J Occup Health 2010; 52: 115–124

Journal of Occupational Health

Risk Factors for Upper Extremity Musculoskeletal Symptoms among Call Center Employees

Angelo d'Errico[1], Patrizia Caputo[1], Umberto Falcone[2], Lidia Fubini[2], Luisella Gilardi[2], Carlo Mamo[1], Alessandro Migliardi[1], Denis Quarta[1] and Elena Coffano[2]

[1]Epidemiology Unit and [2]Documentation Center for Health Promotion, ASL TO3-Piemont Region, Italy

Abstract: Risk Factors for Upper Extremity Musculoskeletal Symptoms among Call Center Employees: Angelo d'Errico, *et al*. Epidemiology Unit ASL TO3-Piedmont Region, Italy—Objectives: To investigate the prevalence of musculoskeletal symptoms in the upper extremity (UE) in a sample of Italian call center (CC) operators, and the relationship between the symptoms and potential workplace risk factors. **Methods:** During 2005-2006, 775 workers from seven CCs in the Turin area participated in a questionnaire survey of exposure to ergonomic, organizational and psychosocial factors at work, socio-demographics, lifestyle, symptoms and diseases. Musculoskeletal symptoms were defined as self-reported musculoskeletal symptoms in the UE during the previous 28 days, for which a physician was consulted and/or drugs were taken. Relative risks were estimated through Poisson regression models with the Huber-White sandwich estimator of variance. **Result:** Overall, 45% of workers reported UE symptoms in the last four weeks. Symptoms in the neck were the most prevalent (39%), followed by the shoulder (22%), hand-wrist (10%) and elbow (4%). Among workplace risk factors, neck-shoulder symptoms were associated with low job control, elevated noise, poor desk lighting and impossibility to lean back while sitting; whereas elbow-hand/wrist symptoms were associated with short intervals between calls, insufficient working space, lack of forearm support, job insecurity and long seniority in the CC industry. **Conclusions:** The high prevalence of UE symptoms in this sample was similar to that reported by other studies conducted in this industry. Our results confirm previously reported associations, such as poor characteristics of the workstation and psychological stressors. The striking difference between the set of risk factors for neck-shoulder and elbow/wrist-hand symptoms indicates that the two regions should be investigated separately.
(J Occup Health 2010; 52: 115–124)

Key words: Employment, Epidemiology, Musculoskeletal diseases, Telephone, Upper extremity, Work

The call center (CC) industry has grown fast in the last decades in developed countries. In Italy, a great expansion of this sector has also occurred, with an increase from 1,500 workers employed in 1994 to more than 200,000 in 2005–2006[1)]. Most important commercial companies nowadays use such centers to answer complaints, improve and render more personal the relationship with their customers, and advertise and sell goods.

Call centers are work environments where the main activity is performed through the simultaneous use of telephone and video terminal units (VDU). Although this definition could also apply to many office environments, most call centers are different due to the peculiar characteristics of the work organization, which may be considered as a modern industry producing services using information and communication technologies[2)]. Work in call centers has a limited variety of tasks and is highly repetitive; operators often have to follow a script which limits their autonomy, especially when combined with an automatic distribution of calls, and have to confront stressful situations in the relationship with customers. Other psychosocial aspects frequently found in the call-center work environments include high time pressure, inadequate breaks, constant monitoring of performance and high production targets to reach[3)]. A fast pace combined with the need to simultaneously use a telephone and VDU also implies higher exposure to repetitive movements than in most office environments. Furthermore, it involves maintaining constrained static

Received Aug 14, 2009; Accepted Jan 8, 2010
Published online in J-STAGE Feb 23, 2010
Correspondence to: A. d'Errico, Epidemiology Unit ASL TO3-Piedmont Region, Via Sabaudia 164, Grugliasco (TO) 10095, Italy (e-mail: angelo.derrico@epi.piemonte.it)

postures for a great part of the work shift, often made worse by poor workstation design, overcrowding and a diffuse "hot desk" condition, which creates problems for individual adjustment of the workstation[4].

Several studies have reported high prevalences of upper extremity musculoskeletal disorders (UEMSDs) or symptoms among CC workers, which were even greater than those observed in other occupational groups also considered at high risk[5–7]. The main known risk factors for UEMSDs are ergonomic (fast work pace, repetitive movements, short time for recovery, forced exertion, non-neutral static and dynamic postures, mechanical pressure, vibration) and psychosocial (high psychological demand, low job control, high job strain, low social support at work, fewer opportunities to take rest breaks)[8]. Given the number of potential risk factors for UEMSDs in the CC work environment, concern has been expressed that the high prevalence of musculoskeletal symptoms observed in various studies may be attributable to the adverse characteristics of their work environment and organization. A few epidemiological studies of CC workers have investigated the risk of UE symptoms or disorders in relation to workplace characteristics. In general, they observed associations with poor ergonomics of the workstation, high workload or work pace, and adverse psychosocial factors, such as low control, high job strain and poor support from management[3, 5, 9–11]. However, the comparability of their findings appears limited because of differences in the criteria adopted for case identification, in the risk factors examined and in the analytical methods employed. From the results of several studies of CC and other VDU workers, risk factors for neck-shoulder symptoms appear to differ, at least in part, from those in the forearm and in the wrist/hand region[5, 12, 13]. Therefore, it would be of interest to examine the association between symptoms and suspected workplace risk factors separately for these two upper limb regions.

