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Work-related Musculoskeletal Symptoms in Surgeons

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Abstract *Introduction* Surgeons are a unique group of healthcare professionals who are at risk for developing work-related musculoskeletal symptoms (WMS). The diversity of operating skills for laparoscopic and endovascular procedures impose different physical demands on surgeons, who also work under time pressure. The present study aims to examine the physical and psychosocial factors and their association with WMS among general surgeons in Hong Kong. *Method* A survey was conducted among surgeons working in the General Surgery departments in public hospitals of Hong Kong. Over 500 questionnaires were mailed and 135 surgeons completed the survey successfully (response rate 27%). Questions included demographics, workload, ergonomic and psychosocial factors. The relationship of these factors with WMS symptoms in the past 12 months was examined. *Results* Results indicated a high prevalence rate of WMS symptoms in surgeons, mainly in the neck (82.9%), low back (68.1%), shoulder (57.8%) and upper back (52.6%) regions. Sustained static and/or awkward posture was perceived as the factor most commonly associated with neck symptoms by 88.9% of respondents. Logistic regression showed the total score for physical ergonomic factors was the most significant predictor for all 4 body regions of musculoskeletal symptoms, with OR of 2.028 (95%CI 1.29–3.19) for the neck, 1.809 (1.34–2.43) for shoulder and 1.716 (1.24–2.37) for the lower back. Workstyle score was significantly associated with the symptom severity in the low back region ($P = .003$) but not with the other regions. *Conclusion* These results confirmed a strong association of physical and psychosocial factors with the musculoskeletal symptoms in surgeons. There is a potential for such musculoskeletal symptoms to escalate in the future, with rapid advances and increasing application of minimally invasive surgery.

Keywords Work-related musculoskeletal symptoms · Psychosocial · Ergonomics · Surgeons · Laparoscopic and endovascular surgery

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Introduction

Work-related musculoskeletal symptoms (WMS) are a major health issue in many occupations all over the world [1]. Extensive research has been conducted on these musculoskeletal problems in different occupational groups such as office workers, bus drivers, cleaners and sewing machine operators [2–5]. Among the healthcare professions, extensive research has been done on nurses, nurse assistants and patient care workers with a focus on lifting and back pain [6, 7]. Prevalence rates ranging from 10 to over 40% for occupational low back pain have been reported in studies concerning nursing professionals [6, 7]. Past research on hospital workers have mainly been focused on nurses [8] and very few studies have examined musculoskeletal symptoms among doctors in various specialties. Liberman et al. [9] conducted a survey among over 600 colorectal surgeons who performed colonoscopy regularly and reported a high prevalence rate of "injuries" in the hands/fingers ($n = 257$), then the neck ($n = 65$) and back ($n = 52$). Wauben et al. [10] conducted a survey among surgeons in Europe, and reported a 22% response rate out of over 1,200 questionnaires sent out. The target group was surgeons and residents within the digestive, thoracic, urologic, gynecologic and pediatric disciplines. Among the 285 surgeons who responded in that study, over 80% reported experiencing discomfort in the neck, shoulders and back areas. However, the focus of that study was mainly on evaluating ergonomic awareness and not much detail was presented about the characteristics of musculoskeletal symptoms in the respondents. Beside these two studies, there has been very little information about the prevalence of WMS reported among surgeons of different disciplines. One study on over 400 operating room assistants in the Netherlands, reported a prevalence of 46% for back pain [11]. It would be expected that surgeons of various specialties may also be at high risk for neck and back pain as a result of their sustained postures during surgical procedures.

The study by Wauben et al. [10] examined surgeons who performed surgeries involving laparoscopic and thoracic procedures mainly. These are similar to the discipline of "General Surgery" in Hong Kong. According to the definition by the College of Surgeons of Hong Kong [12], the scope of surgery under the specialty of "general surgery" can include breast, abdominal, colorectal, endocrine, vascular, amputation and transplant surgery. In the hospital system in Hong Kong, the department is usually just named the "department of surgery", and it may have sub-specialty teams of vascular surgery, abdominal surgery, urological surgery and others.

