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Article

Prevalence of Musculoskeletal Disorders Among Perfusion Staff in Germany

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Abstract

Background: Musculoskeletal disorders (MSDs) are highly prevalent among healthcare workers, particularly in nursing staff, where reported prevalence rates range from 57% to 93%. Perfusionists are highly specialized healthcare professionals responsible for operating heart-lung machines during cardiac surgery. To date, the prevalence of MSDs in this professional group has not been systematically investigated. To address this gap, perfusionists in Germany were surveyed about MSDs. **Methods:** The German version of the Nordic Musculoskeletal Questionnaire (NMQ) was used. Pearson correlation and chi-squared tests were applied. **Results:** 287 perfusionists (72 female, 215 male; age 42.6 ± 11.9 years, professional experience 13.5 ± 10.9 years) from 45 German cardiac centers participated. 86% reported MSDs, with the lower back (65.5%) and neck (58.9%) being most frequently affected, with 4.5% to 36.6% in the other body regions. Increasing age was significantly associated with higher prevalence in six body regions, more professional experience was connected in five regions. Occupational risk factors previously identified in nursing were found to be applicable in perfusion. **Conclusion:** This study demonstrates a high prevalence of MSDs among perfusion staff in Germany. The findings underscore the need for preventive measures, coping strategies, and further research to reduce work related musculoskeletal strain in perfusion staff.

Keywords: musculoskeletal disorders; prevalence; perfusion; healthcare professionals; NMQ; survey; human factors in healthcare; occupational health; low back pain

1. Introduction

Musculoskeletal disorders (MSDs) are functional impairments of the musculoskeletal system that affect muscles, tendons, ligaments or nerves. They are often accompanied by pain or functional limitations and are considered one of the leading causes of work incapacity worldwide [1–3]. MSDs are highly prevalent in healthcare professions, particularly in nursing [4–7]. Previous review articles have reported prevalence rates in healthcare workers ranging from 57% to 93% annually. The most frequently affected body regions were the lower back (46% - 84%), neck (38% - 71%), shoulders (33% - 74%) and knees (20% - 61%) [5,7–10].

One occupational group in which MSD prevalence has not yet been investigated is perfusion staff. Perfusionists are highly specialized healthcare professionals who operate the heart lung machine (HLM) in the operating room (OR). The HLM is used to supply oxygen and nutrients to organs and tissues during cardiac and vascular surgeries. This machine fully replaces the heart and lung functions of a patient and is to be operated and monitored by perfusionists [11]. These professionals sit or stand in front of the machine for the entire duration of surgery, which may last several hours per workday. Further their job involves the set-up of single use components and moving the heavy HLM as well as working in forced postures. The long working hours and high workload in the healthcare sector also affect the personnel.

In general, some characteristics of a working environment are known to increase the risk for developing MSDs such as prolonged static positions, standing or sitting for long periods of time, working with a twisted or bent posture, moving heavy equipment and long, fluctuating work schedules [5,8,10,12–14]. It is assumed that those risk factors are present in the profession of perfusion.

As of early 2025, approximately 650 perfusionists were practicing in Germany [15,16], compared to about 5300 in Europe [17] and 5000 in the United States [18]. The already limited workforce, combined with the broader shortage of healthcare professionals, poses a significant risk to the healthcare sector and therefore to the general public. According to Turnage et al. (2017), perfusionists are particularly vulnerable to staffing shortages because replacing such highly specialized professionals is challenging [19]. Additionally, Lewis et al. (2016) indicate, that 39% of U.S. perfusionists are expected to leave the profession within a decade [20]. Retaining skilled personnel is therefore crucial.

Given that many established risk factors for MSDs are likely present in the perfusion workplace, the present study aims to investigate the prevalence of MSDs among perfusion staff in Germany and to examine associations with known occupational risk factors.

2. Materials and Methods

The study was composed as a multicenter, cross-sectional, observational analysis of all perfusionists employed in cardiac centers in Germany. The study protocol was approved by the ethics committee of FH Münster University of Applied Sciences.

