



Elaheh Kabir-Mokamelkha, Mashallah Aghilinejad, Naser Dehghan, Pardis Sanati, Mahin Hosseinejad

Work-related musculoskeletal disorders and ergonomic risk assessment among radiologists and gastroenterologists using the workplace ergonomic risk assessment method

Occupational Medicine Research Center, Department of Occupational Medicine, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

ABSTRACT

Background. Ergonomic risk factors in the workplace expose gastroenterologists and radiologists to Work-related Musculoskeletal Disorders (WRMSDs). This study aims to compare the frequency of musculoskeletal disorders and ergonomic risk factors in these two groups of physicians.

Materials and methods. This descriptive study was conducted on 360 physicians (radiologists and gastroenterologists) at the 5 University and teaching hospitals in Tehran. The prevalence of musculoskeletal symptoms was detected using the Nordic Musculoskeletal Questionnaire. The Workplace Ergonomic Risk Assessment (WERA) method was used to estimate and evaluate the ergonomic risk factors in each physician. Finally, the frequency of musculoskeletal disorders was compared between the two groups using statistical tests.

Results. The prevalence of shoulder (70% vs 36.66%; $OR=4.03$ (2.59–6.25); $p<0.001$) and hand pain (45% vs 30%; $OR=2.78$ (1.80–4.31); $p<0.001$) among radiologists was significantly higher than that among gastroenterologists. In contrast, gastroenterologists had a significantly higher prevalence of upper (65% vs 38.33%; $OR=2.98$ (1.94–4.58); $p<0.001$) and lower back pain (67.2% vs 49.44%; $OR=2.55$ (2.06–3.17); $p<0.001$) than radiologists. The mean WERA final score, the leg score, forceful score, contact stress, and task duration in radiologists were higher than that of gastroenterologists and the back score in gastroenterologists was higher than radiologists ($p<0.05$).

Limitations. In this study, the psychological factors affecting musculoskeletal disorders have not been investigated.

Conclusion. WRMSDs had a relatively high prevalence among radiologists (shoulder and hand pain) and gastroenterologists (upper and lower back). Due to the impact of ergonomic risk factors on these disorders in the workplace, ergonomic interventions should be implemented to reduce these risk factors in occupational settings.

Keywords: ergonomic; gastroenterologists; musculoskeletal disorders; radiologists

Compliance with ethical standards. The study protocol was reviewed and approved by ethical committee of the Iran University of Medical Sciences and Health Services (code: IR.IUMS.FMD.REC.1398.060.)

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For correspondence: Mahin Hosseinejad, Assistant professor, occupational medicine research center, Department of Occupational Medicine, School of Medicine, Iran University of Medical Sciences, Tehran, Iran. E-mail: hosseinejad.m@iums.ac.ir

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Кабир-Мокамельха Э., Агхилинеджад М., Дехгхан Н., Санати П., Хоссейнинеджад М.

Профессиональные заболевания опорно-двигательного аппарата и оценка эргономических рисков у рентгенологов и гастроэнтерологов с использованием метода оценки эргономических рисков на рабочем месте

Научно-исследовательский Центр медицины труда, отделение медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран

РЕЗЮМЕ

Введение. Факторы эргономических рисков на рабочем месте у гастроэнтерологов и радиологов создают угрозу заболеваний опорно-двигательного аппарата (ПЗОДА).

Цель исследования – сравнить заболеваемость с поражением опорно-двигательного аппарата и эргономические факторы риска у врачей этих специальностей.

Материалы и методы. В этом дескриптивном исследовании были обследованы 360 врачей (рентгенологов и гастроэнтерологов) в 5 университетских клиниках Тегерана. Частоту симптомов поражения опорно-двигательного аппарата определяли по Скандинавскому опроснику о состоянии опорно-двигательного аппарата. Метод оценки эргономического риска на рабочем месте (ОЭРПМ) использовали для определения и оценки эргономических факторов риска у каждого врача. На завершающем этапе распространённость поражений опорно-двигательного аппарата у врачей из двух групп сравнили с использованием статистических тестов.