The work of surgeons can involve high levels of mental concentration and very precise movements that can be categorized as mild-to-moderate physical demands [13]. They have to be extremely skillful with their hands as well as make important decisions quickly at critical moments during surgery, which can literally be "life-and-death" matters. Other elements of their jobs include ward rounds, surgical meetings, patient consultations and report-writing. It would be expected that surgeons are constantly exposed to both physical and psychosocial workplace demands, as they have to manage not only the physical work of performing surgery, but also to communicate with both the patients and their families.

The diversity of operating skills imposes different demands of physical efforts on surgeons. Within the discipline of general surgery, the most commonly used surgical approaches involve open procedures and minimally invasive procedures, and the latter ones are becoming more and more popular as technology advances. Laparoscopic and endovascular procedures are very commonly performed and they require very fine eye-hand coordination from the surgeons. For example, laparoscopic surgery requires the surgeon to work with abducted shoulders for long periods of time [13] and fluoroscopy guided endovascular procedures require the surgeon to wear a lead apron of about 5–7 kg throughout the entire procedure.

While some of the physical aspects of the surgeons' work have been examined in past research, the influence of psychosocial risk factors has not been explored. There is general consensus among researchers that WMS and disorders usually involve a multi-factorial etiology and psychosocial factors have a very major role in affecting these symptoms [2, 14, 15]. In an effort to integrate some of the psychosocial factors and concomitant physical factors, Feuerstein and colleagues proposed that the response of the worker in terms of "behavioral, cognitive and physiological elements are triggered by the perceived or actual elevation in job demands to respond to the increases in work demands" [15, 16]. They propose that not all workers react similarly to increases in perceived or real work demands and therefore the extent of the reaction has the potential to exacerbate and maintain symptoms particularly in those who have a heightened reaction. This reaction which is dependant of a given work situation is referred to as the individual's "workstyle" [16, 17]. It was created to provide a measure that incorporates both physical and psychosocial dimensions of exposure in workers who perform intensive upper limb work, such as office workers [18, 19]. The questions the measure asks can be particularly relevant for professionals like surgeons who may impose stress on themselves due to a high sense of responsibility and not providing small breaks to allow muscles to recover. They may also be generating more pressure or force when using the various surgical tools than is required for the use of such tools, as a secondary phenomenon of the perceived levels of work demands.

The present study aims to examine the prevalence of work-related musculoskeletal symptoms among surgeons in the general surgery specialty in Hong Kong and identify the characteristics of their musculoskeletal problems in relation to physical and psychosocial factors that may be involved in such work. The results can provide information about the size of the problem and the findings can be used to develop intervention strategies for this group of surgeons and possibly other specialties as well.

Methods

Participants

The study examined self-report of musculoskeletal symptoms of surgeons working in general surgery departments in various public general hospitals in Hong Kong. The survey was posted to all the surgeons working in the general surgery departments in the public health care system in Hong Kong. Follow-up phone calls were made to the departments to encourage participation. Ethics approval was obtained from the local universities and the medical center involved, prior to commencing the study. Altogether over 500 questionnaires were posted and the response rate was 27%, with 135 forms successfully completed and included in the data analysis. This response rate is comparable to those of previous studies—22% in the study by Wauben et al. [10] and 28% in Liberman et al. [9]. These survey studies were conducted by sending the questionnaires by emails or by post to all members of the respective surgical associations.

The Survey Design

The survey contained information on four major categories:

1. Demographic and workload data (average number of operations and operating hours per week and type of operations);
2. Past and present history of musculoskeletal symptoms (modified version of the Standardized Nordic Questionnaire, based on Kuorinka et al. [20]);
3. Evaluation of ergonomic risk factors (questions developed based on past literature [2, 21, 22]; and
4. Modified Workstyle Short Form [17].

Most of the questions utilized the checklist approach in order to reduce ambiguity and to facilitate quantitative analysis. Respondents were asked to identify body regions that they had experienced discomfort in the past 12 months, based on demarcations of body regions in the Standardized Nordic Questionnaire [20].

The evaluation on ergonomic risk factors involved six questions which asked the participant to consider whether the factors of posture, repetition, force and environmental factors would contribute to their musculoskeletal problems. These physical risk factors are the most commonly recognized ones according to past research [21, 22]. For the ergonomic risk factors, an affirmative response of "yes" to that question was given 1 point and "no" regarded as "0". Hence for the total of 6 questions in this part, the maximum score was 6.