All 78 centers listed by the German association of perfusion were invited to participate in the study [15]. The revised and validated German-language version of the Nordic Musculoskeletal Questionnaire (FB*MSB) was used [21–25]. The questionnaire records demographic data and the prevalence of MSDs in ten regions of the body. Questionnaires were distributed via the participating cardiac centers and completed individually by the perfusionists. All participants received written information about the study and data protection prior to participation. Written consent was given by all participants included in the study. Completed questionnaires were digitized and analyzed statistically (SPSS version 29.0.1). Continuous variables are shown as mean with 95% confidence interval as well as standard deviation and range. Categorical data are presented as frequencies and percentages. MSD prevalence was calculated for the entire study population and expressed as a percentage of the cohort for each of the ten body regions.

The metric variables of the demographics within the cohort were tested for correlation using the Pearson correlation test. For the analysis, three demographic factors were split into four groups each, based on preceding studies [12,14,25–28]. Those are age (≤ 35 , 36–45, 46–55, > 55 years), BMI (underweight, normal weight, overweight, obese), and years of experience (YoE) as perfusionist (≤ 5 , 6–10, 11–20, > 20 YoE).

The occurrence of MSDs among different groups within the cohort was analyzed using the chi squared test. Fisher's exact test was applied where cell counts were < 5 . The tests were carried out as paired crosstab tests where one group of interest was tested against the rest of the cohort. This was repeated for all subgroups of a characteristic, so that a total of four tests were performed per characteristic. To account for α -error inflation, p-values were adjusted using Bonferroni Holm correction [29]. In these tests, the ϕ -coefficient was calculated to indicate an association between the dichotomous variables. Significance level $\alpha < .05$ was chosen for all statistical analyses [30].

3. Results

A total of 45 cardiac centers in Germany participated in the study. From these, 287 questionnaires were included in the analysis, corresponding to a response rate of 58%. According to the German association of perfusion there are currently about 650 active perfusionists in Germany [15]. Thus, the sample represents 44% of the national perfusion workforce. Of the participants, 25.1%

(n = 72) were female and 74.9% (n = 215) were male. The mean age was 42.6 ± 11.9 years with an average professional experience as perfusionist of 13.5 ± 10.9 years. The mean BMI was 26.0 ± 3.7 kg/m2 (Table 1). With 89.5% (n = 257), the majority of participants reported being right-handed, while 5.6% (n = 16) identified as left-handed and 4.9% (n = 14) as ambidextrous.

Table 1. Demographic data of the participating perfusionists. CI: confidence interval; SD: standard deviation.

Variable	Mean [95% CI]	SD (range)
Age (years)	42.6 [41.3; 44.0]	11.9 (22-69)
BMI (kg/m²)	26.0 [25.6; 26.5]	3.7 (17.6-45.5)
Experience as perfusionist (years)	13.5 [12.2; 14.7]	10.9 (1-39)

A strong positive correlation was observed between age in years and years of professional experience ($p < .001$; $r = .868$). Age also presented a weak positive correlation with the BMI ($p = .038$; $r = .123$).

Overall, 86.4% of participants reported experiencing MSDs in at least one body region during the previous 12 months. The most frequently affected body region was the lower back with 65.5%, followed by the neck with 58.9%. More than a third of the respondents reported complaints in the upper back (36.6%), shoulder joints and upper arms (34.8%), and knees (31.7%). In the body regions of the hands and wrists as well as in the feet and ankles, the prevalence was 27.2%. The hip and thighs, elbows and forearms, and lower legs presented annual prevalence rates below 20% (Figure 1). Participants were categorized by age, BMI, and YoE in perfusion as shown in Table 2. The Table presents subgroup sizes and their proportions within the overall cohort.

