

# Work-related musculoskeletal disorders in anesthesiologists: A cross-sectional study on prevalence and risk factors

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## Abstract

**Aim:** To investigate the prevalence of self-reported work-related musculoskeletal disorders (WRMDs) of anesthesiologists, to evaluate potential risk factors, including personal and workload characteristics and working ergonomics.

**Material and Methods:** A cross-sectional international survey including personal and workload characteristics of anesthesiologists was conducted. The Standardized Nordic Musculoskeletal Questionnaire was used to identify working ergonomics and the quality of ergonomic conditions of the operating room. The prevalence of WRMDs was calculated, and predictors of these symptoms were evaluated using binary logistic regression.

**Results:** 98.4% of respondents reported a WRMD in the previous 12 months, mainly low back disorders (70.7%). Cardiothoracic anesthesiologists were more likely to report 12-month knee problems (66%). Overall, pediatric anesthesiologists were more likely to report 12-month WRMDs in most of their body sites. Women were more likely to develop WRMDs in the upper back (OR=2.465; 95% CI:1.061-5.729) as compared with men. Long-duration bending was the most significant ergonomic hazard for all 3 body regions of musculoskeletal symptoms, with an OR of 4.210 (95% CI:1.081-16.391) for the neck, 4.619 (1.274-16.744) for the upper back, and 4.750 (1.045-21.590) for the low back. Suboptimal quality of ergonomic conditions in the operating room was significantly associated with increased WRMDs risk of the neck (OR=0.346; 95% CI:0.147- 0.812) and shoulder (OR=0.405; 95% CI:0.167- 0.982) regions.

**Conclusion:** Anesthesiologists are at high risk for WRMDs. There is a need to improve ergonomic conditions of operative rooms according to demands of anesthesiologists and to educate them on proper posture for a longer and pain-free career.

**Keywords:** Anesthesiologist; ergonomics; work-related musculoskeletal disorders; posture; survey.

## INTRODUCTION

Work-related musculoskeletal disorders (WRMDs), a group of painful disorders of muscles, tendons, nerves and ligaments are caused by the overuse of musculoskeletal structures with repetitive and forceful working activities (1). The association between musculoskeletal disorders and occupational factors was recognized at the beginning of the eighteenth century (2). WRMDs are quite common in many occupations and the second largest cause of temporary work disability after the common cold (3). In industrialized countries, they represent one of the greatest problems accounting 40% of work-related injuries treatment cost, reduced performance, and lower quality of life (4).

The job tasks of healthcare professionals carry high risks for musculoskeletal disorders. Numerous studies have documented WRMDs among different professional groups such as surgeons, sonographers, nurses, dentists, physical therapists, lab technicians, and others (1,5-13). Low back was the most prevalent problem region with a frequency of 65.7% for nurses (5). Surgeons most frequently report pain in the neck region with a rate of 82.9%, followed by the low back with 68.1% (6). A study on dentists' musculoskeletal symptoms showed a high prevalence of symptoms from the neck region with 88.17%, followed by lower back pain with 86.02%, and wrist pain with 54.8% (7). A study in anesthesiologists yielded the prevalence of low back pain as 46.6%. Moreover, 70.1% of

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the study participants had no low back symptoms prior to beginning their anesthesia training (12). In a 15-year follow-up cohort of nurses' aides, long-lasting low back pain was identified as one of the leading causes of being granted a disability pension (13). In the United Kingdom, WRMDs were detected as the most common cause of ill health retirement for dentists (14).

Personal characteristics (e.g. age, sex, body mass index, health status, exercise habits), occupational factors (physical workload and working posture), and workplace ergonomics contribute to the development of WRMDs (1,2,5). Performing repetitive and forceful tasks, static work, and adopting awkward postures for long periods result in impairments to musculoskeletal structures (6). Anesthesiologists are vulnerable to WRMDs because they use upper extremity and neck muscles during airway management procedures, perform forceful hand gripping during mask ventilation, and have to bend and adopt awkward postures during working activities. A cross-sectional survey study investigated the prevalence of work-related low back pain in anesthesia providers (faculty, residents, and nurse anesthetists), and showed that nearly half of all participants had low back pain subjectively attributed to their clinical practice (12). However, the results of the study were not specific to anesthesiologists or any particular subspecialty.