From the Workstyle Short Form [17], 11 questions were adopted in the present questionnaire survey, and these questions are considered most relevant to reflect the influence of the behavioral and cognitive factors involved in the reaction of the surgeons. For each question, the answers were in 5 categories: almost never (0); rarely (1); sometimes (2); frequently (3); and almost always (4). Hence the score range for this part was 0–40. The items included are presented in Table 1.

Table 1 Items of workstyle adopted in the present study (adopted from Feuerstein and Nicholas [17])

Q1. I continue to work with pain and discomfort so that the quality of my work won't suffer
Q2. My hands and arms feel tired during the workday
Q3. I continue to work in a way that contributes to pain in order to get my work done
Q4. I take medications to manage pain, muscle tension, or symptoms in my fingers, wrists, hands, or arms in order to keep working
Q5. If I have to talk to my supervisor about my symptoms, it will appear that I cannot handle the work
Q6. My schedule at work is very uncontrollable
Q7. I really don't have time to take a break because of everything that must get done
Q8. I am physically exhausted at the end of the day
Q9. I push myself and have higher expectations than my supervisors and others that I have to deal with at work
Q10. I always try to do my best because that's what I owe myself
Q11. I put a lot of pressure on myself

Data Analysis

The data obtained from the survey were analyzed using SPSS 16.0 (©SPSS Inc, Chicago, IL). Individual, work experience and workload factors were first examined in the whole group and then compared between males and females by 2-sample *t*-tests. The four body regions of neck, shoulder, upper back and lower back had the highest prevalence rates of musculoskeletal symptoms among all body areas, and these were examined more closely in terms of their history, impact on work and leisure activities, need for medical attention and work-relatedness. The physical ergonomic risk factors as well as the "workstyle" scores [17] were also examined in terms of their total scores in each part. After examining the different types of data such as demographic, workload, ergonomic and workstyle factors separately, backward stepwise logistic regression models were built with 15 independent variables for each of the four areas of body discomforts. Univariate logistic regressions were performed first with 15 independent variables that consisted of individual factors, workload variables, physical factor score and workstyle score. Those variables that reached $P > .1$ were eliminated. The remaining variables with $P < .1$ were entered into the multivariate backward stepwise logistic regression. The final multivariate logistic regression model showed only those variables with statistical significance $<.05$. Multivariate linear regression models were built for the numerical symptom score for each of the 4 body areas, using the same 15 factors in the univariate regression, followed by backward stepwise regression with those variables that reached $P < .1$ in the same approach.

Results

Demographic and Workload Characteristics of Surgeons

A 135 surgeons completed the survey successfully with all items completed with 111 males and 23 females. There were 87 specialists, 27 higher trainees and 21 basic trainees. Their ages ranged from 23 to over 40, and the mean working years of the group were 10.0 years ± 7.3. On the average, they worked a total of about 53.6 h (±13.1) per week and the main duties included operating, attending ward rounds and out-patient clinics. Table 2 is a summary of their demographic and workload characteristics. In terms of their own estimated working hours and types of duties performed, there appeared to be no difference between the genders, except in the number of hours for out-patient (OPD) and office work and the number of open surgeries performed per month. These figures are just estimations to provide some indications of workload and need to be compared to other published data in other countries. The four types of surgeries listed—open, laparoscopic, endovascular and endourology, were identified by the authors as the most common types of surgeries performed and it appears that open surgery is still by far the most common one. Further study needs to investigate the more precise physical demands of the different types of surgery and examine their relationships with musculoskeletal symptoms.

Characteristics of Work-Related Musculoskeletal Disorders

Over 80% of the respondents reported experiencing at least one area of musculoskeletal symptoms in the past