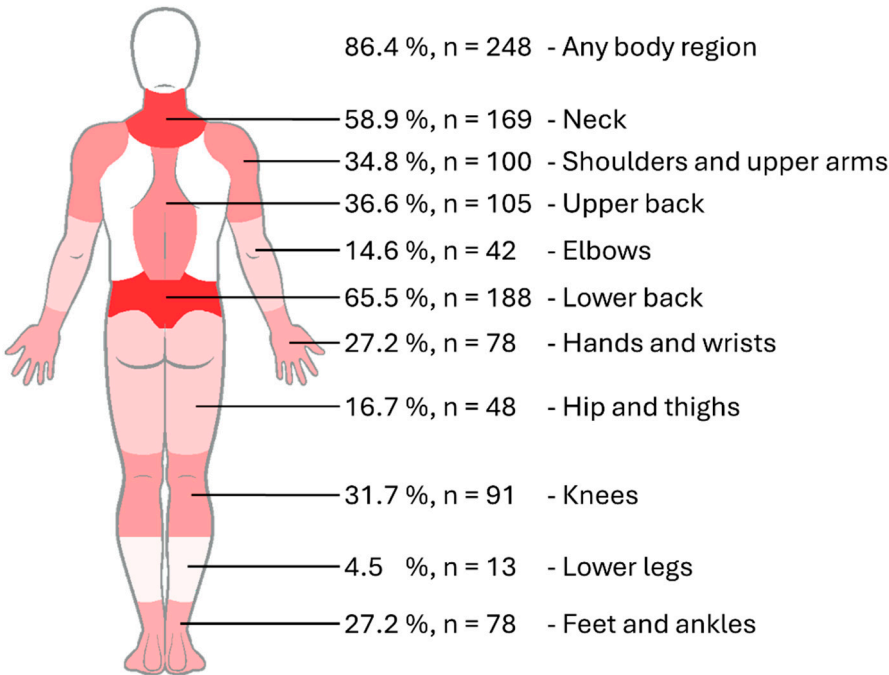


Figure 1. Annual prevalence of MSDs in German perfusionists across 10 body regions. Red shading illustrates prevalence proportionally as saturation intensifies with higher rates.

Table 2. Distribution of participants within subgroups by age, BMI, and years of experience (YoE) in perfusion, with number of participants and percentage relative to the total cohort.

Age groups	%	n	BMI groups	%	n	Experience groups	%	n
≤35 years	36.5	105	Underweight	0.7	2	≤5 YoE	35.5	102
36-45 years	23.7	68	Normal weight	43.9	126	6-10 YoE	16.7	48
46-55 years	18.5	53	Overweight	43.2	124	11-20 YoE	19.5	56
>55 years	21.3	61	Obese	12.2	35	>20 YoE	28.2	81

Utilizing the chi-squared test, significant subgroup differences in MSD prevalence were observed in seven of the ten body regions between the age, BMI and YoE groups. The significant results of these tests are displayed in Table 3. When there were no significant associations ($p > .05$) the according group is left out.

Table 3. Significant differences in MSD prevalence by group, associated body region, group-specific and rest of the cohort prevalences, p-values, and ϕ -coefficients.

Group (vs. rest)	Body Region	MSD Prev. (group vs. rest)	p	ϕ
Normal weight	Feet and ankles	20% vs. 33%	.039	-.146
Overweight	Feet and ankles	36% vs. 21%	.024	.163
YoE ≤ 5	Shoulder and upper arms	24% vs. 41%	.009	-.176
	Lower Back	55% vs. 71%	.02	-.166
	Knees	21% vs. 38%	.009	-.177
YoE > 20	Shoulder and upper arms	53% vs. 28%	.004	.24
	Hip and thighs	26% vs. 13%	.036	.155
	Knees	49% vs. 25%	.004	.238
	Feet and ankles	38% vs. 23%	.032	.156
Age ≤ 35	Shoulder and upper arms	24% vs. 41%	.009	-.176
	Lower Back	54% vs. 72%	.008	-.179
	Hip and thighs	9% vs. 21%	.015	-.166
	Knees	14% vs. 42%	.004	-.284
Age > 55	Neck	75% vs. 54%	.012	.174
	Shoulder and upper arms	54% vs. 30%	.004	.21
	Hands and wrists	46% vs. 22%	.004	.219
	Lower Back	79% vs. 62%	.045	.144
	Hip and thighs	33% vs. 12%	.005	.224
	Knees	49% vs. 27%	.004	.195

Regarding BMI, differences were only observed in the feet and ankles, where overweight participants reported a higher prevalence, while normal weight participants reported a lower prevalence. Professional experience of more than 20 YoE was associated with increased MSD prevalence in four body regions. Two of these regions, as well as the lower back revealed significantly fewer MSDs in perfusionists with less professional experience (≤5 YoE). Older perfusionists (>55 years) consistently reported higher rates of MSDs and presented significantly more MSDs in six body regions. Four of these regions also presented significantly lower rates of MSDs in younger participants (≤35 years). No significant associations were found in the body regions of elbows and forearms, upper back and lower legs.