Результаты. У радиологов частота болей в плечах (70 и 36,66%, ОШ = 4,03 (2,59–6,25), $p < 0,001$) и в руках (45 и 30%, ОШ = 2,78 (1,80–4,31), $p < 0,001$) было значительно выше, чем у гастроэнтерологов. Напротив, у гастроэнтерологов боль в верхних (65 и 38,33%, ОШ = 2,98 (1,94–4,58), $p < 0,001$) и нижних отделах позвоночника (67,2 и 49,44%, ОШ = 2,55 (2,06–3,17), $p < 0,001$) отмечалась значительно чаще, чем у радиологов. У радиологов средняя итоговая оценка ОЭРПМ, оценка состояния нижних конечностей, оценка энергетических затрат, стресс при контакте и продолжительность нагрузки были выше, чем у гастроэнтерологов, у последних оценка нагрузки на позвоночник была выше, чем у радиологов ($p < 0,05$).

Ограничение исследования. В этом исследовании психологические факторы, влияющие на состояние опорно-двигательного аппарата, не исследовались.

Заключение. У радиологов частота поражений опорно-двигательного аппарата (боль в плечах и руках) была выше, чем у гастроэнтерологов (верхний и нижний отделы позвоночника). С учётом влияния эргономических факторов риска на эти нарушения на рабочем месте представляется целесообразным разработать эргономические меры для снижения факторов риска профессиональной деятельности.

Ключевые слова: эргономика; гастроэнтерологи; нарушения опорно-двигательного аппарата; радиологи

Соблюдение этических стандартов. Протокол исследования был утверждён Этическим комитетом Иранского университета медицинских наук и здравоохранения (Код: IR.IUMS.FMD.REC.1398.060).

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Для корреспонденции: Махин Хоссейинеджад, доцент, Научно-исследовательский центр медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран. E-mail: hoseininejad.m@iums.ac.ir

Участие авторов: Кабир-Мокамелха Э. – концепция и дизайн исследования, анализ и интерпретация, написание и редактирование текста; Ахилинеджад М. – концепция и дизайн исследования, написание текста; Деххан Н. – сбор и обработка данных, написание текста; Санати П. – сбор и обработка данных, написание текста; Хоссейинеджад М. – анализ и интерпретация, написание и редактирование текста.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов в связи с публикацией данной статьи.

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Introduction

Work-related Musculoskeletal Disorders (WRMSDs) are common occupational health problems [1] and affect the health of workers, the health system, and bring economic and social costs [2].

Musculoskeletal disorders are multifactorial and except for socio-demographic factors (age, gender, Body Mass Index (BMI), physical activity, smoking/drinking, systemic illness), psychological factors, and ergonomic factors in the workplace, are also effective in causing them among workers all over the world [3–8].

WRMSDs have been reported by most healthcare providers such as ultra-sonographers, surgeons, interventional radiologists, and other physicians because their work activities put them at risk for conditions [9–13].

WRMSDs have a high prevalence among gastroenterologists compared to other physicians who do not perform the procedure. Several studies have reported the prevalence of these disease from 20% to 89% and the most disorders were seen in the thumbs, wrists, neck, and low back regions [14–20].

Except for gastroenterologists, other physicians such as sonographers are also at risk of work-related musculoskeletal injuries and disorders. Several studies have reported a high prevalence of WRMSDs among sonographers. In a study conducted in Canada and the USA, its prevalence reached up to 90% and ranged from 63–98% in a Europe study [19, 20].

Based on those as mentioned before, WRMSDs are very common among radiologists and gastroenterologist, but in most studies on the prevalence of MSDs, only one group of physicians has been evaluated and no comparison has been done between physicians in different wards. In addition, despite similar ergonomic risk factors such as over-use of some muscle groups, awkward posture, and repetitive motions, one of the differences between the working conditions of these two groups is that radiologists spend most of their working time in a sitting position, while gastroenterologists often perform procedures in a standing position [21, 22]. Hence, it is important to determine the prevalence of WRMSDs in these two groups in terms of ergonomic interventions to be made.