Table 2 Demographic and workload profiles of surgeons

	Whole group ($n = 135$)	Males ($n = 111$)	Females ($n = 23$)	Between group statistics
Height (cm)	171.1 (7.3)	172.9 (6.0)	161.9 (6.0)	<0.0005*
Weight (kg)	68.2 (12.3)	71.2 (10.6)	52.8 (7.7)	<0.0005*
Age group				
23–27	21 (15.6%)	17 (15.6%)	4 (17.4%)	
28–31	25 (18.5%)	18 (16.5%)	7 (30.4%)	
32–35	33 (24.4%)	23 (19.3%)	10 (43.5%)	
36–39	18 (13.3%)	17 (15.6%)	1 (4.3%)	
>40 years	38 (28.1%)	36 (33.0%)	1 (4.3%)	
Experience level				
Basic trainee	21 (15.6%)	16 (14.7%)	5 (21.7%)	
Advanced trainee	28 (20.7%)	20 (18.3%)	7 (30.4%)	
Specialist	86 (63.7%)	73 (67.0%)	11 (47.8%)	
Working years (year)	10.0 (7.3)	10.6 (8.9)	8.6 (3.5)	$t_{48.9} = 3.63$, $P = .001$*
Working hours/week (h)	53.6 (23.5)	53.8 (23.7)	52.0 (21.8)	$t_{130} = 0.33$, $P = .740$
No. of surgery/week	6.4 (3.0)	6.3 (3.0)	6.9 (3.0)	$t_{129} = -0.88$, $P = .377$
No. of surgery hours/week	19.1 (12.1)	18.0 (9.2)	23.0 (18.1)	$t_{24.4} = -1.28$, $P = .056$
No. of OPD and office hours/week	20.4 (19.5)	21.8 (20.9)	14.0 (9.8)	$t_{71.1} = 2.71$, $P = .008$*
No. of ward round and consultation hours/week	14.1 (8.2)	14.0 (8.4)	15.0 (7.7)	$t_{130} = -0.54$, $P = .589$
Type of surgery cases/month				
Open	15.6 (10.7)	14.7 (10.2)	20.6 (11.5)	$t_{127} = -2.46$, $P = .015$*
Laparoscopic	6.7 (7.5)	7.0 (7.9)	5.5 (6.1)	$t_{128} = 0.87$, $P = .387$
Endovascular	0.7 (3.0)	0.7 (3.0)	0.9 (2.9)	$t_{129} = -0.24$, $P = .810$
Endourology	1.7 (6.3)	1.8 (6.7)	0.3 (1.2)	$t_{128.3} = 2.26$, $P = .025$
Others	0.2 (2.1)	0.22 (2.3)	0.0 (0.0)	$t_{130} = -0.46$, $P = .648$

Note: Data are presented as group mean values (SD) for continuous variables and expressed as counts (% of respective group) under age groups and job rank

* Significance level at $P < .05$

OPD outpatient

12 months. The neck region had the highest prevalence rate of 82.9% ($n = 112$), followed by the low back with 68.1%, shoulder 57.8% and upper back 52.6%.

The surgeons were also asked to describe the characteristics of the worst area of musculoskeletal symptoms, based on questions adopted from the Standardized Nordic Questionnaire [20], which has been widely used to study WMS in many different occupations. The results showed that most respondents chose the four areas of neck, shoulder, upper back and lower back as the "worst" area, and the answers to various questions would give an indication of the severity of the symptoms and how they affect the person's daily life (see Table 3). In terms of the past history of symptoms, there appeared to be no apparent differences among the four body regions; and the duration of symptoms seemed to be fairly evenly distributed among the different categories. The results did not show a high frequency of symptoms affecting work or leisure activities, and majority did not require medical attention. However, very high percentages of these bodily discomforts were aggravated by daily work—ranging from 82.9 to 93.3% for the four regions.

When asked to rate the discomfort scores on a numerical scale of 0–10 (with 1 being minimal discomforts and 10 being extreme intolerable discomforts), the discomfort scores on both sides of the spine such as the neck and back areas showed rather even distributions on both sides. The four body areas had mean scores ranging from 2.2 (±2.7) in the upper back to 3.6 (±2.7) in the neck. The upper limb regions showed somewhat higher discomfort scores on the right compared to the left. On the whole, the results seemed to suggest a pattern of widespread problems with high prevalence rates but mild in terms of symptom severity in the major body areas.

