

## Exposure level of ergonomic risk factors in hotel industries

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**Abstract.** Ergonomic Risk Factors (ERFs) which contribute to Musculoskeletal Disorders (MSDs) among room attendants were considered as a problem or trouble since these ERFs would affect their work performance for hotel industries. The purpose of this study was to examine the exposure level of ERFs among room attendants in hotel industries. 65 of respondents were obtained from selected hotels in Peninsular Malaysia. Data were collected by direct observation via Workplace Ergonomic Risk Assessment (WERA) and Quick Exposure Checklist (QEC). There were 36 males and 29 females room attendants involved throughout the research. Most of room attendants experienced high exposure level for back, leg, forceful and vibration based on the exposure level evaluation through WERA while QEC results showed that all room attendants were found to have moderate exposure level for risk factors including back for movement use, shoulders/arms, wrists/hands and neck. All the results obtained showed that the related ERFs for MSDs were associated and essential ergonomic interventions are needed in order to eliminate risk of exposures to MSDs among room attendants in hotel industries.

### 1. Introduction

Physical factors have been linked to stress reactions which can influence to the Ergonomic Risk Factors (ERFs) such as posture, repetition, and movements simultaneously have been identified as risk factors for MSDs [1]. Several studies have reported that some physically demanding work situations involving work with twisted or bent body positions, static or repetitive work and a rushed work pace, have been considered as ERFs which associated with various musculoskeletal symptoms and disorders [2-3]. Previous study [4] claimed that ERFs including repetitive motion, forceful exertion and awkward posture are contributed to musculoskeletal injuries such as Cumulative Trauma Disorders (CTDs). Indeed, the exposure to ERFs for prolonged periods can lead to a variety of potentially disabling injuries and disorders of musculoskeletal tissues and peripheral nerves [5]. Hotel room



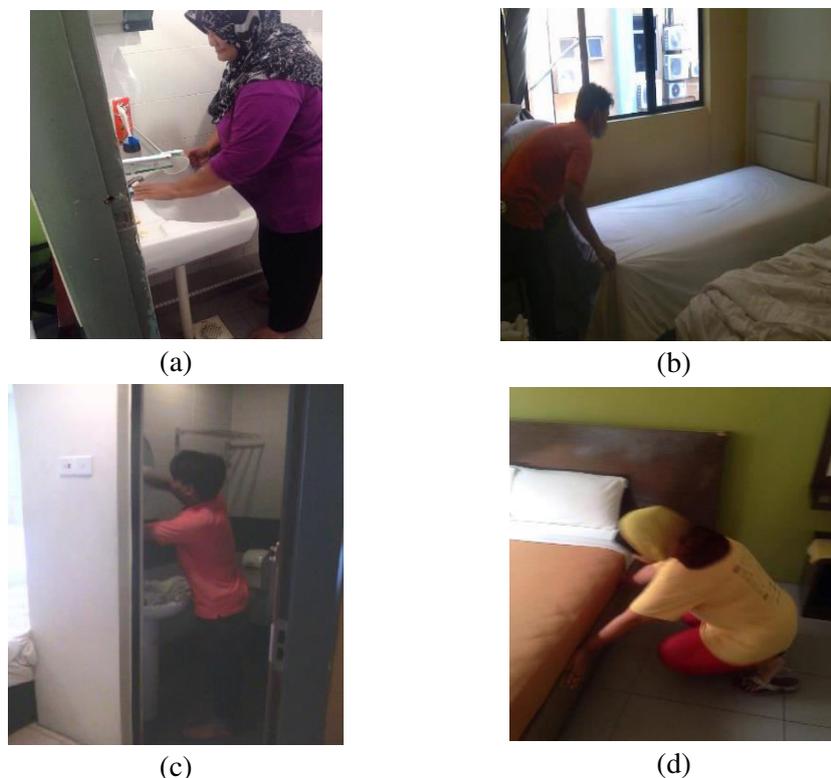
attendants carry out physically demanding tasks such as making beds, tidying rooms, cleaning and polishing toilets, washing floors, removing stains and vacuuming [6]. ERFs for work-related upper-limb MSDs regarding housekeeping tasks have been grouped into three main categories involving posture, repetition, force and vibration [7].