Therefore, due to the high prevalence of MSDs and the presence of similar ergonomic risk factors among radiologists and gastroenterologist, this study aimed to compare the prevalence of MSDs and ergonomic risk factors in these two groups of physicians to reduce these risk factors.

Material and Methods

This descriptive study was conducted on all radiologists and gastroenterologists at the 5 University and teaching hospitals in Tehran from March- December 2019. Inclusion criteria included: having at least one year of work experience without an extra job, no history of bone fracture, neurodegenerative disease, major surgery, rheumatic or specific musculoskeletal disorders, or renal or liver failure. Based on these criteria, out of 385 doctors working in these 5 hospitals, 180 gastroenterologists and 180 radiologists were included in the study. Written informed consent was obtained from each participant before study entry. The study protocol was reviewed and approved by the ethics committee (code: IR.IUMS.FMD.REC.1398.060). Participants information was obtained from interviews; the first part of the interview included general information such as age, gender, marital status, BMI, and history of underlying diseases.

The second part of the interview included occupational information such as job title (gastroenterologist or radiologist), work experience, daily and weekly working hours, and shift work status.

Tools. In this study, the prevalence of musculoskeletal symptoms was first examined using the Nordic questionnaire by an occupational medicine resident.

The Nordic Musculoskeletal Questionnaire (NMQ) was developed from a project funded by the Nordic Council of Ministers [23].

This questionnaire was designed to develop a standardized questionnaire methodology that allows comparison of the low back, neck, shoulder, and general complaints for use in epidemiological studies. The tool was not developed for clinical diagnosis. It can be used as a questionnaire or interview tool [23].

The NMQ has been used in several studies for evaluating musculoskeletal problems, including computer and call center workers [24], car drivers [25], coopers in the whisky industry [26], and forestry workers [27].

Previous studies reported that the NMQ is a sensitive, repeatable, and useful tool for screening and surveillance. To estimate and evaluate the ergonomic risk factors in each of these physicians, Workplace Ergonomic Risk Assessment (WERA) method was used. WERA is an observational tool developed to screen the working task quickly for exposure to physical risk factors associated with WRMSDs [28].

The WERA tool involves six physical risk factors: posture, repetition, forcefulness, vibration, contact stress, and task

Table 1 / Таблица 1

Comparison demographic characteristics among the radiologist and gastroenterologist**Сравнение демографических характеристик радиолога и гастроэнтеролога**

Demographic variables Демографические переменные	Gastroenterologists Гастроэнтеролог <i>n</i> = 180	Radiologist Радиолог <i>n</i> = 180	<i>p</i>
Age (year) / Возраст (лет), Mean ± SD	48.25 ± 6.80	49.00 ± 6.30	0.471
Work experience (year) / Трудовой стаж (лет), Mean ± SD	18.82 ± 6.50	22.50 ± 5.00	0.179
Body Mass Index (kg/m ²) / Индекс массы тела (кг/м ²), Mean ± SD	25.09 ± 2.63	23.20 ± 1.04	0.392
Daily work (hours) / Продолжительность рабочего дня (ч), Mean ± SD	7.18 ± 2.69	6.15 ± 3.20	0.388
Weekly work (hours) / Продолжительность рабочей недели (ч), Mean ± SD	41.62 ± 1.05	38.13 ± 2.65	0.193
Gender: / Пол:			
Male / Мужской, <i>n</i> (%)	130 (72.5)	126 (70)	0.467
Female / Женский, <i>n</i> (%)	50 (27.5)	54 (30)	0.467
Marital status: / Семейное положение:			
Single / Одинокий, <i>n</i> (%)	23 (12.5)	32 (17.5)	0.314
Married / В браке, <i>n</i> (%)	157 (87.5)	148 (82.5)	0.314
Smoking: / Курение:			
Smoker / Курящий, <i>n</i> (%)	16 (8.75)	9 (5)	0.376
Non smoker / Некурящий, <i>n</i> (%)	164 (91.25)	171 (95)	0.376

Note: SD – Standard Deviation.