Ergonomic Factors and Workstyle Factors

Subjects were asked to consider whether the common physical factors such as posture, repetition, forceful exertion or environmental factors were related to their discomforts in various body regions. The results showed that "sustaining static or awkward posture during surgery" was identified as the most prominent factor related to body discomforts with a positive response of 88.9% ($n = 120$). Forceful exertion showed a 44.4% positive response rate and repetition 37.8%. The results also indicated that a high proportion of surgeons related the static posture factor to

Table 3 Characteristics of musculoskeletal discomfort of the top four body regions with the most prevalent symptoms

Question	Neck ($n = 45$)	Lower back ($n = 35$)	Upper back ($n = 15$)	Shoulder ($n = 13$)
Duration of discomfort in last 12 months				
1–7 days	9 (20.0)	11 (31.4)	2 (13.3)	0 (0.0)
8–30 days	17 (37.8)	10 (28.6)	6 (40.0)	5 (38.5)
1–3 months	9 (20.0)	5 (14.3)	4 (26.7)	2 (15.4)
4–6 months	2 (4.4)	3 (8.6)	0 (0.0)	1 (7.7)
>6 months	8 (17.8)	6 (7.1)	3 (20.0)	5 (38.5)
Total duration since onset				
>5 years	11(24.4)	9 (25.7)	4 (26.7)	4 (30.8)
4–5 years	5 (11.1)	9 (25.7)	5 (33.3)	1 (7.7)
1–3 years	19 (42.2)	11 (31.4)	2 (13.3)	6 (46.2)
<1 year	10 (22.2)	6 (17.1)	4 (26.7)	2 (15.4)
Reduced work activities	5 (11.1)	4 (11.4)	1 (6.7)	1 (7.7)
Reduced leisure activities	14 (31.1)	10 (28.6)	7 (46.7)	6 (46.2)
Received medical treatment				
Doctor	3 (6.7)	2 (5.7)	2 (13.3)	1 (7.7)
Physiotherapist	3 (6.7)	6 (17.1)	4 (26.7)	1 (7.7)
Chiropractor	0 (0.0)	0 (0.0)	1 (6.7)	0 (0.0)
Others	1 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)
Ever taken medication	14 (31.1)	2 (5.7)	6 (40)	5 (38.5)
Now on medication	4 (8.9)	2 (5.7)	1 (6.7)	2 (15.4)
X-ray	5 (11.1)	5 (14.3)	2 (13.3)	0 (0.0)
Discomfort in last 7 days	31 (68.9)	21 (60.0)	10 (66.7)	8 (61.5)
Aggravated by daily work	38 (84.4)	29 (82.9)	14 (93.3)	11 (84.6)
Increased discomfort at the end of day	39 (86.7)	28 (80.0)	13 (86.7)	10 (76.9)
Increased discomfort in the morning	9 (20.0)	4 (11.4)	2 (13.3)	1 (7.7)

Note: Data are expressed as "number of yes" (%)

Table 4 Example showing the backward stepwise logistic regression model for neck symptoms

	Variables in the equation							
	B	SE	Wald	*df*	Significance	Exp(B)	95.0% CI for Exp(B)	
							Lower	Upper
Step 1[a]								
BH	−.058	.041	2.031	1	.154	.944	.871	1.022
Work_year	−.023	.036	.433	1	.510	.977	.911	1.047
Phy_fac	.663	.248	7.148	1	.008**	1.940	1.193	3.153
WS_score	.016	.044	.124	1	.724	1.016	.931	1.108
Constant	10.254	7.081	2.097	1	.148	28,387.208		
Step 2[a]								
BH	−.058	.041	2.027	1	.154	.944	.872	1.022
Work_year	−.027	.034	.622	1	.430	.973	.911	1.041
Phy_fac	.690	.236	8.533	1	.003**	1.993	1.255	3.165
Constant	10.558	7.016	2.265	1	.132	38,482.913		
Step 3[a]								
BH	−.060	.040	2.278	1	.131	.941	.870	1.018
Phy_fac	.704	.236	8.935	1	.003**	2.023	1.274	3.210
Constant	10.678	6.921	2.380	1	.123	43,407.677		
Step 4[a]								
Phy_fac	.707	.231	9.347	1	.002**	2.028	1.289	3.190
Constant	.293	.501	.342	1	.559	1.340		

BH, body height; work_year, years worked as surgeon; phys_fac, physical factors; WS_score, workstyle score

* Denotes significance <.05, ** Denotes significance <.01

[a] Variable(s) entered on step 1: BH, work_year, phy_fac, WS_score

their neck pain (76.7%) as well as low back pain (61.7%; Table 4). Performing repetitive upper limb movements and forceful exertions were considered highly associated with wrist/hand pain (60.8%). The other factors involving furniture and environment were also considered to be highly associated with neck pain (78.0 and 88.9%).