Furthermore, housekeeping among room attendants which involved cleaning task has a high frequency of awkward postures and working environments as contributing ERFs [8]. Compare to others industries such as construction industries that have been reported that statistically significance for the wrist, shoulder and back regions were affecting the worker and lead to the development of pain or discomfort [9] while in car tyre service centre and mould manufacturing industries have reported that the main sources of injury and discomfort in the workplace were poor body posture and highly repetitive motions [10-11]. Somehow in order to prevent physical hazards which are major of ERFs, ergonomic training programs should be available to instruct room attendants on safe work practices, including bed-making, bathroom and guest room cleaning practices, and proper handling of linen carts [12]. The objective of this study was to examine the exposure level of Ergonomic Risk Factors (ERFs) in hotel industries using Workplace Ergonomic Risk Assessment (WERA) and Quick Exposure Checklist (QEC).

## 2. Methods

### 2.1. Subjects and task description

From July through September 2016, evaluation for exposure level of ERFs was conducted among 65 room attendants who age between 20 and 60 at different selected hotels in Peninsular Malaysia involving Terengganu, Selangor and Johor. The study was focused on how the housekeeping tasks among the selected subjects affect the ERFs at workplace.



**Figure 1.** (a) Cleaning toilet with repetitive movements for polishing sink (b) Making bed with back bend forward for more than 30°, (c) Cleaning toilet with repetitive movements for scrubbing wall, (d) Making bed with contact stress and forceful exertion using hands for pushing bed

Samples of exposure level of ERFs evaluation process among room attendants are shown in Figure 1. Figure 1 (a) showed a room attendant was cleaning room toilet with repetitive movements due to polishing sink. Figure 1 (b) showed a room attendant was making bed with awkward posture due to bend back forward for more than 30°. Figure 1 (c) showed a room attendant was cleaning toilet with repetitive movements and awkward posture due to scrubbing wall at above the elbow height. Scrubbing and polishing with same motion may cause pain or discomfort involving hands, shoulders and elbows. Figure 1 (d) showed a room attendant was making bed with contact stress and forceful exertion due to using hands as a hammer for pushing bed. All of these physical factors would lead to the development of MSDs.

## 2.2. Workplace Ergonomic Risk Assessment (WERA)

WERA is an observational tool which was developed to provide a method of screening the working task quickly for exposure physical risk factor associated with Work-related Musculoskeletal Disorders (WMSDs) [13]. WERA tool involves the six physical risk factors including posture, repetition, forceful, vibration, and contact stress and task duration. Additionally, the tools cover also the five main body regions which include shoulder, wrist, back, neck and leg. As stated by Rahman et al. [13] WERA tool has a scoring system and action levels which provide a guide to the level of risk and need for action in order to conduct more detailed assessments. The tool is one of the best methods for examining the level of ERFs as it has been tested on its reliability, validity and usability during the development process. WERA tool can be done in any space of workplaces without disruption to the workforce even though it is known as a pen and paper technique which can be used without any special equipment.

## 2.3. Quick Exposure Checklist (QEC)

QEC is a tool for Occupational Health and Safety (OHS) practitioners in order to assess task exposure to risks for work-related musculoskeletal disorders (WMSDs) [14-15]. The tool was developed and evaluated by Dr. G. Li and Dr. Peter Buckle (1999 & 2008), with support from researchers at Robens Centre for Health Ergonomics, University of Surrey and some other 150 OHS practitioners. QEC is easy and straightforward tool to use and provide exposure scores for body areas which include the back, shoulder/arm, wrist/hand, and neck, with related to posture and repetitive movements. Table 1 showed the important risk factors which based on QEC method.

**Table 1.** Important risk factors in QEC method [14-15]

<b>Back</b>	<b>Wrist/Hand</b>
Load weight	Force
Duration	Duration
Frequency of movement	Frequency of movement
Posture	Posture
<b>Shoulder/Arm</b>	<b>Neck</b>
Load weight	Duration
Duration	Posture
Task height	Visual Demand
Frequency of movement	Non-applicable

The exposure levels for those four important risk factors which include back, shoulder/arm, wrist/hand and neck are categorized into four exposure categories which are low, moderate, high and very high. The range of exposure score for back in static is 8-15 for low, 16-22 for moderate, 23-29 for high, and 29-40 for very high. The range of exposure score for back in moving and shoulder or arm are the same

which 10-20 for low, 21-30 for moderate, 31-40 for high and 41-56 very high. While exposure score for wrist/hand starts with 10-20 for low, 21-30 for moderate, 31-40 for high and 40-46 for very high. Lastly exposure scores range for the neck risk factor starts with 4-6 for low, 8-10 for moderate, 12-14 for high, and 16-20 for very high. Other than that, there are also levels of exposure scores for driving, vibration, work pace and stress which located at the last part of the checklist. Table 2 showed the exposure levels based on the QEC method.