To date, no extensive studies conducted to directly assess the prevalence of WRMDs, which can be an occupational health problem for anesthesiologists. The primary aim of this study was to investigate the prevalence of WRMDs among pediatric, obstetric, and cardiothoracic anesthesiologists. The secondary aims were to compare the prevalence and distribution of WRMDs among the three groups, evaluate the potential risk factors that contributed to the development of WRMDs including working ergonomics, personal and workload characteristics, and to identify the high-risk group.

## **MATERIAL and METHODS**

### **Participants**

This cross-sectional study was designed as a worldwide survey on WRMDs in pediatric, obstetric, and cardiothoracic anesthesiologists. A literature search was performed to identify the names of researchers who had recently published research in the subject areas of pediatric, obstetric, and cardiothoracic anesthesiology between 2010 and 2018 in PubMed. From each publication, the e-mail address of the corresponding author was extracted, and three separate e-mailing lists were developed for the authors. In the period between July 2017 and October 2017, an electronic 35-question survey was generated in Google Forms and was mailed to 530 anesthesiologists. The e-mail contained information about the study objectives and a link to the online electronic survey. The questionnaire was offered in both English and Turkish. E-mails were sent monthly to encourage participation with a notice to avoid survey duplication. Participants responded to the questionnaires anonymously. Returned

surveys were included in the results if all the questions were answered. Before completing the questionnaire, a declaration was required that the respondent worked in one of the three-specialism areas.

### **Ethical considerations**

This study was approved by the Medical Ethics Committee of Medipol University. All participants were free to decide whether to answer the survey and could end the questionnaire at any time.

### **Survey design**

#### **The questionnaire consisted of five sections;**

1. Demographic information (age, sex, height, weight, marital status), lifestyle data (smoking, alcohol and exercise habits), chronic illness, general health status, and academic-related data (years of experience, professional status, working institution, area of specialization);
2. Workload characteristics (the number of anesthesia procedures per week, working hours per week, average time of anesthesia per case, resting time between procedures, number of night shifts per month, overtime working, number of anesthesia nurses);
3. Identification of WRMDs using the Standardized Nordic Musculoskeletal Questionnaire and their effects (a question corresponding to worst pain score, analgesics use, history of surgery, and number of sick leave days due to WRMDs). Respondents were informed to ignore any musculoskeletal disorders that were not work-related while completing in the questionnaire.
4. Evaluation of working ergonomics;
5. Opinion of the anesthesiologist about the quality of ergonomic conditions in the operating room.

The Standardized Nordic Musculoskeletal Questionnaire (NMQ) was used to identify musculoskeletal disorders in the neck and upper extremities, and upper and lower back and lower extremities, with questions about the presence of symptoms (ache, pain, discomfort and numbness) during the past 12 months and 7 days, functional limitations in work, housework or hobbies, and consultation need with a health professional due to these symptoms (15). The NMQ cannot be used for clinical diagnosis. The link to this survey is as follows: <https://goo.gl/forms/vGcu91NSZk3hFhb63>

### **Statistical methods**

Descriptive statistics were used to define respondent characteristics. The normality of the data distribution was checked using the Shapiro-Wilk test. The results for characteristics of participants are presented as frequencies and percentages for categorical variables. The differences between the subspecialties of the anesthesiologists were analyzed using the Chi-square test (Fisher's exact test was substituted for low-frequency events of 5 counts or less). All significant factors ( $p < 0.05$ ) identified using bivariate analysis were included in a binary logistic regression model. Binary logistic regression was used to determine predictors of 12-month WRMDs in each body part. The Hosmer-Lemeshow test was used to evaluate regression model goodness-of-fit. A p-value of less than 0.05 was

considered statistically significant. All statistical analyses were performed at 95% confidence intervals using IBM-SPSS version 23.0 (IBM Corp., Armonk, NY, USA).

## RESULTS

### Demographics and workload characteristics of the respondents

The overall response rate for the survey was 23%. A total of 123 anesthesiologists (60 men, 63 women) responded

to the survey. The mean age of the respondents was 43 (range, 30-67) years. There were 37 pediatric, 39 obstetric, and 47 cardiothoracic anesthesiologists. Most of the respondents were specialists (45.5%) and worked in university hospitals (45.5%). Of the anesthesiologists, 48.8% had an exercise habit and 57.7% described themselves as in fine health status. Table 1 shows the demographic information of the respondents. Table 2 lists the workload characteristics of the respondents.