For understanding the psychosocial factors, questions were adopted from the workstyle short form [17]. This questionnaire was originally designed to examine the combined psychological, physiological and behavioral responses to high work demands in those with upper limb symptoms. Some of the questions from the original workstyle short form [17] were considered appropriate for the present group of surgeons, and 11 questions were incorporated into the present survey. These included questions that asked whether the respondent would work through pain, their social reactivity, sense of responsibility and/or pressure, and whether they would take breaks even when they are in pain. The results showed that 35.6% of respondents almost always reported "working through pain so that the quality of their work would not suffer". Forty-four percent reported sometimes feeling exhausted at the end of the day, and 49.6% reported "trying to do their best because that's what they owe themselves".

Results of Regression Analysis of All Factors on Musculoskeletal Symptoms

Logistic regression models were built to examine the effects of 15 independent variables on the musculoskeletal symptoms in the neck, shoulder, upper back and lower back regions. Only those variables with $P < .1$ in the univariate logistic regression were entered in the multivariate regression models. For the multivariate logistic regression model on neck symptoms, the variables of body height, years of experience as surgeon, physical factor score and workstyle score were included in the first step of the multivariate regression model. In the multivariate regression model for the shoulder symptoms, age, body height, years of experience, number of surgeries per week, experience level, physical factor score and workstyle score were included. For the upper back, age, working hours per week, number of surgeries per week, physical factors and workstyle scores were included. For the lower back, number of surgeries per week, and the number of open procedures per week were also included, in addition to physical and workstyle factors scores.

On the whole, the physical ergonomic factors showed to be the most significant predictor for all four body areas of

Table 5 Summary of final multivariate logistic regression models for the four major musculoskeletal symptom areas

Body region with symptoms (yes/no)	Factor	*B*	SE	Wald	*df*	Significance	Odds ratio (OR)	95.0% CI for Exp(B)	
								Lower bound	Upper bound
Neck	Physical factors	.707	.231	9.347	1	.002**	2.028	1.289	3.190
	Constant	.293	.501	.342	1	.559	1.340		
Shoulder	Work years as surgeon	−.063	.028	5.061	1	.024*	.938	.888	.992
	Physical factors	.593	.152	15.230	1	.000**	1.809	1.343	2.436
	Constant	−.470	.497	.895	1	.344	.625		
Upper back	Physical factors	.516	.138	13.883	1	.000**	1.675	1.277	2.197
	Constant	−1.188	.409	8.444	1	.004	.305		
Lower back	Work years as surgeon	−.012	.028	.201	1	.654	.988	.936	1.043
	Physical factors	.540	.164	10.858	1	.001**	1.716	1.245	2.366
	Constant	−.208	.526	.157	1	.692	.812		

Note: The results presented here include only the variables that show statistical significance in the final multivariate logistic regression models. *OR* odds ratio, *CI* confidence interval

* Denotes significance <.05, ** Denotes significance <.01

musculoskeletal symptoms. Physical risk factors produced the highest OR for the neck symptoms (OR = 2.028, 95%CI: 1.3–3.2; Table 5), followed by shoulder (OR = 1.809, 95%CI: 1.3–2.4), then lower back (OR = 1.716, 95%CI: 1.2–2.4), and upper back (OR = 1.675, 95%CI: 1.3–2.2). The number of working years as surgeon was a significant factor associated with shoulder symptoms (OR = .938, 95%CI: 0.9–1.0), but not for lower back (OR = .988, 95%CI: 0.9–1.0). Workstyle score was not a significant factor in the multivariate logistic regression model for any one of the top four body areas with musculoskeletal symptoms.

The summed score of the bilateral symptoms of the four body regions were used to perform linear regression analysis with the same 15 variables. Again the physical ergonomic factors demonstrated to be the most significant factor associated with the symptom scores for all four body areas. Workstyle score was significantly associated with low back symptom severity ($t = 3.083$, $P = .003$). The number of surgical cases for open and endourology procedures were also significant factors associated with the lower back symptom scores (Table 6).