**Table 2.** Exposure levels for QEC method <sup>[14-15]</sup>

Score	Exposure Level			
	Low	Moderate	High	Very High
Back (static)	8-15	16-22	23-29	29-40
Back (moving)	10-20	21-30	31-40	41-56
Shoulder/arm	10-20	21-30	31-40	41-56
Wrist/hand	10-20	21-30	31-40	41-46
Neck	4-6	8-10	12-14	16-18
Driving	1	4	9	-
Vibration	1	4	9	-
Work Pace	1	4	9	-
Stress	1	4	9	16

#### 2.4. Data Collection

Data for exposure level of ERFs have been acquired by direct observation using WERA and QEC. Evaluation process for data collection was based on room attendants' working performance involving their physical factors such as task duration, postures, repetitive movements, forceful exertions, contact stress and vibration. Pictures were taken for each participant while doing housekeeping tasks for further evaluation process regarding the exposure level of ERFs. The procedure regarding data collection using WERA tool can be explained in five steps. First it needs an observation for the task or job which done by the participant in order to formulate a general ergonomic workplace assessment including the impact of work layout and environment, use of equipment, and behaviour of the worker with respect to risk taking. Additionally, record the data using photograph or a video camera if possible. Second it needs to select the task or job for the assessment. The task or job selection needs to be decided in order to analyze the observation in step one. Next by using the WERA tool, it needs to score for each item of risk factors, calculate the score and mark the numbers at the crossing point of every pair of circled number. Then it needs to calculate the total final score based on the risk factors item which includes all items. Ultimately for the last step, the total final score will be indicated the consideration of actions level whether the task is accepted for low risk level, still accepted for medium risk level, or not accepted for high risk level. According to Li et al. [14-15] there are a few steps to complete the QEC tool which first it needs to identify tasks of concern and talk to the worker about the activities involved at the workplace. Second observe the task for a period or of cycles and complete the observer portion of the tool. Besides, it needs to ask the worker to answer the worker assessment questions and fill in the tool. Additionally, ask the worker for suggestions on how to make improvements for the working performance. Next score the assessment, enter the actions required on the front and reassess during a trial or after the changes.

### 2.5. Data Analysis

The data obtained through WERA and QEC were carried out using Statistical Package for the Social Science (SPSS) Software. Numbers, percentages, mean and standard deviation are applied as descriptive statistics for WERA and QEC results.

## 3. Results

### 3.1. Demographic Items

There were 39 (60%) male room attendants and 26 (40%) female room attendants were involved throughout the research which 80 percent of them were age between 21 to 40 years old. 10 (15.4%) of room attendants were age over than 40 years old while 3 (4.6%) of them were age less than 20 years old and total mean for age among respondents was 29.9 years (SD=8.4). Majority room attendants' working experience were less than 5 years with a percentage of 93.8% and 6.2% of them had over than 6 years working experience. Total mean for working experience among respondents was 2.4 years (SD=2.5). Generally, all room attendants spent about 40 to 50 hours every week for their job which total mean for weekly working time hours spent among them was 46.52 hours (SD=3.05).

**Table 3.** Demographic Items (n=65)

Characteristic	N	%	Mean	SD
<b>Gender</b>				
Male	39	60.0	-	-
Female	26	40.0	-	-
<b>Age</b>				
≤20	3	4.6		
21-40	52	80.0	29.9	8.4
≥41	10	15.4		
<b>Working Experience (Year)</b>				
1-5	61	93.8	2.4	2.5
≥6	4	6.2		
<b>Weekly Working Time (Hours)</b>				
40-50	65	100.0	46.5	3.1
≥51	-	-		

### 3.2. Exposure Level Standards for WERA Physical Risk Factors

Exposure level standards for WERA physical risk factors involving shoulder, wrist, back, neck, leg, forceful, vibration, contact stress and task duration were presented in Table 4. Most of room attendants experienced high exposure level for leg, back, forceful and vibration with the mean 5.1 (SD=0.3), 5.0 (SD=0), 4.8 (SD=0.4), and 4.5 (SD=0.5) respectively. Meanwhile exposure level for other risk factors experienced by room attendants were medium which involved shoulder, wrist, neck, contact stress and task duration with the mean 4.4 (SD=0.5), 4.4 (SD=0.7), 3.9 (SD=0.3), 3.5 (SD=0.5), and 3.8 (SD=0.5) respectively.