The aims of this study were to:

- describe the prevalence of self-reported musculoskeletal symptoms in the upper extremities in a sample of Italian call center operators;
- assess the relationship between upper limb musculoskeletal symptoms and self-reported ergonomic, psychosocial and other potential workplace risk factors for MSDs;
- evaluate whether risk factors for neck-shoulder symptoms differ from those for the elbow-wrist/hand region.

Materials and Methods

Data collection

Workers from seven call centers operating in the Turin area (main industrialized area of Piedmont Region, north-western Italy) were invited to participate in a questionnaire survey[14]. During 2005–2006, 775 people working in telecommunications (70%), telemarketing (16%) or finance (14%) completed a self-administered standardized questionnaire on working conditions, socio-demographics and lifestyle, previous injuries, symptoms and diseases. In each workplace, the questionnaire was presented by the researchers to the workers during a trade union assembly, compiled anonymously and returned directly to the research team, in order to assure confidentiality of the collected information. Workers who participated in the study were about 40% of the overall workforce, but the research team was unable to obtain reliable information from their union partners on the actual number of subjects who had been invited to participate; therefore, a meaningful estimate of the participation rate in the survey was not available. Exposure to ergonomic factors was assessed using the Italian version of the Orege questionnaire[15] and exposure to job demand, control and strain by means of the short version of the Job Content Questionnaire (JCQ)[16]. Information on other potential ergonomic, organizational and psychosocial risk factors for UEMSDs was also collected, including aspects of workstation design, work load, lighting, noise, microclimatic conditions, supervisor support and job insecurity. The presence of musculoskeletal symptoms in four upper limb regions (neck, shoulder, elbow, hand) was assessed through self-report. Inclusion criteria for cases were: 1) to have had musculoskeletal symptoms (pain, burning, stiffing, numbness or tingling) at any time during the last 28 days; plus: 2) to have consulted a physician and/or to have taken drugs because of these symptoms. The outcome was assessed through the following questions: "Have you had any symptoms in muscles or joints in the last four weeks (pain, burning, stiffing, numbness or tingling)?"; and "Have you consulted a doctor or have you taken drugs because of these symptoms?" These questions were associated with a figure showing the body regions (neck, shoulder, elbow, hand/wrist, upper back, low back, buttock/thigh, knee, ankle/foot) with an instruction to check one or more affected body regions ("Please indicate the body region(s) affected"). The case definition was based on both symptoms and actions undertaken, in order to preserve the specificity of the outcome definition, although this choice likely produced a decrease in its sensitivity. In fact, in the analysis of the relationship between independent variables and the outcome, a reduced specificity of the case definition was expected to bias the risk estimates toward the null, whereas a reduced sensitivity would produce only a decrease of the statistical power of the study to observe significant associations between independent variables and the outcome.

Subjects reporting only symptoms, but who did not undertake any action, were included among non-cases.

All participants gave their informed consent to participate in the study.

Data analysis

The relationship between musculoskeletal symptoms in the upper limb and suspected risk factors was investigated examining proximal (neck, shoulder) and distal (elbow, wrist/hand) UE symptoms both together and separately. Most workplace factors were treated as dichotomous variables, including: appropriateness of features of the workstation (keyboard height, available working space, desk lighting, availability of wrist and forearm support, possibility of leaning back while sitting), lack of freedom to decide when to take a break, too short duration of breaks, inadequate training on the software used, job insecurity, presence of production targets to reach and of performance monitoring systems (all yes/no variables), poor support or recognition by the supervisor (often or always vs. rarely or never), and elevated noise (always vs. never or sometimes). Seniority in the CC industry (≤3, 4–6, 7+ yr), daily hours at VDU (≤4, 5–6, 7 +), number of calls at peak (≤15, 16–30, 30 + per hour), duration of intervals between calls at peak (<2, 2–3, 4 + s), relative frequency of mouse and keyboard use (same time, using the mouse more, using the keyboard more) were evaluated as polychotomous variables. The number of inadequate microclimatic conditions reported (room temperature in summer and winter, humidity, ventilation) was summed to create a semi-quantitative scale ranging from 0 to 4 (Cronbach's alpha: 0.73).

Standard JCQ algorithms were used to compute the overall scores of the demand, control and job strain scales, whose effect on the risk of symptoms was assessed by dividing the scales into tertiles.