Discussion

The Surgeons' Job Demands and Musculoskeletal Symptoms

The present study has examined the work-related musculoskeletal problems in general surgeons working in the departments of general surgery in Hong Kong. The demographics reflected a group of mostly 30–40 year-old adults who have on the average about 10 years of experience in their work. The job ranks also suggested a more experienced and senior group of surgeons, with 87 being specialists compared to 48 being trainees. With increasing age and cumulative exposure to job stress, it would be expected that older surgeons may have a higher risk of developing musculoskeletal problems. On the other hand, it has also been reported in other studies that younger workers had higher prevalence rates of musculoskeletal problems due to their lack of experience resulting in poorer job skills and insufficient practice [4, 23, 24]. The "healthy worker effect" also suggests that those who are healthy are more likely to remain at work [24–26].

The present results also showed that there were fewer female surgeons and they were generally of a younger age. This would be expected because traditionally surgery has been a male-dominated profession. In past research studies, it has been commonly reported that females had higher prevalence rates in musculoskeletal disorders than males in general [27, 28]. It has been suggested that there are gender differences in the perception of complaints and different coping strategies used by men and women in dealing with occupational stressors [28–30].

In Hong Kong, the general surgeons in public hospitals usually perform the surgeries on 2–3 days of the week, while out-patient clinics and team meetings are scheduled on other days. The most commonly performed procedures were broadly classified into open, laparoscopic, endovascular and endourology. The results from the linear regression model showed the number of open surgery and endourology cases performed per month to be significant predictors of the lower back symptom scores. This may suggest that such procedures involved greater

Table 6 Summary of final multivariate linear regression models for the four major musculoskeletal symptom scores

Body region with symptoms (score)	Factor	Unstandardized coefficients		Standardized coefficients	*t*	Significance	95% CI for B	
		B	SE	Beta			Upper bound	Lower bound
Neck	Constant	5.231	.926		5.648	.000**	3.398	7.064
	Physical factors	.822	.293	.243	2.810	.006**	.243	1.401
Shoulder	Constant	3.369	1.133		2.972	.004**	1.126	5.612
	Physical factors	1.018	.294	.290	3.460	.001**	.436	1.600
	Work years as surgeon	−.140	.061	−.192	−2.297	.023*	−.261	−.019
Upper back	Constant	1.658	.942		1.760	.081	−.206	3.522
	Physical factors	1.065	.299	.302	3.565	.001**	.474	1.656
Lower back	Constant	−3.222	1.742		−1.850	.067	−6.671	.227
	Open surgery cases (per month)	.099	.043	.192	2.323	.022*	.015	.184
	Endourology cases (per month)	.242	.069	.283	3.517	.001**	.106	.378
	Physical factors	.865	.306	.238	2.829	.005**	.259	1.470
	Workstyle score	.234	.076	.267	3.083	.003**	.084	.385

Note: The results presented here include only the variables that show statistical significance in the final multivariate linear regression models

* Denotes significance <.05, ** Denotes significance <.01

biomechanical stresses on the lumbar spine and contributing to higher symptom severity for this region. In open procedures, the surgeons may adopt more sustained lumbar flexion as the procedures involve working on the deeper internal organs [31]. Endourology procedures may involve awkward posture of the surgeon to work with the anatomical regions involved [32].

Previous studies by Berguer et al. [26] have commented that laparoscopic surgery is significantly more stressful than open surgery in terms of physical demands. It has been reported that holding laparoscopic instruments was associated with high frequencies in hand injuries [9]. In our present study, we have not been able to detect a significant association of laparoscopic surgery with the musculoskeletal symptoms. The frequency and duration of different surgical procedures performed may vary greatly from time to time and between different hospitals, and therefore it may not be easy to establish the direct relationship of these workload factors to the musculoskeletal problems. Future study may examine more direct and objective measurements of actual physical exposures (such as postural measurements and muscle activity) in a field study, in order to gain better understanding of physical exposure factors in surgeons performing different procedures.