**Table 4.** Exposure Level Standards for WERA Physical Risk Factors (n=65)

Physical Risk Factors	Score		Exposure Level
	Mean	SD	
Shoulder <sup>(a)</sup>	4.4	0.5	Medium
Wrist <sup>(a)</sup>	4.4	0.7	Medium
Back <sup>(a)</sup>	5.0	0.0	High
Neck <sup>(a)</sup>	3.9	0.3	Medium
Leg <sup>(b)</sup>	5.1	0.3	High
Forceful <sup>(c)</sup>	4.8	0.4	High
Vibration <sup>(d)</sup>	4.5	0.5	High
Contact Stress <sup>(e)</sup>	3.5	0.5	Medium
Task Duration <sup>(f)</sup>	3.8	0.5	Medium

Notes: - (a) Posture & Repetition, (b) Posture, (c) Lifting the load, (d) Using of vibration tool, (e) Using of tool handle or wearing hand gloves, (f) Task-hour/day

### 3.3. WERA Final Score and Action Level

WERA final score and action level for the research are presented in Table 5. Based on the analysis, risk level for housekeeping tasks which involved all room attendants was medium (100%) with final score in range 28 to 44. The result showed that the housekeeping tasks need to have further investigation and required a few changes in order to reduce the ergonomic risk factors which may contribute in musculoskeletal trouble.

**Table 5.** WERA Final Score and Action Level (n=65)

Final Score	Risk Level	Action	N	%
18-27	Low	Task is acceptable	-	-
28-44	Medium	Task is need to further investigate & required change	65	100.0
45-54	High	Task is not accepted, immediately change	-	-

### 3.4. Exposure Level Standards for Back, Shoulder, Wrist and Neck (Observers' Assessment)

According to the result presented in Table 6, all the exposure level for risk factors which involved back (movement), shoulder/arms, wrists/hands and neck are moderate. The highest score for risk factor was shoulders/arms with mean 30.40 (SD=3.59) followed by back (movement) and wrists/hands with mean 29.78 (SD=4.27) and 28.22 (SD=2.98) respectively. The least score for risk factor for housekeeping tasks was neck with mean 10.31 (SD=1.07). Back (static) risk factor was not involved in housekeeping tasks since all the room attendants experienced movement of their back during work.

**Table 6.** Exposure Level Standards for Back, Shoulder, Wrist and Neck (n=65)

Risk Factors	Score		Exposure Level
	Mean	SD	
Back (Static)	-	-	-
Back (Movement)	29.8	4.3	Moderate
Shoulders/arms	30.4	3.6	Moderate
Wrists/hands	28.2	3.0	Moderate
Neck	10.3	1.1	Moderate

### 3.5. Exposure Level Standards for Driving, Vibration, Work Pace and Stress (Workers' Assessment)

Exposure level for risk factors involving driving, vibration, work pace and stress are presented in Table 7. Based on the analysis obtained, all room attendants had low exposure level for driving risk factor (100%) since they were not involving driving during work. Most of room attendants had medium exposure level for risk factors involving vibration (80%), work pace (92.3%) and stress (53.9%). However, some of room attendants (10.8%) had high exposure level for stress risk factor. Not to mention that there were low exposure level risk factors among room attendants for vibration (20%), work pace (7.7%) and stress (35.4%).