The presence of any disease from a list of conditions known to be associated with UEMSDs (hypertension, diabetes, systemic lupus erythematosus, gout, thyroid diseases, rheumathoid arthritis), previous injuries in the last five years, leisure physical activity, body mass index (BMI), smoking, marital status, educational level, gender and age class (10 yr) were explored as potential confounders of the association between wokplace factors and musculoskeletal symptoms.

Relative risks of UE musculoskeletal symptoms were estimated by the prevalence rate ratios obtained from Poisson regression models with the Huber-White sandwich estimator of variance, which has been demonstrated to be an appropriate alternative method to logistic regression when examining frequent outcomes[17]. Because of the relatively small number of male subjects in the sample (N. 195), analyses were controlled by gender, rather than stratifying by it, after testing the role of gender as an effect modifier. In a first analysis, the effect of each covariate alone was evaluated adjusting for age class (10 yr) and gender. Afterwards, a multivariate model was fitted using a forward procedure, in which variables with $p<0.25$ in the previous step were offered to the multivariate model in rank order of their significance, selecting those with $p<0.05$[18]. First-order interactions between gender and significant variables in the final models were also explored. All the analyses were performed using Stata version 10.0.

Results

In Table 1, the main socio-demographic features of the population enrolled in the study are presented. Most workers were females (74%) and relatively young (almost three-quarters below 40 yr old); more than half of the population was single and had a mid-high level of education (only 15% without high school degree). About 50% of the people had a seniority in the CC sector of less than 5 yr.

Important proportions of CC operators reported adverse working conditions, such as continuously elevated noise (22%), poor microclimatic conditions in the work environment (30% reporting unfavorable conditions for all the items), workstations characterized by inappropriate features (ranging from 11% for incorrect keyboard height to 39% for inadequate desk lighting), poor supervisor recognition or support (78%), job insecurity (51%), high work load (27% reporting more than 30 calls per hour and 34% less than two seconds average interval between calls at peak), limited time for recovery (53% reporting too short pauses) and little discretion in taking breaks (85%). Consequently, a low level of job control and high levels of demand and job strain were observed (Table 2).

Overall, 336 (45%) workers reported upper extremity (UE) symptoms in the previous 28 days for which they consulted a physician and/or took drugs, with a significantly higher prevalence among women than men (48% vs. 38%, $p=0.04$). Symptoms in the neck were the most prevalent (39%), followed by shoulder (22%), hand-wrist (10%) and elbow (4%). Fifty percent of the workers reported symptoms in more than one region. Prevalence of neck-shoulder symptoms was 41.6% (43.6% among females and 35.9% among males, $p=0.13$), and of elbow-wrist/hand symptoms 11.8% (12.5% among females and 9.7% among males, $p=0.07$). No significant differences by gender in the prevalence of symptoms in each of four UE region were found, except for the wrist/hand region, in which symptoms were more frequent among females (11% vs. 7%, $p=0.03$).

In the analyses adjusted for age class and gender, the risk of neck-shoulder symptoms was significantly associated with several adverse characteristics of the workstation (insufficient working space, incorrect keyboard height, lack of wrist support, poor desk lighting, impossible to lean back while sitting) and with elevated noise, poor supervisor support or recognition, unfavorable microclimatic conditions, insufficient duration of breaks,

Table 1. Frequency distribution of the study population by economic sector, socio-demographic characteristics and health conditions (N=755)

Socio-demographic characteristics	N	%
Gender		
Males	195	25.8
Females	560	74.2
Age class		
19–29 yr	257	34.0
30–39 yr	289	38.3
40–49 yr	125	16.6
>50 yr	84	11.1
Marital status		
Married/cohabiting	309	40.9
Single	392	51.9
Separated/divorced/widow	51	6.8
Educational level		
Elementary/low secondary	115	15.2
High school diploma	520	68.9
University degree	120	15.9
Economic sector		
Finance	118	15.6
Telemarketing	106	14.0
Telecommunications	531	70.3
Seniority in the cc sector		
≤3 yr	279	37.0
4–6 yr	220	29.1
>7 yr	256	33.9
Smoking		
Never	408	54.0
Former	144	19.1
Current	192	25.4
Unknown	11	1.5
Body mass index		
<26	628	83.2
26+	104	13.8
Unknown	23	3.1
Injuries in the last 5 yr		
No	504	66.8
Yes	245	32.5
Unknown	6	0.8
Chronic diseases (hypertension, diabetes, SLE, gout, thyroid diseases, rheumathoid arthritis)		
No	602	79.8
Yes	153	20.3
Total	**755**	**100.0**

long seniority in the CC sector, low control, high demand and high job strain (Table 3). The results for symptoms in any UE region were practically the same as for neck-shoulder symptoms, given that only 22 of the 336 UE cases did not report symptoms in this area (data not shown). Many workplace risk factors for neck-shoulder symptoms were also associated with symptoms in the elbow-hand/wrist region, such as insufficient working space, poor desk lighting, incorrect keyboard height, elevated noise, poor supervisor support or recognition, inadequate microclimatic conditions and long CC seniority. Other significant associations for elbow-wrist/hand symptoms included lack of forearm support, short intervals between calls and job insecurity.