**Table 1. Demographic information of anesthesiologists**

Variables	Pediatric anesthesiologist n= 37	Obstetric anesthesiologist n= 39	Cardiothoracic anesthesiologist n= 47	Total n= 123
Age (year)				
<40	10 (27.0)	20 (51.3)	16 (34.0)	46 (37.4)
40-50	17 (45.9)	13 (33.3)	23 (48.9)	53 (43.1)
>50	10 (27.0)	6 (15.4)	8 (17.0)	24 (19.5)
Gender				
Male	11 (29.7)	20 (51.3)	29 (61.7)	60 (48.8)
Female	26 (70.3)	19 (48.7)	18 (38.3)	63 (51.2)
Body Mass Index (BMI)	23.55 (19- 42)	24.34 (21- 36)	24.74 (20- 38)	24.22 (19- 42)
Normal (18.5-24.9)	21 (56.8)	21 (53.8)	23 (48.9)	65 (52.8)
Overweight (25-29.9)	10 (27.0)	15 (38.5)	19 (40.4)	44 (35.8)
Obese (>30)	6 (16.2)	3 (7.7)	5 (10.6)	14 (11.4)
Marital Status				
Single	5 (13.5)	3 (7.7)	7 (14.9)	15 (12.2)
Married	29 (78.4)	36 (92.3)	35 (74.5)	100 (81.3)
Divorced	3 (8.1)	-	5 (10.6)	8 (6.5)
Smoking habit				
Non-smoker	30 (81.1)	27 (69.2)	31 (66.0)	88 (71.5)
Current smoker	3 (8.1)	7 (17.9)	9 (19.1)	19 (15.4)
Past smoker	4 (10.8)	5 (12.8)	7 (14.9)	16 (13.0)
Alcohol habit				
Yes	5 (13.5)	17 (43.6)	17 (36.2)	39 (31.7)
No	32 (86.5)	22 (56.4)	30 (63.8)	84 (68.3)
Exercise habit				
Yes	21 (56.8)	18 (46.2)	21 (44.7)	60 (48.8)
No	16 (43.2)	21 (53.8)	26 (55.3)	63 (51.2)
Having chronic disease	8 (21.6)	7 (17.9)	14 (29.8)	29 (23.6)
General health status				
Good	14 (37.8)	17 (43.6)	13 (27.7)	44 (35.8)
Fine	21 (56.8)	19 (48.7)	31 (66.0)	71 (57.7)
Bad	2 (5.4)	3 (7.7)	3 (6.4)	8 (6.5)
Professional status				
Specialist	16 (43.2)	21 (53.8)	19 (40.4)	56 (45.5)
Assistant professor	8 (21.6)	8 (20.5)	11 (23.4)	27 (22.0)
Associate professor	6 (16.2)	6 (15.4)	11 (23.4)	23 (18.7)
Professor	7 (18.9)	4 (10.3)	6 (12.8)	17 (13.8)
Current working hospital				
University hospital	17 (45.9)	16 (41.0)	23 (48.9)	56 (45.5)
Public hospital	7 (18.9)	12 (30.8)	7 (14.9)	26 (21.1)
Women's and\ or children's hospital	2 (5.4)	4 (10.3)	8 (17.0)	14 (11.4)
Heart hospital \ institute	10 (27.0)	7 (17.9)	-	17 (13.8)
Private hospital	1 (2.7)	-	9 (19.1)	10 (8.1)

Data are presented as counts (% of respective group)