Примечание. Mean ± SD – среднее ± стандартное отклонение.

duration. Additionally, this tool covers the five main body regions: the shoulder, wrist, back, neck, and leg. As stated by Rahman et al. [28], the WERA tool has a scoring system and activity levels that guide the level of risk and the need for action to conduct more detailed assessments. The tool is a reliable and valid method for examining ergonomic risk factors. The WERA tool can be used without special equipment in any workspace without disrupting the workforce [28].

Each of the doctors was observed by an ergonomist using the WERA tool during their work and procedures. In addition, their procedures were recorded using a camera, and then photographs were re-evaluated for ergonomic risk factors by same ergonomist.

Statistical analysis. The study data were analyzed by SPSS (Version 24). Data distribution was evaluated using Kolmogorov–Smirnov test, which indicated the normal distribution of the data ($p > 0.05$). Therefore, parametric tests were used for analysis. For quantitative data, the mean and standard deviation were used. For qualitative data, frequency and percentage were used. Independent sample *T*-tests and Chi-Square tests were used to analysis quantitative and qualitative data statistically. All statistical tests' results of less than 0.05 were considered meaningful.

Results

The study was performed on 360 specialist physicians (180 radiologists and 180 gastroenterologists). The mean age and work experience were 50.20 (±7.20) years with a range of 35 to 68 and 16.63 (±7.28) years with a range of 4 to 30 years, respectively. 256 (71.11 %) physicians were male, 305 (84.72%) of them were married, and the mean BMI of the participants was 25.5 (±2.34). The average working hours per day were 6.68 (±1.77) (range 4 to 13 hours), and the average working hours per week were 39.08 (±14.5) (range 20 to 90 hours). All participants had shift work. Table 1 shows a comparison of the demographic characteristics of physicians.

Comparison of musculoskeletal disorders in radiologists with gastroenterologists. The frequency of musculoskeletal disorders in radiologists and gastroenterologists is shown in Table 2. The prevalence of shoulder (70% vs 36.66%; OR=4.03 (2.59–6.25); $p < 0.001$) and hand pain (45% vs 30%; OR=2.78 (1.80–4.31);

$p < 0.001$) among radiologists was significantly higher than that among gastroenterologists. In contrast, gastroenterologists had a significantly higher prevalence of upper (65% vs 38.33%; OR=2.98 (1.94–4.58); $p < 0.001$) and lower back pain (67.2% vs 49.44%; OR=2.55 (2.06–3.17); $p < 0.001$) than radiologists. There was no significant difference between the prevalence of neck, elbow, hips/thigh, knee, and ankles/feet pain in the two groups ($p > 0.05$).

The mean final score obtained from the WERA tool and comparison of WERA scores in two groups by risk factor. The mean final score obtained from WERA was 40.35±2.44 in radiologists and 35.7±3.93 in gastroenterologists, which was statistically significant ($p < 0.001$). A comparison of WERA scores by risk factor is given in Table 3. The results of the WERA tool analysis showed that the leg score, forceful score, contact stress, and task duration in radiologists were higher than those in gastroenterologists. The back score of gastroenterologists was higher than that of radiologists, and these differences were statistically significant ($p < 0.05$).

The mean final score obtained from the WERA tool among participants in the study based on the pain location. The WERA final score was significantly higher in subjects with shoulder, wrist/hand, and upper back pain. However, in participants who had neck, elbow, lower back, hip/thigh, knee, and ankles/feet pain, there was no statistically significant difference with subjects who did not report these pains ($p > 0.05$) (Table 4). Therefore, further analyses were performed on hand, shoulder, and back pain.

Individual and occupational risk factors associated with shoulder, hand, and upper back pain: The comparison of age, work experience, height, weight, working hours per day, and working hours per week between participants with and without shoulder, hand, and upper back pain is shown in Table 5.