Effects of Physical and Psychosocial Risk Factors

Past research in the surgical community has examined the ergonomic aspects of laparoscopic instruments and their effects on postures and complaints in surgeons [13, 31–37]. Nguyen et al. [37] examined the spinal posture and upper limb movements in surgeons comparing laparoscopic and open surgery through an observational postural scoring system, and reported that laparoscopic surgery involved a more static posture of the neck and trunk but more frequent awkward movements in the upper limb compared to open procedures.

While these past research studies have contributed useful information towards improving surgical instrument design and the working environment for the surgeons, there has been no major study that has examined the surgeons' perception of physical factors of constrained posture, repetition, forceful exertion and relating these to the different areas of musculoskeletal symptoms. The present results showed that the surgeons seemed to have a good insight of the salient occupational risk factors such as sustaining an awkward posture—and a high percentage of the respondents identified this factor to be closely related to neck and low back discomforts. The results of the regression analysis further confirmed that the physical risk factor score was the most significant predictor for all the four top regions of musculoskeletal symptoms. This is consistent with research of similar design in other occupational groups such as bus drivers, who were also able to identify important physical risk factors and relate these appropriately to body regions that would be under biomechanical stress [4].

In view of the rapid development in minimally invasive surgery, it is likely that surgeons will be engaged even more extensively in performing such procedures for long durations in the future. Similar to the rising trends for intensive computer use in office workers, the risk of developing MSD in surgeons will be further increased due to the long hours of work and maintaining a static posture while performing movements of very fine eye-hand coordination. Hence understanding the characteristics of the symptoms and associated workplace factors are important steps towards finding effective solutions to these problems.

The present study is the first to investigate the influence of psychosocial risk factors affecting the surgeons. Previous studies have mainly focused on the physical ergonomic factors which involve more the physical aspects of the surgeons' work. The total workstyle score showed to be a significant factor in the univariate analysis for each of the four body region discomfort examined, but not significant in the final multivariate logistic regression models. On face value, the results may suggest that workstyle is not associated with the presence or absence of the WMS in this particular group of workers. However, the original workstyle instrument was designed specifically for examining work-related upper limb symptoms, it is possible that different physiological mechanisms may be involved in the body regions of neck, shoulder, upper back and lower back and therefore workstyle may not be a universal predictor of all these different types of musculoskeletal symptoms. This factor may possibly explain the consistent finding with only the physical risk factors being significant predictors for the presence of musculoskeletal symptoms in all four regions.

It was interesting to find that workstyle was a significant predictor for the symptom severity for the lower back, as it was proposed in previous studies on workstyle that it may be a factor for exacerbating musculoskeletal symptoms rather than causing the problems [15, 19].

In addition, as the design of the workstyle questionnaire was to examine the interaction between physical and psychosocial risk factors, it is also possible that this measure is highly correlated to the total score of the physical risk factors and therefore its effect was masked due to overlapping measurement constructs [1]. This is also a common phenomenon encountered in epidemiological studies reported in the occupational literature that utilized a number of different instruments.

Limitations of Study

The present study is only a cross-sectional survey so it is not known whether the musculoskeletal symptoms were the cause or the result of the physical and psychosocial risk factors. In addition, the response rate is relatively low from an epidemiological perspective, and it is not known whether the present sample could truly reflect the characteristics of the larger population of general surgeons in Hong Kong, or elsewhere. There is also the issue of examining self-reported symptoms which is prone to individual variations in perception of discomfort and pain [1, 38]. The use of self-report for evaluating ergonomic exposure is also considered to be less reliable as opposed to observational or quantitative measurements of physical stressors in the workplace [1, 38, 39].

Conclusion

In conclusion, the present survey study has shown high prevalence rates of neck, back and shoulder musculoskeletal symptoms in surgeons, which appear to be of a mild intensity in the current sample. The results showed that physical risk factors involving constrained posture, repetitive upper limb movements, forceful exertion and environmental factors were the most significant predictors of the work-related musculoskeletal symptoms in surgeons. Workstyle and the number of open and endourology procedures were found to be significantly associated with the symptom severity of the lower back region. Further study should examine both the physical and psychosocial factors contributing to these problems more extensively, and develop appropriate intervention strategies for the surgeons.

The results also indicated that the surgeons had a high sense of commitment and self-imposed pressure, resulting in a tendency to continue working through pain in order to complete all their work. These factors are all important contributors to WMS and further study should consider these issues carefully in developing effective interventions to address such problems.

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