**Table 2. Workload-related data of anesthesiologists**

Variables	Pediatric anesthesiologist n= 37	Obstetric anesthesiologist n= 39	Cardiothoracic anesthesiologist n= 47	Total n= 123
Working experience (year)				
<10	11 (29.7)	24 (61.5)	16 (34.0)	51 (41.5)
11-15	13 (35.1)	5 (12.8)	11 (23.4)	29 (23.6)
≥16	13 (35.1)	10 (25.6)	20 (42.6)	43 (35.0)
Number of working hours (hour/week)				
<40	8 (21.6)	10 (25.6)	3 (6.4)	21 (17.1)
41-60	17 (45.9)	20 (51.3)	32 (68.1)	69 (56.1)
≥60	12 (32.4)	9 (23.1)	12 (25.5)	33 (26.8)
Number of anesthesia procedures per week				
<15	10 (27.0)	4 (10.3)	18 (38.3)	32 (26.0)
16-24	9 (24.3)	7 (17.9)	13 (27.7)	29 (23.6)
25-50	9 (24.3)	16 (41.0)	12 (25.5)	37 (30.1)
>50	9 (24.3)	12 (30.8)	4 (8.5)	25 (20.3)
Average time of anesthesia in a case (hour)				
<1	7 (18.9)	4 (10.3)	-	11 (8.9)
1-3	24 (64.9)	34 (87.2)	9 (19.1)	67 (54.5)
>3	6 (16.2)	1 (2.6)	38 (80.9)	45 (36.6)
Enough resting time between procedures				
yes	13 (35.1)	19 (48.7)	19 (40.4)	51 (41.5)
no	24 (64.9)	20 (51.3)	28 (59.6)	72 (58.5)
Number of anesthesia nurse in a case				
none	5 (13.5)	6 (15.4)	6 (12.8)	17 (13.8)
1	21 (56.8)	24 (61.5)	25 (53.2)	70 (56.9)
2	8 (21.6)	5 (12.8)	8 (17.0)	21 (17.1)
≥3	3 (8.1)	4 (10.3)	8 (17.0)	15 (12.2)
Number of night shifts per month				
none	8 (21.6)	10 (25.6)	12 (25.5)	30 (24.4)
1-4	24 (64.9)	22 (56.4)	23 (48.9)	69 (56.1)
≥5	5 (13.5)	7 (17.9)	12 (25.5)	24 (19.5)
Overtime work	26 (70.3)	22 (56.4)	30 (63.8)	78 (63.4)

Data are presented as counts (% of respective group)

### Prevalence rates of work-related musculoskeletal disorders

The third section of the survey identified the prevalence of musculoskeletal disorders in the nine different anatomic regions used in the NMQ. Women reported significantly more WRMDs as compared with men in the upper back and elbows ( $p=0.007$ ,  $p=0.002$  respectively). Years of experience was not related to WRMDs, with the exception of the knee. The prevalence of symptoms in the knee was significantly greater in the group of anesthesiologists with more than 16 years' experience (36.5%) ( $p=0.035$ ). Detailed prevalence and differences of WRMDs among the subspecialties are presented in Table 3. The most frequently reported problems among all the subspecialties were in the low back region (70.7%) in the previous 12 months. Cardiothoracic anesthesiologists were significantly more likely to have 12-month knee disorders than obstetric anesthesiologists were (66% vs. 33.3%;  $p=0.011$ ). Pediatric anesthesiologists reports shoulder (51.4%) and elbow (40.5%) region problems significantly more often than obstetric and cardiothoracic anesthesiologists elbow ( $p<0.05$ ). Cardiothoracic anesthesiologists reported low back area problems (66%) significantly more often than obstetric and pediatric anesthesiologists did ( $p<0.05$ ).

### Working Ergonomics in operating room

The overall prevalence rates of self-reported working ergonomics in the operating room are shown in Figure 1. The participants worked more often in a standing position rather than sitting (85.4% vs. 31.7%). Cardiothoracic anesthesiologists worked in a standing posture significantly more often than pediatric anesthesiologists did ( $p=0.013$ ). In addition, they stood on steps for long periods significantly more often than pediatric and obstetric anesthesiologists did ( $p<0.001$ ). There were statistically significant differences in terms of performing repetitive wrist flexion and extension movements and keeping the wrist twisted for extended periods between pediatric anesthesiologists and other subspecialties ( $p<0.05$ ). Only 30.9% of the respondents thought that they worked in an ergonomically furnished operating room.