The average age and work experience were significantly higher in subjects with shoulder and hand pain than in those without pain ($p < 0.05$). The only risk factor for upper back pain was the WERA final score, and individual and occupational risk factors had no statistically significant relationship ($p > 0.05$) (Table 5).

Finally, we used logistic regression analysis to evaluate the effect of confounding factors on shoulder and hand pain. Multivariate logistic regression analysis revealed that the final

Table 2 / Таблица 2

Comparison of the frequency of musculoskeletal disorders among the participants in the study by Chi Square testСравнение частоты нарушений опорно-двигательного аппарата у обследованных участников по критерию χ^2

Musculoskeletal disorders Нарушения опорно-двигательного аппарата	Radiologist Радиолог <i>n</i> (%)	Gastroenterologists Гастроэнтерологи <i>n</i> (%)	<i>p</i>	OR (95% CI)
Neck pain / Боль в области шеи (<i>n</i> = 186)	96 (53.3)	90 (50)	0.263	(0.75–1.72) 1.14
Shoulders pain / Боль в области плеч (<i>n</i> = 192)	126 (70)	66 (36.66)	< 0.001	4.03 (2.59–6.25)
Elbows pain / Боль в локтях (<i>n</i> = 72)	34 (18.88)	40 (22.22)	0.217	0.81 (0.48–1.36)
Wrist/Hands pain / Боль в кистях/руках (<i>n</i> = 152)	98 (45)	54 (30)	< 0.001	2.78 (1.80–4.30)
Upper back pain / Боль в верхнем отделе позвоночника (<i>n</i> = 186)	69 (38.33)	117 (65)	< 0.001	2.98 (1.94–4.58)
Lower back pain / Боль в нижних отделах позвоночника (<i>n</i> = 210)	89 (49.44)	121 (67.2)	< 0.001	2.55 (2.06–3.17)
Hips/thighs pain / Боль в тазобедренном суставе/бёдрах (<i>n</i> = 30)	13 (7.2)	17 (9.44)	0.223	1.33 (0.63–2.84)
Knees pain / Боль в коленях (<i>n</i> = 72)	31 (17.22)	41 (22.77)	0.094	1.41 (0.84–2.38)
Ankles/feet pain / Боль в щиколотках/ступнях (<i>n</i> = 24)	< 10 (5.55)	14 (7.77)	0.192	1.45 (0.62–3.35)

Note: OR – Odds Ratio; CI – Confidence Interval.

Примечание. OR – отношение шансов; CI – доверительный интервал.

Table 3 / Таблица 3

Comparison of final score and risk factors by WERA by *T*-test, Mean \pm SDСравнение итоговой оценки факторов риска по ОЭРПМ с помощью *T*-теста, Mean \pm SD

Score Оценка	Radiologist / Радиолог	Gastroenterologists / Гастроэнтерологи	<i>p</i>
Total score / Полная оценка	40.35 \pm 2.44	35.7 \pm 3.93	< 0.001
Shoulder score / Оценка плеч	4.00 \pm 1.01	4.05 \pm 0.50	0.661
Wrist score / Оценка кистей	4.60 \pm 0.50	4.67 \pm 0.85	0.729
Back score / Оценка позвоночника	2.80 \pm 0.85	4.65 \pm 0.48	< 0.001
Neck score / Оценка шеи	4.35 \pm 0.48	4.70 \pm 0.51	0.152
Leg score / Оценка нижних конечностей	5.70 \pm 0.44	4.00 \pm 0.22	< 0.001
Forceful score / Оценка энергетических затрат	3.40 \pm 0.5	2.67 \pm 0.50	< 0.001
Vibration / Вибрация	4.00 \pm 0.01	3.97 \pm 0.15	0.428
Contact stress / Стресс при контакте	5.20 \pm 4.10	4.97 \pm 0.15	0.002
Task duration / Продолжительность нагрузки	4.00 \pm 0.00	3.60 \pm 0.42	0.002

Note: WERA – Workplace Ergonomic Risk Assessment; SD – Standard Deviation. Significance level is less than 0.05.

