP. Therefore, these items should be considered and corrected in any ergonomic program addressing low back problems.[3,6,7] Defective work habits such as absent breaks every 20-30 minutes during office work, prolonged immobilization and to continue working in the presence of discomfort and pain; as well as lack of healthy ergonomic training were raised as the probable second risk factor in the present study based on its low ergonomic score. Also, these 2 risk factors were negatively correlated with LBP intensity and duration. Recently, Ivanova et al. 2011,[9] raised the concept of ergonomic training management for LBP, since it is not only a preventive strategy but also a rehabilitative treatment. This will have a

major impact on health care utilization for LBP and cost saving.

Other risk factors for LBP that were reported in the present study were overweight and obesity of the studied population. This is in conformance with many other health studies reporting obesity as a common risk among sedentary workers.[21,22] Krismer and van Tudler 2007,[3] emphasized the importance of obesity as a preventable risk factor for LBP. The preventive pre-placement and periodic medical examinations did not give proper attention to the problem of LBP among office workers in the present study; only less than half of them mentioned that they were examined clinically and/or radiologically for the low back in periodic medical examination. On the other hand, trauma outside work was reported only by 4% of the LBP cases in the present study. A properly designed ergonomic training program, as mentioned above, would improve knowledge and transferable skills of the worker inside and outside the work. It would help him to avoid risk factors, to adopt healthy lifestyle, and to disseminate these benefits to other family members. It has been stated that the outcome of a health training program of workers would be reflected not only on their performance but also on their ability to make proper use of the available health services without extra cost.[23-25]

The cost of prevention of LBP in the present study is that of the ergonomic program. The cost was calculated according to the estimated average market price. The durability of new ergonomic chairs and the training program would extend for 3 years and that is why the average cost of LBP was calculated for the previous 3 years. The observed situation in the present study, where the indirect cost of LBP represented the greatest proportion of LBP cost is similar to observations reported in other studies.[26,27] The inflation in the cost of disease, the cost of labor

turnover due to LBP, the cost of lost productivity and other administrative costs were not considered in the present study, which would have even add more to the benefits of prevention. As with many health interventions, the aim of the preventive program generally is to reduce morbidity and/or mortality from a disease. If the value of these health gains can be measured in momentary terms, then a cost-benefit analysis can be undertaken, the benefits of a program can be compared directly with the costs, and a conclusion drawn about whether the benefits exceed the costs.[25] The same procedure was simply adopted by Carsten et al. 2009,[13] in modeling the prevalence and cost of LBP in general population.

The direct cost of LBP, as calculated in the present study, showed a greater contribution by the inpatient cost than by the outpatient cost; however, the inpatient cost was consumed by 5 cases only. Moreover, it was stated that the high risk individuals for LBP are the most likely to get benefit from a health ergonomic program optimizing the outcome of cost-benefit ratio.[23] For cost calculation of services for LBP patients in the current study, homogeneity of cost was used for calculations to provide a conservative estimate, utilizing the mean cost of actually provided service. The final cost-benefit ratio of the ergonomic program for management of LBP among office workers of the present study was 1: 3.67. According to the standards in health prevention, this ratio is considered as cost effective.[24]

Conclusion and Recommendations

Low back problems are common among office workers and should receive preventive attention. Pre-placement and periodic medical examinations are recommended for office workers, with particular emphasis on the low back health problems. Ergonomic checklist could be used as a good tool in identification of risky

ergonomic items in relation to LBP. Properly designed ergonomic programs are cost effective in management of LBP among office workers. Adoption of ergonomic standards for computer office workstations, ergonomic training, adjustment of work-rest regimen, and promotion of healthy lifestyle including weight control are important components of a health oriented ergonomic program.