### Having medical operation, analgesic use, and sick absenteeism

The pain intensity of the most affected body region was measured using a visual analogue scale (VAS; min = 0, max = 10). The median (min-max) value of VAS scores for each subspecialty was 6 (1-10). Analgesics were received by 68.3% of the respondents, 43.9% reported taking sick leave in the last year, and 13.8% had undergone surgery

related to their diagnosis of WRMDs. There were no significant differences between the subspecialties in terms of analgesic use, sick leave, and seeking surgery ( $p=0.416$ ,  $p=0.376$ , and  $p=0.404$ , respectively).

### Regression analysis of risk factors on work-related musculoskeletal disorders

Predictor variables and awkward postures of 12-month WRMDs in each body part are shown in Table 4. Women were more likely to develop WRMDs in the upper back (OR=2.465) than men. More than 3 hours of anesthesia time in a case was significantly associated with WRMDs in

the hips/thighs (OR=6.725). Bending for extended periods was the most significant predictor for all 3-body regions of musculoskeletal symptoms, with an OR of 4.210 for the neck, 4.619 for the upper back, and 4.750 for the low back. Repetitive wrist flexion and extension movements increased the risk for WRMDs of the wrists / hands (OR=4.605). The head remaining low for long periods frequently caused a greater chance of developing WRMDs of the elbow (OR=4.279). Lifting of heavy instruments was positively associated with WRMDs of the shoulder (OR=3.941).

**Table 3. Prevalence and prevalence difference of the WRMDs among subspecialty of anesthesiologists according to the Nordic Questionnaire**

	Subspecialty	Neck (%)	Shoulder (%)	Elbows (%)	Wrists\ hands (%)	Upper back (%)	Low back (%)	Hips\tighs (%)	Knees (%)	Ankles\feet (%)
WRMDs during the last 12 months	Pediatric	70.3	43.2	21.6	29.7	43.2	75.7	35.1	51.4	48.6
	Obstetric	48.7	43.6	12.8	23.1	38.5	61.5	25.6	33.3	35.9
	Cardiothoracic	59.6	34.0	19.1	25.5	40.4	74.5	25.5	66.0 <sup>1</sup>	48.9
	Total	59.3	39.8	17.9	26.0	40.7	70.7	28.5	51.2	44.7
		$p=0.161$	$p=0.587$	$p=0.582$	$p=0.800$	$p=0.913$	$p=0.309$	$p=0.560$	<b><math>^1p=0.011</math></b>	$p=0.407$
Region of the body being often complain about	Pediatric	54.1	51.4 <sup>2</sup>	40.5 <sup>2</sup>	24.3	27.0	40.5	29.7	43.2	32.4
	Obstetric	38.5	28.2	17.9	10.3	28.2	43.6	15.4	20.5	20.5
	Cardiothoracic	36.2	12.8	10.6	10.6	23.4	66.0 <sup>3</sup>	14.9	42.6	31.9
	Total	42.3	29.3	22.0	14.6	26.0	51.2	19.5	35.8	28.5
		$p=0.217$	<b><math>^1p=0.039</math></b>	<b><math>^1p=0.030</math></b>	$p=0.137$	$p=0.868$	<b><math>^1p=0.038</math></b>	$p=0.172$	$p=0.055$	$p=0.412$
			<b><math>^2p&lt;0.001</math></b>	<b><math>^2p=0.001</math></b>			<b><math>^3p=0.014</math></b>			
WRMDs preventing from normal activities (e.g. job, housework, hobbies) during the last 12 months	Pediatric	21.6	18.9	8.1	13.5	16.2	18.9	10.8	24.3	21.6
	Obstetric	10.3	17.9	2.6	12.8	5.1	30.8	7.7	12.8	12.8
	Cardiothoracic	21.3	4.3	2.1	10.6	4.3	38.3	6.4	21.3	10.6
	Total	17.9	13.0	4.1	12.2	8.1	30.1	8.1	19.5	14.6
		$p=0.332$	$p=0.076$	$p=0.328$	$p=0.914$	$p=0.098$	$p=0.157$	$p=0.757$	$p=0.417$	$p=0.341$
Visit a physician during the last 12 months	Pediatric	16.2	13.5	2.7	10.8	8.1	18.9	5.4	18.9	16.2
	Obstetric	7.7	12.8	5.1	7.7	12.8	20.5	10.3	15.4	12.8
	Cardiothoracic	17.0	6.4	4.3	8.5	8.5	25.5	8.5	19.1	4.3
	Total	13.8	10.6	4.1	8.9	9.8	22.0	8.1	17.9	10.6
		$p=0.404$	$p=0.492$	$p=0.864$	$p=0.885$	$p=0.736$	$p=0.742$	$p=0.736$	$p=0.885$	$p=0.179$
WRMDs during the last 7 days	Pediatric	35.1	16.2	5.4	18.9	21.6	35.1	10.8	27.0	13.5
	Obstetric	28.2	23.1	2.6	7.7	17.9	35.9	7.7	17.9	20.5
	Cardiothoracic	25.5	12.8	6.4	10.6	23.4	44.7	10.6	29.8	19.1
	Total	29.3	17.1	4.9	12.2	21.1	39.0	9.8	25.2	17.9
		$p=0.621$	$p=0.443$	$p=0.704$	$p=0.300$	$p=0.824$	$p=0.598$	$p=0.871$	$p=0.432$	$p=0.699$