In final multivariate models, neck-shoulder symptoms were significantly associated with elevated noise (RR=1.28), impossibility of leaning back while sitting (RR=1.27), poor desk lighting (RR=1.27) and low job control (RR=1.30 and RR=1.25 for the middle and the high tertiles, respectively), together with age class, gender, previous injuries and chronic diseases (Table 4). The set of risk factors for elbow-hand/wrist symptoms was quite different from that of neck-shoulder symptoms, including insufficient working space (RR=1.78), lack of forearm support (RR=1.63), CC seniority longer than 7 yr (RR=1.82), job insecurity (RR=2.24), short intervals between calls (RR=2.15 and RR=1.79 for 2–3 s and <2 s categories, respectively), low educational level (RR=2.99) and previous injuries (RR=1.94) (Table 4). No significant interaction on the risk of proximal or distal symptoms was found between gender and the significant variables retained in the final multivariate models.

As expected, for both body regions the prevalence of musculoskeletal symptoms, when examined irrespective of the fact that subjects sought care, was higher (neck-shoulder symptoms: 63.2%; elbow-wrist/hand symptoms: 26.5%) than that observed using the more stringent case definition "symptoms plus medical consultation or drugs". From multivariate analysis, significant risk factors for neck-shoulder symptoms remained practically the same using "only symptoms" as a criterion, although the final model included physical activity and poor supervisor support or recognition. Risk factors for elbow-hand/wrist symptoms changed substantially employing the "only symptoms" definition, but still included job insecurity and long seniority in the CC sector, as well as high demand, inadequate microclimatic conditions and incorrect keyboard height (data not shown).

Discussion

In this cross-sectional study, a high prevalence of UE musculoskeletal symptoms was found in a population of call-center operators, with almost half of the subjects reporting symptoms for which they consulted a physician or took drugs. Lack of accurate information on the participation rate in the survey makes it uncertain as to what extent the sample interviewed may have been affected by self-selection, which may have artificially increased symptoms prevalence. Moreover, we do not

Table 2. Prevalence of unfavorable working conditions in the study population (N=755)

Variable	N	%
Incorrect keyboard height	85	11.3
Insufficient working space	261	34.6
Inadequate desk lighting	296	39.2
Lack of wrist support	249	33.0
Lack of forearm support	212	28.1
Not possible to lean back while sitting	135	17.9
Not having the freedom to decide when to take a break	638	84.5
Insufficient duration of breaks	402	53.3
Insufficient training on the computer systems in use	208	27.6
Job insecurity	387	51.3
Presence of production standard to reach	266	35.2
Presence of performance monitoring systems	589	78.0
Poor supervisor support or recognition	592	78.4
Continuously elevated noise	173	22.9
Using the keyboard more than the mouse	109	14.4
Using the mouse more than the keyboard	211	28.0
Variable	**Mean**	**St. dev.**
Daily hours working with VDU	6.2	1.5
Number of unfavorable microclimatic conditions	2.4	1.4
Interval between calls at peak (seconds)	5.7	14.8
Number of calls at peak	28.6	19.1
Demand	34.4	4.8
Control	50.9	10.6
Job strain	0.71	0.20

have any information confirming that subjects really consulted a physician or took drugs for these symptoms, nor did we collect information on the type of drugs taken by the subjects, limitations which may have reduced the specificity of the outcome and contributed to inflate its prevalence. Nonetheless, the observed prevalence is comparable to those reported by other studies of CC workers[5, 6, 10, 19] or of office operators working with VDUs[20, 21].

As in other studies of CC or office workers, neck-shoulder symptoms predominated among musculoskeletal symptoms in the upper limb. In our case series, the proportion of subjects with neck-shoulder cases of the total number of cases was extremely high (93%) and, as a consequence, the results of risk factors for the upper limb as a whole and for the neck-shoulder region were almost identical. It seems likely that the results of studies analyzing symptoms without making distinctions by UE region may also have been affected by a high proportion of neck-shoulder cases, which may have obscured risk factors for symptoms in the elbow-hand/wrist region.

Several work characteristics were associated with musculoskeletal symptoms in the age- and sex-adjusted analysis, many of which with both proximal and distal symptoms, including various aspects of the workstation design, psychosocial exposures, inadequate microclimatic conditions and long seniority in the CC sector. However, many of these covariates were significantly correlated to each other and only a few were retained in the final multivariate models, with strong differences between the set of risk factors associated with neck-shoulder and with elbow-wrist/hand symptoms. In spite of such differences, these results appear to confirm previous observations indicating that psychological stressors and poor ergonomics of the workstation are the main workplace risk factors for upper limb musculoskeletal symptoms among CC workers.