Примечание. Здесь и в табл. 4: ОЭРПМ – оценка эргономического риска на рабочем месте; SD – стандартное отклонение. Уровень значимости менее 0,05.

Table 4 / Таблица 4

Comparison of WERA final scores between study participants based on pain location by *T*-testСравнение итоговой оценки ОЭРПМ у обследованных по локализации боли с использованием *T*-теста

Pain location Локализация боли	WERA final score / Итоговая оценка ОЭРПМ Mean \pm SD		<i>p</i>
	Yes / Да	No / Нет	
Shoulder pain / Боль в плечах	3.90 \pm 39.71	3.40 \pm 37.99	0.041
Neck pain / Боль в области шеи	38.78 \pm 3.37	38.75 \pm 3.82	0.929
Elbows pain / Боль в локтях	38.85 \pm 3.54	38.33 \pm 3.70	0.632
Wrist/Hands pain / Боль в кистях/руках	40.25 \pm 3.27	37.51 \pm 3.33	0.002
Upper back pain / Боль в верхнем отделе позвоночника	39.57 \pm 3.72	37.60 \pm 3.43	0.032
Lower back pain / Боль в нижнем отделе позвоночника	38.74 \pm 3.82	37.10 \pm 2.84	0.848
Hips/thighs pain / Боль в тазобедренных суставах	40.00 \pm 2.88	38.58 \pm 3.50	0.233
Knees pain / Боль в коленях	40.30 \pm 2.90	38.35 \pm 3.60	0.087
Ankels/feet pain / Боль в щиколотках/ступнях	40.00 \pm 2.90	38.66 \pm 3.60	0.474

Table 5 / Таблица 5

Personal and occupational risk factors for shoulder, hand and back pain by T-test**Персональные и производственные факторы риска для боли в плечах, руках и позвоночнике**

Показатель Index	Shoulder Pain / Боль в плече			Hand pain / Боль в руке			Back pain / Боль в позвоночнике		
	Yes / Да	No / Нет	p	Yes / Да	No / Нет	p	Yes / Да	No / Нет	p
Age (years) / Возраст (лет)	47.4 ± 5.8	52.5 ± 7.4	0.005	47.1 ± 6.4	53.9 ± 6.3	< 0.001	47.9 ± 7.3	51.9 ± 6.7	0.188
Work experience (years) Трудовой стаж (лет)	13.8 ± 6.1	19.3 ± 7.7	0.007	13.1 ± 6.3	20.8 ± 6.5	< 0.001	15.6 ± 7.5	18.0 ± 7.2	0.265
Height (cm) / Длина тела (см)	173.8 ± 7.7	173.8 ± 7.7	0.821	173.9 ± 7.8	173.1 ± 6.6	0.683	172.9 ± 7.4	174.5 ± 7.0	0.477
Weight(kg) / Масса тела (кг)	75.0 ± 7.9	78.3 ± 11.4	0.349	76.7 ± 9.5	77.3 ± 10.4	0.867	77.8 ± 2.8	77.3 ± 1.8	0.916
Daily work hours Продолжительность рабочего дня	6.4 ± 1.1	6.9 ± 2.2	0.322	6.6 ± 1.8	6.9 ± 1.7	0.924	6.1 ± 1.7	6.6 ± 1.8	0.941
Weekly work hours Продолжительность рабочей недели	38.6 ± 11.1	39.5 ± 17.8	0.851	38.6 ± 2.1	39.6 ± 2.4	0.732	38.4 ± 5.3	39.9 ± 3.5	0.634

Note: Significance level is less than 0.05.

Примечание. Уровень значимости менее 0,05.

WERA score is an independent factor in causing shoulder pain (OR = 1.7; 95% CI: 1.6–1.9; $p=0.008$) and hand pain (OR=1.27; 95% CI: 1.04–1.54; $p=0.012$).