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REFERENCES

1. Deyo RA, Miraza SK, Martin NI. Back pain prevalence and visit rates: estimates from U.S. national surveys, 2002. Spine 2006; 31:2724-7.
2. Chou R, Qaseem A, Snow V, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. Ann Intern Med 2007; 147:478-91.
3. Krismer M, van Tulder M. Low back pain (non-specific). Best Practice & Research Clinical Rheumatology 2007; 21(1):77-91.
4. Carey TS, Garrett J, Jackman A, et al. The outcomes and costs of care for acute low back pain among patients seen by primary care practitioner, chiropractors, and orthopedic surgeons. The North Carolina Back Pain Project. N Engl J Med 1995; 333:913-7.
5. Smeets RJ, Severens JL, Beelen S, Vlaeyen JW, Knottnerus JA. More is not always better: cost-effectiveness analysis of combined, single behavioral and single physical rehabilitation programs for chronic low back pain. Eur J Pain 2009; 13: 71-81.
6. Kroemer KHE, Grandjean E. Fitting the Task to the Human. A Textbook of Occupational Ergonomics 5th ed. Taylor and Francis publishers USA 1997.
7. Bendix T, Hagberg M. Trunk posture and load on the trapezius muscle whilst sitting at sloing desks. Ergonomics 1984; 27: 873-82.
8. Ricci JA, Stewart WF, Chee E, et al. Back pain exacerbations and lost productive time costs in United States workers. Spine 2006; 31: 3052-60.
9. Ivanova JI, Birnbaum HG, Schiller M, et al. Real-world practice patterns, health-care utilization, and costs in patients with low back pain: the long road to guideline-concordant care. Spine 2011; www.TheSpineJournalOnline.com
10. Canadian Center for Occupational Health and Safety (CCOHS). Office ergonomics – How to adjust office chairs? CCOHS 2001.
11. Gerberding JL. Evaluation checklist for computer workstation. CDC, Agency of the Department of Health and Human Services, Atlanta, Georgia, USA 2002.
12. Institute for Occupational Physiology at the University of Dortmund. Checklist for computer workstations. WHO Collaborating Center for Occupational Health 2006; www.ergonetz.de
13. Schmidt CO, Schweikert B, Wenig CM, et al. Modeling the prevalence and cost of back pain with neuropathic components in the general population. Eur J Pain

2009; 13: 1030-5.
14. Deyo RA, Rainville J, Kent DL. What can the history and physical examination tell us about low back pain? JAMA 1992; 268: 760-5.
15. WHO. Obesity and overweight. Geneva: World Health Organization, Factsheet 2006; 311.
16. Bouhassira D, Lanteri-Minet M, Attal N, Laurent B, Touboul C. Prevalence of chronic pain with neuropathic characteristics in the general population. Pain 2008; 136: 380-7.
17. Drummond MF, O'Brien B, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programs. 2nd ed. Oxford University Press, Oxford 1997.
18. Andersson GB. Low back pain. J Rehab Res Develop 1997; 34: 9-10
19. Loney PL, Stratford PW. The prevalence of low back pain in adults: a methodological review of the literature. Physical Therapy 1999; 79: 384-96.
20. Walker BF. The prevalence of low back pain: a systematic review of the literature from 1966 to 1998. J Spinal Disord 2000; 13: 205-17.
21. Tepas DI. Do eating and drinking habits interact with Work schedule variables? Work Stress 1990; 4: 203-11.
22. Suwazono Y, Dochi M, Sakata K, et al. a longitudinal study on the effect of shift work on weight gain in male Japanese workers. Obesity 2008; 168: 1887-93.
23. Jones-lee MW. The economics of safety and physical risk. Basil Blackwell, Oxford 1989.
24. Luce BR, Manning WG, Siegel JE, Lipscomb J. Estimating costs in cost-effectiveness analysis. (Ch. 6), In: Ed. Gold MR, Siegel JE, Russell LB, Weinstein MC. Cost-effectiveness in health and medicine. New York, Oxford: Oxford University Press, 1996.
25. Hansjurgens B. Economic evaluation through cost-benefit analysis – possibilities and limitations. Toxicology 2004; 205(3): 241-52.
26. VanTulder MW, Koes BW, Bouter LM. A cost-of-illness study of back pain in the Netherland. Pain 1995; 62: 233-40.
27. VanVelden ME, Severens JL, Novak A. Economic evaluation of healthcare programs and decision making: the influence of economic evaluations on different healthcare decision-making levels. Pharmacoeconomics 2005; 23: 1075-82.