Among psychosocial factors, low job control has been reported as a significant predictor of UEMSDs in the two most important reviews of the subject[8, 22] and, as in our results, the association seems more consistent for neck-shoulder symptoms[23]. The reasons why psychosocial factors would affect the neck-shoulder region more than the distal upper limbs are poorly understood. According to a model by Johansson and Sojka[24], psychological stressors would act to alter the sensitivity of the muscle spindles, whose density is particulary high in the neck region, resulting in the long lasting activation of low-

Table 3. Relative risks of musculoskeletal symptoms in neck-shoulder and elbow-wrist/hand, by occupational and socio-demographic characteristics, adjusted for age class and gender

	Neck-shoulder symptoms (N=314)		Elbow-wrist/hand symptoms (N=89)	
Exposure	RR	95% C.I.	RR	95% C.I.
Incorrect keyboard height	**1.28**	**1.03–1.59**	**2.01**	**1.30–3.11**
Insufficient working space	**1.32**	**1.12–1.56**	**1.97**	**1.32–2.94**
Inadequate desk lighting	**1.47**	**1.25–1.73**	**1.76**	**1.18–2.61**
Lack of wrist support	**1.20**	**1.01–1.42**	0.94	0.61–1.43
Lack of forearm support	1.07	0.90–1.28	**1.73**	**1.16–2.56**
Not possible to lean back while sitting	**1.39**	**1.16–1.66**	1.32	0.83–2.10
No freedom to decide when to take a break	1.16	0.89–1.51	1.10	0.62–1.93
Insufficient duration of breaks	**1.23**	**1.03–1.47**	1.31	0.87–1.97
Insufficient training on computer systems in use	1.00	0.83–1.21	0.91	0.59–1.41
Inadequate microclimatic conditions -1	1.06	0.75–1.50	1.25	0.52–3.01
Inadequate microclimatic conditions -2	1.27	0.92–1.74	1.31	0.55–3.12
Inadequate microclimatic conditions -3	**1.36**	**1.00–1.84**	**2.14**	**0.99–4.61**
Inadequate microclimatic conditions -4	**1.41**	**1.06–1.88**	**2.64**	**1.30–5.36**
Job insecurity	1.05	0.89–1.25	**2.19**	**1.40–3.42**
Presence of production standard to reach	0.93	0.77–1.13	0.74	0.47–1.19
Presence of performance monitoring systems	1.18	0.94–1.48	1.05	0.64–1.70
Poor supervisor support or recognition	**1.47**	**1.14–1.89**	**3.09**	**1.45–6.56**
2–3 s time interval between calls	1.01	0.81–1.26	**2.11**	**1.19–3.72**
<2 s time interval between calls	1.00	0.80–1.25	**1.78**	**0.97–3.25**
16–30 calls per hour at peak	1.03	0.83–1.29	1.51	0.86–2.64
>30 calls per hour at peak	0.93	0.74–1.16	1.64	0.93–2.89
Continuously elevated noise	**1.50**	**1.27–1.77**	**1.98**	**1.33–2.93**
CC seniority 4–6 yr	**1.25**	**0.99–1.58**	1.11	0.61–2.00
CC seniority >6 yr	**1.38**	**1.09–1.74**	**1.88**	**1.11–3.19**
Similar time of keyboard and mouse use	1.22	0.92–1.61	1.26	0.67–2.35
Using the mouse more than the keyboard	1.25	0.93–1.69	1.19	0.61–2.35
5–6 daily hours at VDU	1.04	0.81–1.34	0.71	0.40–1.26
>6 daily hours at VDU	1.08	0.86–1.37	0.82	0.51–1.33
Demand - middle tertile	1.18	0.95–1.46	1.36	0.84–2.21
Demand - high tertile	**1.25**	**1.00–1.54**	1.29	0.77–2.17
Control - middle tertile	**1.40**	**1.10–1.77**	1.29	0.76–2.19
Control - low tertile	**1.46**	**1.15–1.85**	1.36	0.79–2.32
Job strain - middle tertile	**1.32**	**1.04–1.67**	0.94	0.55–1.59
Job strain - high tertile	**1.49**	**1.19–1.87**	1.37	0.85–2.20
Chronic disease	**1.38**	**1.16–1.66**	1.47	0.94–2.29
Musculoskeletal injuries in the last 5 yr	**1.97**	**1.68–2.31**	**2.14**	**1.47–3.13**
No leisure physical activity	**1.20**	**1.00–1.44**	1.14	0.75–1.74
Single	1.00	0.82–1.22	1.01	0.64–1.59
Previously married	1.04	0.78–1.39	1.20	0.67–2.15
Middle educational level	1.18	0.90–1.56	1.70	0.78–3.70
High educational level	1.37	0.97–1.94	2.24	0.87–5.77
BMI ≥26	0.98	0.77–1.25	0.96	0.57–1.60
Former smokers	1.16	0.94–1.43	0.93	0.54–1.58
Current smokers	1.09	0.90–1.33	1.29	0.84–1.98
Female gender[2]	**1.26**	**1.03–1.55**	1.46	0.90–2.35