WRMDs: Work-related musculoskeletal disorders; Data are expressed as "number of yes" (%)

Statistically significant difference between the subspecialty of anesthesiologists marked bold ( $p<0.05$ )

<sup>1</sup>Statistically different from Obstetric anesthesiologists

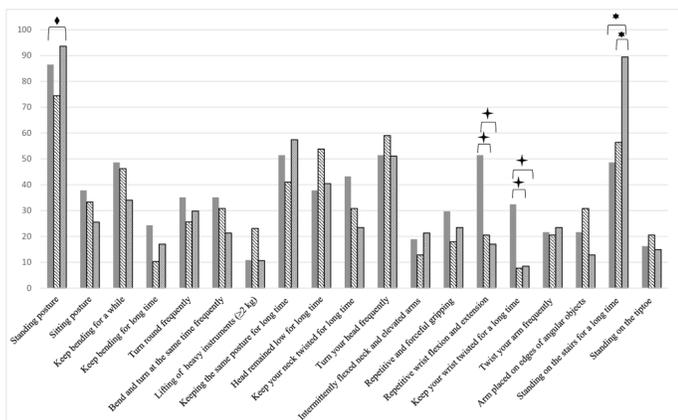
<sup>2</sup>Statistically different from Cardiothoracic anesthesiologists

<sup>3</sup>Statistically different from Pediatric anesthesiologists

**Table 4. Binary logistic regression of factors influencing WRMDs for anaesthesiologists**

	B	S.E	OR	95% CI	p
<b>Neck</b>					
Keep bending for long time (yes>no)	1.437	0.693	4.210	1.081- 16.391	0.038
The quality of ergonomic conditions in operating room (optimal>suboptimal)	-1.062	0.435	0.346	0.147- 0.812	0.015
<b>Shoulder</b>					
Lifting of heavy instruments ( $\geq 2$ kg) (yes>no)	1.372	0.593	3.941	1.233- 12.602	0.021
The quality of ergonomic conditions in operating room (optimal>suboptimal)	-0.903	0.452	0.405	0.167- 0.982	0.046
<b>Elbow</b>					
Head remained low for long time (yes>no)	1.454	0.580	4.279	1.372- 13.348	0.012
<b>Wrists\hands</b>					
Repetitive wrist flexion and extension (yes>no)	1.527	0.565	4.605	1.520- 13.949	0.007
<b>Upper back</b>					
Gender (female>male)	0.902	0.430	2.465	1.061- 5.729	0.036
Keep bending for long time (yes>no)	1.530	0.657	4.619	1.274-16.744	0.020
<b>Low back</b>					
Keep bending for long time (yes>no)	1.558	0.772	4.750	1.045-21.590	0.044
<b>Hips\thighs</b>					
Average time of anesthesia in a case (more than 3 hour> less than 1 hour)	1.906	0.811	6.725	1.371- 32.981	0.019
<b>Knee</b>					
Obstetric anesthesiologist (reference)			1.00		
Pediatric anesthesiologists	-1.566	0.703	0.209	0.053-0.828	0.026
Cardiothoracic anesthesiologists	-1.618	0.639	0.198	0.057-0.693	0.011
Sitting posture (yes>no)	-1.305	0.570	0.271	0.089- 0.829	0.022
<b>Ankles\feet</b>					
Enough resting time between procedures (yes>no)	-0.961	0.434	0.382	0.163- 0.895	0.027