Discussion

This study was performed on 360 specialist physicians (180 radiologists and 180 gastroenterologists) and compared ergonomic risk factors and the prevalence of WRMSDs among radiologists with gastroenterologists. Our study showed that WRMSDs had a relatively high prevalence among radiologists and gastroenterologists. The Gastroenterologists had a significantly higher prevalence of upper and lower back pain than radiologists, and the prevalence of shoulder and hand pain among radiologists was significantly higher than among gastroenterologists. According to the participants' mean age (50 years) and work experience (16 years), the study population is middle-aged and experienced. Therefore, their occupational exposure to ergonomic risk factors is enough to confidently link musculoskeletal disorders to work. Ergonomic risk factors in the workplace, such as forced repetitive tasks, prolonged non-neutral postures, awkward posture, high pressure, and poor tool design, expose physicians to MSDs. In particular, procedural physicians and surgeons are at high risk for WRMSDs, which may be life-threatening and affect the quality and quantity of patient care [29]. Prolonged awkward postures, repetition, contact stress, and vibration as cumulative trauma are risk factors for WRMSDs [30]. Endoscopy and sonography procedures involve many of these risk factors, with some other specific ones. Vibrations, prolonged sitting and standing with few opportunities for rest, over-use of some muscle groups, excessive force, awkward posture, repetitive motions, and weight of equipment are ergonomic risk factors for the development of MSDs in these physicians [21, 22]. Specifically, gastroenterologists push, pull, and torque the insertion tube in awkward postures, with repeated pinching or gripping of the endoscope [31].

In our study, gastroenterologists had a significantly higher prevalence of upper and lower back pain than radiologists. In a study of endoscopists by Ridditid et al., upper and lower back pain was the most common musculoskeletal disorder [16]. Other studies among endoscopists have reported back pain as a common disorder [32]. In a study by Kuwabara T. in Japan, 190 endoscopists were studied, with the most common pain sites in the back, neck, right shoulder, and left thumb [33]. Based on previous studies, gender, seniority, awkward posture, and endoscopy- maneuvers such as torqueing during the endoscopy procedures, high procedure volume, and

prolonged duration of endoscopy, are known as risk factors for musculoskeletal disorders in endoscopists [14–18, 32–36]. Also, new diagnostic and therapeutic endoscopic procedures such as endoscopic submucosal dissection (ESD), enteroscopy, and endoscopic ultrasound (EUS), may prone endoscopists to a higher prevalence of MSDs than previously reported [16, 17, 37]. In this study, we found that specific ergonomic risk factors based on WERA significantly impact the prevalence of musculoskeletal symptoms. The WERA final score was significantly higher in subjects with shoulder, wrist/hand, and upper back pain and was an independent factor in causing shoulder and hand pain. The mean final score obtained from WERA was significantly higher in radiologists. In radiologists, poor and improper posture and position include wrist flexion and extension, twisting or extension of the neck, twisting and flexion of the trunk, reaching, and arm abduction [38]. The prevalence of shoulder and hand pain among radiologists was significantly higher than among gastroenterologists. In the study by Evance et al., the most common musculoskeletal disorder among sonographers was shoulder pain (90%), and more than half (54%) reported hand and wrist pain [39]. Also, a study by Al Mubarek et al. reported that the prevalence of shoulder and neck pain among sonographers was 65% and 57 % respectively [40]. The present study's findings are also consistent with the results of a study conducted by Peik et al. among ultrasound specialists, which reported a high prevalence of shoulder and neck pain [41].

A study by Village et al. found that sonographers spent 68% of their working time with an abducted arm more than 30° and 63% with shoulders rotated more than 30°, indicating that ultrasound specialists spend much time in a static and unsupported position, which is associated with pressure on the neck and upper limb muscles and associated symptoms [42].