Table 4. Risk factors for musculoskeletal symptoms in neck-shoulder and elbow-hand/wrist region, from final multivariate models ($p<0.05$)

	Neck-shoulder symptoms		Elbow-wrist/hand symptoms	
Exposure	RR	95% CI	RR	95% CI
Elevated noise	1.28	1.07–1.52		
Not possible to lean back while sitting	1.27	1.05–1.52		
Insufficient desk lighting	1.27	1.05–1.53		
Control–middle tertile	1.30	1.02–1.64		
Control–low tertile	1.25	0.98–1.60		
Insufficient working space			1.78	1.15–2.76
Lack of forearm support			1.63	1.10–2.43
Job insecurity			2.24	1.33–3.75
2–3 s time interval between calls			2.15	1.25–3.71
<2 s time interval between calls			1.79	1.00–3.19
CC seniority 4–6 yr			1.34	0.73–2.47
CC seniority >6 yr			1.82	1.09–3.04
High school degree			2.07	0.84–5.06
Less than high school degree			2.99	1.15–7.79
Previous injuries	1.83	1.55–2.16	1.94	1.29–2.92
Chronic diseases	1.39	1.16–1.67		
Female gender	1.30	1.06–1.59		
Age 30-39	1.38	1.11–1.71		
Age 40-49	1.27	0.98–1.65		
Age >49	1.43	1.09–1.89		

threshold motor units, known as Cinderella fibers[25]. Overactivity of these units would lead to degenerative processes in the muscle cells[26] causing pain.

The association with exposure to short intervals between calls (less than four seconds), which may be interpreted as an indicator of high work pace, also appears consistent with other reports of elbow-hand/wrist disorders[5, 27]. Job insecurity has been reported to increase the risk of musculoskeletal symptoms in the upper limb in both office and industrial workers[9, 28]. The mechanism linking job insecurity to musculoskeletal symptoms is not known, but it has been hypothesized that workers who are insecure about their job are more likely to continue working after symptoms development, because of the fear of being fired, without trying to reduce their exposure through a job change, and would be therefore more likely to develop more severe symptoms or disorders[28].

An increased risk of UE musculoskeletal symptoms has been linked to various aspects of workstation design in several studies of CCs and office workers, although with some differences in the characteristics found associated[5, 7, 19, 29]. In particular, lack of forearm support has been consistently associated with an increased risk of symptoms in the elbow-wrist/hand region, apparently because of an increase in ulnar deviation of the wrist, which is a known risk factor for hand/wrist disorders[30]. As in our results, poor lighting increased the risk of neck symptoms among VDU users, although not significantly[31], while in another study on teleservice operators neck symptoms were associated with perception of chair discomfort[32]. The observed association between long seniority in the CC industry and the prevalence of distal symptoms also appears consistent with previous reports of an increased risk of hand/wrist symptoms associated with long duration as a CC operator[7] and long-term use of VDUs[33].

Nonetheless, for other workplace factors our findings do not appear consistent with the literature. For example, no association was observed with increasing time spent working with a VDU or with frequent mouse use, although two systematic reviews, including prospective studies, found convincing evidence of an increased risk of UE musculoskeletal symptoms associated with exposure to these factors[34, 35]. Inadequate duration of breaks and poor supervisor support were not retained in the fully adjusted models, despite other studies finding that they consistently increased the risk of UE symptoms among CC and other office workers[10, 36, 37]. Also, noise exposure has never been linked, to our knowledge, to UEMSD risk, but it has been observed that the frequent presence of sudden sounds and operators' voices in CCs may act as a psychological stressor, because it makes it more difficult to understand clients during telephone

calls[6, 38, 39].

The present results need to be interpreted in the light of the several limitations of the study. First, the case definition adopted was not based on a clinical examination, but on self-reported symptoms, which may have reduced its accuracy, potentially biasing the observed risk estimates in both directions. However, most other studies of CC or office workers used self-reported symptoms as a proxy of musculoskeletal disorders, rather than clinical diagnoses, and collected them by means of questionnaires comparable to ours, e.g. the Nordic Musculoskeletal Questionnaire[40] or similar, which have shown acceptable validity against clinical examination[41].

Second, the cross-sectional design of the study does not allow us to infer that the observed associations between exposure to workplace factors and musculoskeletal symptoms represent causal relationships. Also, the use of self-reported information on both exposures and outcomes may have generated artificial correlations between them[42]. In fact, it cannot be excluded that cases overestimated their exposure to workplace hazards, compared to non-cases, because of their musculoskeletal symptoms.