**Table 7.** Exposure Level Standards for Driving, Vibration, Work Pace and Stress (n=65)

Score	Exposure Level	Driving		Vibration		Work Pace		Stress	
		N	%	N	%	N	%	N	%
1	Low	65	100.0	13	20.0	5	7.7	23	35.4
4	Medium	-	-	52	80.0	60	92.3	35	53.9
9	High	-	-	-	-	-	-	7	10.8
16	Very High	-	-	-	-	-	-	-	-
<b>Total</b>		65	100.0	65	100.0	65	100.0	65	100.0

### 3.6. QEC Final Score and Action Level

QEC final score result is recorded and presented in Table 8. Based on the research analysis, there were no acceptable and investigate and change immediately for the action level. Most of room attendants (83.1%) involved 54 of sample size over 65 had to investigate further and change soon for their action level which their QEC final score result in range 51 to 70 percent. Meanwhile there were 11 room attendants (16.9%) reached further investigation of action level for their QEC final score result which in range 41 to 50 percent. The result obtained showed musculoskeletal problems among room attendants are high and need further action in order to reduce the exposure level of the risk factors involved for housekeeping tasks.

**Table 8.** QEC Final Score and Action Level (n=65)

Score	Action Level	N	%
≤40%	Acceptable	-	-
41-50%	Investigate further	11	16.9
51-70%	Investigate further and change soon	54	83.1
≥70%	Investigate and change immediately	-	-
<b>Total</b>		65	100.0

#### 4. Discussion

Low back and wrists/hands pain are widespread problems among hotel room attendants in this study. The majority of selected subjects also reported several ergonomic problems involving awkward posture and highly repetitive motion due to their housekeeping tasks such as cleaning room, mopping and polishing toilet. High exposure level for back physical risk factor had been found to be associated with heavy lifting and forceful movements [16], as well as working in an awkward bent position [17]. Kilbom [18] was found also that in a sample of 62 housekeeping services there were 22% who complained to have trouble with the neck, 33% with shoulder, 33% with low back, and 11% with wrist which correlated to the analysis of exposure level standards for physical risk factors through WERA method. For ordinary room cleaning, there were 33 % of the phases fall within the medium risk level, 40 % in the low risk level, and 27 % in the no risk level, while for heavy cleaning, 74 % of the phases fall within the medium risk level and 26 % fall in the low risk level [19]. Overall most of housekeeping services are in medium risk level. According to the Bureau of Labor Statistics [20], there were ergonomic injuries of body impacts which involved back (52%), shoulders (18%), arms and legs (5%) due to overexertion and wrists (43%), back (11%) and hands (5%) due to repetitive motion. The use of vibrating cleaning tools, such as electrical vacuum cleaner which used to clean floors exposes room attendants to hand-arm vibrations and lead to musculoskeletal problems [21].

#### 5. Conclusion

Most of room attendants have high exposure level of ERFs involving back, leg, forceful and vibration. Meanwhile, all room attendants showed medium risk level regarding the housekeeping tasks as they are reported to have moderate exposure level for risk factors including back for movement use, shoulders/arms, wrists/hands, and neck. The housekeeping tasks among room attendants need to have further investigation and change soon in order to improve their working performance with less ERFs. Effective prevention strategies and proper procedure regarding housekeeping tasks are recommended at hotel industries in order to mitigate the physical risk factors among room attendants.

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#### References

- [1] Elvia, L. and Rosalío Á. C.: Analysis of the role of job stress in the presence of musculoskeletal symptoms, related with ergonomic factors. 6th International Conference on Applied Human Factors and Ergonomics (AHFE) and the Affiliated Conferences, AHFE 2015: Procedia Manufacturing 3, 4964 – 4970 (2015).