CI: Confidence interval, OR: Odds ratio,  $p < 0.05$  was considered statistically significant



**Figure 1.** Prevalence of self-reported ergonomic hazards in operating room

## DISCUSSION

The increasing prevalence of WRMDs among at-risk physicians has been called 'an impending epidemic' and 'the tip of the iceberg' (16). Similarly, this cross-sectional worldwide study shows that pediatric, obstetric, and cardiothoracic anesthesiologists carry high risks for musculoskeletal disorders. The respondents reported different WRMDs because these subspecialties have different workload characteristics and working

ergonomics during anesthetic care in the operating room.

## Work-related musculoskeletal disease symptoms prevalence

The response rate (23%) in this survey is similar to other studies (17,18). Almost all (98.4%) respondents had experienced musculoskeletal symptoms in at least one body region attributed to the daily activities of their clinical practice during the past 12 months. Even though anesthesiologists with musculoskeletal problems might have felt more willing to answer, the prevalence rate of WRMDs among anesthesiologists was similar or exceeded the prevalence of WRMDs in sonographers in China (98.3%), otolaryngologists and head and neck surgeons in Canada (97%), general surgeons in Hong Kong (80%), and dentists in India (92%) (6,7,11,17). Anson et al. showed that anesthesia providers (anesthesiologists and nurse anesthetists) often reported low back pain, but no rate for anesthesiologists was reported (12). This was the first study to investigate all WRMDs in three different anesthesiology subspecialties.

Regarding the nine parts of the body, the mainly affected parts were the low back and neck for all subspecialties, followed by the shoulder for obstetric anesthesiologists, and knees for cardiothoracic and pediatric anesthesiologists in the past 12 months. Many studies have identified the most frequently affected anatomic parts due to occupations. The neck (82.9%) and low back (68.1%) region were the most reported body part for

general surgeons; neck (88.17%), lower back (86.02%), and wrist (54.8%) for dentists; neck (95.1%), shoulder (84.1%) and low back (82.4) for sonographers; and low back (65.7%), ankles, and feet (41.5%) for nurses (5,6,7,11). As a result, each healthcare worker may be predisposed to pain or injury in slightly different areas of the body, depending on their tasks and positioning in relation to the patient.

The mechanisms of WRMDs are defined as multifactorial and described with composite models. Individual factors related to sex and comorbidities, job design, workplace environment (psychosocial as well as physical), overwork, fatigue, and stress levels of employees are important factors attributed to the development of WRMDs (19). In our study, women significantly reported higher WRMDs in upper back and elbow disorders and had about two and a half risk to develop upper back WRMDs as compared with men. In a study among physical therapists, the prevalence of WRMDs after joining the physical therapy profession was found to be high in female professionals as compared to their male counterparts (10). It has been suggested that the perception of symptoms and coping strategies used in handling occupational stressors are different between women and men (20).

Prolonged working hours with inadequate rest breaks or working overtime leads to fatigue and reduced muscle recovery (13,19). The impact of working overtime on all types of musculoskeletal diseases was shown for nurses (21). In the present study, case times lasting more than 3 hours was a significant predictor of hip/thigh problems with an OR of 6.725. Bégin et al. found that working more than 16 hours per week in the outpatient clinic increased the risk of experiencing musculoskeletal symptoms in head and neck surgeons (17). Zhang et al. also found a significant relationship between scanning hours per day, days worked per week, and number of patients per day and WRMDs. In addition, they indicated that inadequate rest breaks could be considered as a risk factor for developing WRMDs (22).

In our study, having enough resting time between cases had a significant association with decreased odds of ankles/feet disorders. Unfortunately, more than half of the anesthesiologists reported working overtime and not having adequate resting time. A fatigued anesthesiologist may not be vigilant while monitoring patients, which may lead to misinterpreting parameters and making errors in medical judgment. The Association of Anesthetists of Great Britain & Ireland recommended regular rest breaks and exercise to avoid fatigue (23).

This survey demonstrated no significant difference was detected in WRMDs among anesthesiologists according to number of anesthesia nurse in the operating room. Working with a nurse anesthetist may facilitate the work of the anesthesiologist in the operating room but their job definitions are specific and they cannot take over or share workload due to the difference of duties and responsibilities.