Third, a strong overlap was present between distal and proximal symptoms, with three-quarters of subjects with elbow-hand/wrist symptoms also reporting symptoms in the neck-shoulder region. Therefore, it appears difficult to exclude the possibility that risk factors for distal symptoms were different from those in the neck-shoulder only because subjects with distal symptoms were more severe cases, characterized by a higher number of affected regions and a wider diffusion of symptoms. Last, although several individual risk factors for UEMSDs were taken into account in the analyses, we lacked information on many other potential confounders of the observed associations, in particular on exposure to biomechanical and psychosocial factors occurring out of the workplace, such as those related to second jobs, leisure activities or domestic work. Especially, ergonomic exposures related to domestic work may have had an influence on the risk of musculoskeletal symptoms, given the high proportion of women in the study[43]. The high risk associated with low education in the final model on distal symptoms, even after controlling for many occupational characteristics, actually suggests that biomechanical and psychosocial exposures outside the CC workplace, correlated with low education or low social class, may also have been implicated, although this association might also be attributable to the fact that exposure to some relevant workplace factor, unevenly distributed by education, was not adequately assessed.

In conclusion, a high prevalence of upper limb musculoskeletal symptoms was observed in a population of CC workers, especially in the neck-shoulder region. Several psychosocial and ergonomic factors, partially consistent with previous reports, were found to increase the risk of symptoms' prevalence in the upper limbs. As observed by other authors, among VDU workers, the set of risk factors for neck-shoulder symptoms appears to differ substantially from that for symptoms in the elbow-hand/wrist region.

References

1) Customer Management Multimedia Competence (CMMC).Press release. Fource National day of the Relationship with Client. [Online]. 2005 [cited 2006 October 11].
2) Bagnara S, Marti P. Human work in call centres: a challenge for cognitive ergonomics. Theor Issues Ergon Sci 2001; 2: 223–37.
3) Sprigg CA, Smith PR, Jackson PR. Psychosocial risk factors in call centres: An evaluation of work design and well being. Research Report 169. Sudbury (UK): HSE BOOKS; 2003.
4) Australian Commission for Occupational Safety and Health. Code of practice—Occupational safety and health in call centres. [Online]. 2005 [cited 2007 Oct 14]; Available from: URL: http://www.commerce.wa.gov.au/WorkSafe/PDF/Codes_of_Practice/Code_call_centre.pdf
5) Rocha LE, Glina DM, Marinho MF, Nakasato D. Risk factors for musculoskeletal symptoms among call center operators of a bank in Sao Paulo, Brazil. Ind Health 2005; 43: 637–46.
6) Norman K, Nilsson T, Hagberg M, Tornqvist EW, Toomingas A. Working conditions and health among female and male employees at a call center in Sweden. Am J Ind Med 2004; 46: 55–62.
7) Ferreira M Jr, Saldiva PH. Computer-telephone interactive tasks: Predictors of musculoskeletal disorders according to work analysis and workers' perception. Appl Ergon 2002; 33: 147–53.
8) National Research Council, Institute of Medicine. Musculoskeletal disorders and the workplace: Low back and upper extremities. National Academy Press, Washington, DC, 2001.
9) Hales TR, Sauter SL, Peterson MR, et al. Musculoskeletal disorders among visual display terminal users in a telecommunications company. Ergonomics 1994; 37: 1603–21.
10) Halford V, Cohen HH. Technology use and psychosocial factors in the self-reporting of musculoskeletal disorder symptoms in call center workers. J Safety Res 2003; 34: 167–73.
11) Charbotel B, Croidieu S, Vohito M, et al. Working conditions in call-centers, the impact on employee health: a transversal study. Part II. Int Arch Occup Environ Health 2009; 82: 747–56.
12) Ryan GA, Bampton M. Comparison of data process operators with and without upper limb symptoms. Community Health Stud 1988; 12: 63–8.
13) Leclerc A, Franchi P, Cristofari MF, et al. Carpal tunnel syndrome and work organisation in repetitive work: a cross sectional study in France. Study Group on