However, some studies have shown that low back pain had a high prevalence among radiologists. In 2018, Parikh et al. [43] showed that approximately one-third of radiologists or radiation oncologists experienced lower back pain and Seidel and Krupinski [44] showed that more than fifty percent of all participating radiologists had neck or lower back pain at least once a week. The prolonged computer uses and long hours spent sitting at a computer workstation may be risk factors for low back pain in radiologists [45–48]. This is the first study to compare ergonomic risk factors and the prevalence of WRMSDs among sonographers and gastroenterologists. One of the strengths of the study was the use of the WERA method to evaluate ergonomic risk factors in the workplace by an ergonomist. However, despite these strengths, the present study has some limitations. First, this study was a

cross-sectional survey; therefore, causality could not be assessed directly. Second, the musculoskeletal symptoms were self-reported and it may also introduce bias such as those who experienced musculoskeletal symptoms were more likely to respond than those who did not. In addition, psychosocial factors were not included. So we recommend that cohort studies be performed to evaluate the study population over time and to examine other risk factors associated with musculoskeletal disorders.

Conclusion

WRMSDs had a relatively high prevalence among radiologists (shoulder and hand pain) and gastroenterologists (upper and lower back). Due to the impact of ergonomic risk factors on these disorders in the workplace, ergonomic interventions and increasing the awareness should be implemented to reduce these risk factors in occupational settings.

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Information about the authors:

Elaheh Kabir-Mokamelkhah, Associated professor, Occupational Medicine Research Center, Department of Occupational Medicine, School of Medicine, Iran University of Medical Sciences, Tehran, Iran. <https://orcid.org/0000-0002-2141-5841> Scopus Author ID: 56120964900 E-mail: kabir.e@iums.ac.ir

Mashallah Aghilinejad, professor, Occupational Medicine Research Center, Department of Occupational Medicine, School of Medicine, Iran University of Medical Sciences, Tehran, Iran. <https://orcid.org/0000-0003-4329-1541> E-mail: aghilinejad.m@iums.ac.ir

Naser Dehghan, PHD, Occupational Medicine Research Center, Iran University of Medical Sciences, Tehran, Iran. <https://orcid.org/0000-0002-1818-5360> Scopus Author ID: 55747756700 E-mail: dehghan.naser@gmail.com

Pardis Sanati, MD, Occupational Medicine Research Center, Department of Occupational Medicine, School of Medicine, Iran University of Medical Sciences, Tehran, Iran. <https://orcid.org/0009-0003-8352-0529> E-mail: dr.pardissanati@gmail.com

Mahin Hosseinejad, Assistant professor, occupational medicine research center, Department of Occupational Medicine, School of Medicine, Iran University of Medical Sciences, Tehran, Iran. <https://orcid.org/0000-0002-0443-4717> Scopus Author ID: 57211712285 E-mail: hoseinejad.m@iums.ac.ir

Сведения об авторах:

Кабир-Мокамельха Э., доцент, Научно-исследовательский центр медицины труда, отделение медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран. <https://orcid.org/0000-0002-2141-5841> Scopus Author ID: 56120964900. E-mail: kabir.e@iums.ac.ir

Агхилинеджад М., профессор, Научно-исследовательский центр медицины труда, отделение медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран. <https://orcid.org/0000-0003-4329-1541> E-mail: aghilinejad.m@iums.ac.ir

Дехгхан Н., канд. наук, Научно-исследовательский центр медицины труда, отделение медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран. <https://orcid.org/0000-0002-1818-5360> Scopus Author ID: 55747756700. E-mail: dehghan.naser@gmail.com

Санати П., Научно-исследовательский центр медицины труда, отделение медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран. <https://orcid.org/0009-0003-8352-0529> E-mail: dr.pardissanati@gmail.com

Хоссейнеджад М., доцент, Научно-исследовательский центр медицины труда, отделение медицины труда, медицинский факультет Иранского университета медицинских наук, Тегеран, Иран. <https://orcid.org/0000-0002-0443-4717> Scopus Author ID: 57211712285. E-mail: hoseinejad.m@iums.ac.ir