- [2] Kerstin Ekberg, M. Karlsson, O Axelson, B. Björkqvist, Birgitta Bjerre-Kjely & P. Malm: Cross-sectional study of risk factors for symptoms in the neck and shoulder area, *Ergonomics*, 38:5, 971-980 (1995).
- [3] Ohlsson, K., Attewell, R. And Skerving, S.: Self-reported symptoms in the neck and upper limbs offemale assembly workers, *Scandinavian Journal of Work Environment and Health*, 15, 75-80 (1989).
- [4] Keyserling W. M., Stetson D. S., Silverstein B. A. & Brouwer M. L.: A checklist for evaluating ergonomic risk factors associated with upper extremity cumulative trauma disorders, *Ergonomics*, 36:7, 807-831, DOI: 10.1080/00140139308967945 (1993).
- [5] Jung-Keun Park, Jon Boyer, Jamie Tessler, Jeffrey Casey, Linda Schemm, Rebecca Gore, and Laura Punnett: Promoting Healthy and Safe Employment (PHASE) in Healthcare Project Team Inter-rater reliability of PATH observations for assessment of ergonomic risk factors in hospital work. *Ergonomics*. 52:7, 820-829 (2009).
- [6] CCOHS, Canadian Centre for Occupational Health and Safety, “Hotel Housekeeping” [Online] Available at [https://www.ccohs.ca/oshanswers/occup\\_workplace/hotel\\_housekeeping](https://www.ccohs.ca/oshanswers/occup_workplace/hotel_housekeeping) (2016).
- [7] Alison F. Bell & Julie R. Steele: Risk of musculoskeletal injury among cleaners during vacuuming, *Ergonomics*, 55:2, 237-247 (2012).
- [8] Rupesh Kumar, Montakarn Chaikumarn & Jan Lundberg: Participatory Ergonomics and an Evaluation of a Low-Cost Improvement Effect on Cleaners’ Working Posture. *International Journal of Occupational Safety and Ergonomics*. 11:2, 203 210, DOI: 10.1080/10803548.2005.11076639 (2005).
- [9] Rahman, M.N.A., M.R.A. Rani, and M.J. Rohani: Investigation of work-related musculoskeletal disorders in wall plastering jobs within the construction industry. *WORK: A Journal of Prevention, Assessment and Rehabilitation*, 43 (4), 507-514 (2012).
- [10] Rahman, M.N.A., Aziz, F.A. and Yusuff, R.M: Survey of body part symptoms among workers in a car tyre service centre. *Journal of Human Ergology*, 39 (1), 53-56 (2010)
- [11] Rahman, M.N.A., Haq, H.R., Hassan, M.F., Arifin, M.A., Yunus, M.Z., Bakar, S.A., Adzila, S: Musculoskeletal discomfort among workers in mould making manufacturing industry. *ARPN Journal of Engineering and Applied Sciences*, 10 (15), 6269-6273 (2015)
- [12] Yu-Chin, J. H., Apostolopoulos, Hatzudis, K., and Sönmez, S.: Occupational Exposures and Health Outcomes among Latina Hotel Cleaners. *Hispanic Health Care International*. Vol. 12, No. 1: University of North Carolina at Greensboro (2014).
- [13] Rahman, M.N.A., M.R.A. Rani, and M.J. Rohani, WERA: An Observational Tool Develop to Assess the Physical Risk Factor associated with WRMDs. *Journal of Human Ergology*, 40 (2), 19-36 (2011).
- [14] Li, G. and Buckle, P.: Evaluating Change in Exposure to Risk for Musculoskeletal Disorders-A Practical Tool. Prepared by Robens Centre for House Ergonomics, University of Surrey, for the Health and Safety Executive (HSE) Books, Contract research report; 251/1999 (1999).
- [15] Li, G., Buckle, P., Woods, V., and David, G.: The development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. Robens Centre for Health Ergonomics. European Institute of Health and Medical Sciences, University of Surrey (2008).
- [16] Punnett, L., Fine, L. J., Keyserling, W. M., Herrin, G. D., and Chaffin, D. B.: Back disorders and non-neutral trunk postures of automobile assembly workers. *Scandinavian Journal of Work and Environmental Health* 17, 5, 337–346 (1991).
- [17] Vingard, E., Alfredsson, L., Hagberg, M., Kilbom, Å., Theorell, T., Waldenström, M., Wigaeus Hjelm, E., Wiktorin, C., and Hogstedt, C.: To what extent do current and past physical and psychosocial occupational factors explain care-seeking for low back pain in a working

- population? Results from the Musculoskeletal Intervention Center Norrtälje Study, *Spine*, 25 (4), 493-500 (2000).
- [18] Kilbom: Self-Reporting of postures and practices and their relation to musculoskeletal disorders. Work Institute, Research report 10th (1990).
- [19] EU-OSHA, European Agency for Safety and Health at Work: Working Environment Information, Preventing Harm to Cleaning Workers. ISBN 978-92-9191-259-9 (2009).
- [20] Bureau of Labor Statistics, United States Department of Labor: BLS Annual Summary Data (2010).
- [21] Krause N, Rugulies R, and Maslach C.: Effort-Reward Imbalance at Work and Self-Rated Health of Las Vegas Hotel Room Cleaners. *Am J Ind Med*. 53:372–386 (2009).