Repetitive Work. Occup Environ Med 1998; 55: 180–7.
14) Gilardi L, Fubini L, d'Errico A, Falcone U, Mamo C, Migliardi A, Quarta D, Coffano ME. Working conditions and health problems among call-centre operators: A study on self-reported data in the Piedmont Region (Italy). Med Lav 2008; 99: 415–23 (in Italian).
15) Apostoli P, Bazzini G, Sala E, Imbriani M. The Italian version of "OREGE" (Outil de Repérage et d'Evaluation des Gestes) of INRS (Institut national de recherche et de sécurité) for the evaluation of upper extremity musculoskeletal disorders. G Ital Med Lav Ergon. 2002; 24: 3–25 (in Italian).
16) Karasek RA, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): An instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol 1998; 3: 322–55.
17) Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: An empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol 2003; 3: 21.
18) Hosmer DW, Lemeshow S. Applied logistic regression, 2nd ed. New York: John Wiley & Sons; 2000.
19) Hoekstra E, Hurell J, Swanson N. Evaluation of work-related musculoskeletal disorders and job stress among teleservice center representatives. App Occ Env Hyg 1995; 10: 812–7.
20) Sillanpää J, Huikko S, Nyberg M, Kivi P, Laippala P, Uitti J. Effect of work with visual display units on musculo-skeletal disorders in the office environment. Occup Med (Lond) 2003; 53: 443–51.
21) Janwantanakul P, Pensri P, Jiamjarasrangsri V, Sinsongsook T. Prevalence of self-reported musculoskeletal symptoms among office workers. Occup Med (Lond) 2008; 58: 436–8.
22) Bongers PM, Kremer AM, ter Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist?: A review of the epidemiological literature. Am J Ind Med 2002; 41: 315–42.
23) Vasseljen O, Holte KA, Westgaard RH. Shoulder and neck complaints in customer relations: Individual risk factors and perceived exposures at work. Ergonomics 2001; 44: 355–72.
24) Johansson H, Sojka P. Pathophysiological mechanisms involved in genesis and spread of muscular tension in occupational muscle pain and in chronic musculoskeletal pain syndromes: A hypothesis. Med Hypoth 1991; 35: 196–203.
25) Hagg G. Static work loads and occupational myalgia—A new explanation model. In: Anderson PA, Hobart DJ, Danhoff JV, editors. Electromyographical Kinesiology. Amsterdam: Elsevier Science Publishers B.V; 1991. p 141–4.
26) Sjøgaard G, Lundberg U, Kadefors R. The role of muscle activity and mental load in the development of pain and degenerative processes on the muscle cellular level during computer work. Eur J Appl Physiol 2000; 83: 99–105.
27) Nahit ES, Pritchard CM, Cherry NM, Silman AJ, Macfarlane GJ. The influence of work related psychosocial factors and psychological distress on regional musculoskeletal pain: A study of newly employed workers. J Rheumatol 2001; 28: 1378–84.
28) Lipscomb H, Kucera K, Epling C, Dement J. Upper extremity musculoskeletal symptoms and disorders among a cohort of women employed in poultry processing. Am J Ind Med 2008; 51: 24–36.
29) Punnett L, Bergqvist U. Visual display unit work and upper extremity musculoskeletal disorders: A review of epidemiological findings. Solna (Sweden): National Institute for Working Life; 1997.
30) Rempel DM, Krause N, Goldberg R, Benner D, Hudes M, Goldner GU. A randomised controlled trial evaluating the effects of two workstation interventions on upper body pain and incident musculoskeletal disorders among computer operators. Occup Environ Med 2006; 63: 300–6.
31) Korhonen T, Ketola R, Toivonen R, Luukkonen R, Häkkänen M, Viikari-Juntura E. Work related and individual predictors for incident neck pain among office employees working with video display units. Occup Environ Med 2003; 60: 475–82.
32) Hoekstra EJ, Hurrell J, Swanson N. HHE Report No.HETA-92-0382-2450. Boston (Massachusetts), Fort Lauderdale (Florida): Social Security Administration Teleservice Centers; 1992.
33) Marcus M, Gerr F. Upper extremity musculoskeletal symptoms among female office workers: Associations with video display terminal use and occupational psychosocial stressors. Am J Ind Med 1996; 29: 161–70.
34) Village J, Rempel D, Teschke K. Musculoskeletal disorders of the upper extremity associated with computer work: A systematic review. Occup Ergonomics 2005; 5: 205–18.
35) IJmker S, Huysmans MA, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM. Should office workers spend fewer hours at their computer? A systematic review of the literature. Occup Environ Med 2007; 64: 211–22.
36) Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. Ergonomics 1995; 38: 763–76.
37) Karlqvist L, Tornqvist EW, Hagberg M, Hagman M, Toomingas A. Self-reported working conditions of VDU operators and associations with musculoskeletal symptoms: a cross-sectional study focussing on gender differences. Int J Ind Ergon 2002; 30: 277–94.
38) Evans GW, Johnson D. Stress and open-office noise. J Appl Psychol 2000; 85: 779–83.
39) Kjellberg A, Landstrom U, Tesarz M, Soderberg L, Akerlund E. The effects of nonphysical noise characteristics; ongoing task and noise sensitivity on annoyance and distraction due to noise at work. J Environ Psychol 1996; 16: 123–36.
40) Dickinson CE, Campion K, Foster AF, Newman SJ,

O'Rourke AM, Thomas PG. Questionnaire development: an examination of the Nordic Musculoskeletal questionnaire. Appl Ergon 1992; 23: 197–201.
41) Palmer K, Smith G, Kellingray S et al. Repeatability and validity of an upper limb and neck discomfort questionnaire: The utility of the standardized Nordic questionnaire. Occup Med (Lond) 1999; 49: 171–5.
42) Kristensen TS. Job stress and cardiovascular disease: A theoretic critical review. J Occup Health Psychol 1996; 1: 246–60.
43) Sala E, Mattioli S, Violante FS, Apostoli P. Risk assessment of biomechanical load for the upper limbs in housework. Med Lav 2007; 98: 232–51 (in Italian).