### **Work ergonomics and musculoskeletal pain symptoms**

Anesthesiologists spend more time in the operating room. They have a wide variety of tasks including preoperative evaluation, consultation with the surgeons, specific anesthesia plan preparation, airway management, intraoperative life support, and postoperative pain management. Outside the operating room, anesthesiologists work with emergency cases, trauma, and intensive care units, and in pain clinics (24). Anesthesiologists usually work in prolonged sustained static and/or awkward postures with strong repetitive movements (long-duration mask ventilation, intubation, resuscitation, frequent spinal flexion activities) and heavy lifting when handling equipment.

Maintaining a balanced or neutral body posture is the first essential ergonomic principle in avoiding ergonomic problems (25,26). Sustaining awkward postures for the wrist, elbow, shoulder, neck, and low back puts more stress on the musculoskeletal system, and static load, which means working for long periods in a static position, causes the body to fatigue (27). In our study, we analyzed the prevalence of awkward postures of anesthesiologists and we confirmed that bending for long periods was the most significant predictor for WRMDs in the neck, and upper and low back. Similarly, having the head in a low position for extended periods increased the risk of elbow disorders. This is consistent with previous studies performed with surgeons and physical therapists (6,10).

The correlation between standing posture and musculoskeletal stress has been reported, and sitting was accepted as the optimum posture (22,28). An anesthesiologist can stand for a long time until the patient is stable or another qualified anesthesiologist replaces them. In this study, sitting reduced the risk of WRMDs of the knee. This finding is consistent with the findings of Zhang et al. who reported that adopting a sitting posture while performing scanning was associated with reduced rates of WRMDs, especially for the low back and the neck (22).

Our survey demonstrated that pediatric anesthesiologists (29.7%) reported wrist/hand WRMDs more often than the others did. A possible explanation for this disparity may be that pediatric anesthesiologists perform mask ventilation with their hands more often in an almost repetitive wrist flexion and extension, and keeping the wrist twisted for a long time, which can cause carpal tunnel syndrome and tendinitis (29). The regression analysis also confirmed the increased risk of wrist/hand disorders with repetitive wrist flexion and extension.

For the present study, 69.1% of the respondents evaluated the quality of ergonomic conditions in the operating room as suboptimal. In addition, WRMDs of the neck and shoulder were associated with poor ergonomics in the operating room. Although it seems difficult to provide a neutral posture for anesthesiologists while working, medical instruments can be assessed based on an ergonomic concept and differences in shape and details can be made.

Several adaptations have contributed to maintaining a neutral posture, such as monitor view instead of direct visualization, optimal monitor positioning for the physician, and redesigned instruments (30,31). There is growing recognition of the role of ergonomic design for equipment (tables, monitors, lighting, cables, and instruments) in the operating room for surgeons and anesthesiologists (26,30-32). Thus, maximum muscle performance with minimum load could be achieved. Kim et al. demonstrated that 3D-printed ergonomic support grips for a conventional Macintosh laryngoscope facilitated greater success with endotracheal intubation (27). Wireless monitoring units using Bluetooth could help reduce the number of cables attached to patients and thus improve anesthesia ergonomics and patient management (28). A number of studies have also given some basic ergonomic advice about ultrasound-guided femoral nerve block, spinal anesthesia, and operating table height for obtaining better laryngeal views during tracheal intubation (24,30-32).

There are some limitations regarding the present study. First, although the study was designed with unbiased sampling, the sample size of respondents may be too small to make the results of this study representative; therefore, the study needs to be repeated in all subspecialties of anesthesiologists, with a larger sample. Second, we have indicated many potential predisposing factors, but further studies are needed to show changes in WRMDs and working performance with changes in ergonomics over time. Third, the cross-sectional design of the study is one such limitation, as it fails to establish the effects of smoking status and exercise habit on musculoskeletal disorders.

## CONCLUSION

The study results confirmed our hypothesis that some demographics, workload characteristics, and working ergonomics related to WRMDs differently influenced each subspecialty of anesthesiologists. We hope that our study will pave the way for further studies to identify how ergonomics can be improved and change the physical environment in the operating room, and raise awareness of body positioning for anesthesiologists.

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