4. Discussion

This nationwide cross-sectional study revealed a high prevalence of MSDs in perfusionists in Germany, with 86% of participants reporting symptoms in a least one body region. This is comparable to prevalence rates in other health professions. Comprehensive review articles on the topic reported rates ranging from 57% to 93% [5,8–10]. It can be assumed that perfusion staff are at a similar risk in developing work-related MSDs.

Age has previously been assessed as a non-modifiable risk factor for developing MSDs [31]. It can therefore be assumed that the prevalence rates correlate with age, even without occupational overexposure. However, higher age has proven to be a risk factor for developing MSDs in the regions of neck, shoulder, lower back and knees [9,10,27,32,33]. In this study, age emerged as the most consistent factor associated with MSDs. Perfusionists at age >55 years showed significantly more MSDs ($p < .05$) in neck, shoulder, hands and wrists, lower back, hip and thighs as well as knees. In those body regions the age group reported about 20% more MSDs than the rest of the cohort. It is consequently believed that age is a present risk factor in perfusion and must be dealt with accordingly. Additionally, YoE and age are highly correlated, making it difficult to distinguish MSD causes. Therefore, contributing risk factors identified in healthcare workers are extrapolated to perfusion staff where applicable, with age considered as an independent factor.

The highest MSD prevalence was reported in the **lower back** (65.5%). It can plausibly be explained by known risk factors such as prolonged static postures, non-neutral trunk positions, and handling of heavy or specialized equipment [5,8,9,25,26,32–35]. These exposures are present on a daily basis in perfusion when preparing and operating the HLM and could lead to MSD symptoms over the course of a career. Complaints were significantly less common among participants with ≤ 5 YoE, suggesting that lower back MSDs develop after the first years in perfusion when exposed to risk factors for some time. A connection between professional experience and MSDs has previously been proven, especially with a sharp increase within the first years of employment [10,12,34,36].

The **neck** presented a high prevalence rate (58.9%). This could be attributed to proven risk factors like frequent neck twisting, repetitive movements and static positions [5,8–10]. Although prevalence was highest among older participants, the considerable prevalence observed in younger perfusionists suggests systematic occupational hazards. Those could include monitoring screens in unfavorable OR-layouts and adjusting equipment.

Shoulders and upper arms MSDs (34.8%) were significantly associated with increasing age and YoE. The highest subgroup prevalence rate was observed in participants with >20 YoE (53%). Commonly described risk factors for shoulder discomfort are repetitive use of the upper extremities, working with raised arms, and handling tools [5,8,9,25,32]. Since these characteristics are present in perfusion, cumulative exposure is a plausible explanation.

Complaints in the **knees** (31.7%) were significantly associated with higher age and increased YoE. Identified risk factors for knee pain were standing for long periods of time, retention of static positions, increasing YoE and age [8,9,27,32]. Since the perfusion occupation can require long times of standing in the OR, a systematic endangerment could be a strong possibility.

Hand and wrist complaints (27.2%) showed a significant connection to higher age. Although our study did not identify other risk factors, preceding studies on haemodialysis nurses proved a higher risk when assembling and dismantling single-use components on a daily basis [37,38]. Since the setup and clearing of the HLM is a key element of the daily tasks of perfusionists, systematic endangerment cannot be ruled out.

In the region of **feet and ankle** (27.2%) overweight participants presented a significantly higher prevalence, indicating weight bearing stress as the main contributor [9]. Also associated was higher professional experience, pointing towards prolonged standing over the course of a career as possible risk factor [8,9].

Hip and thigh (16.7%) discomfort was associated with increasing age and higher YoE. Prolonged standing is linked to MSDs [5,25], however age correlates with reduced flexibility and

MSDs [10,25,27]. The low prevalence among younger participants suggests that risk factors are more age-related than occupation-specific, rendering targeted interventions a low priority.

The **upper back** (36.6%) prevalence was higher than most of the body regions but lacks statistical significance and is not well reported in the literature. Prevalence in the **elbows** (14.6%) and **lower legs** (4.5%) was comparatively low and showed no significant subgroup associations. While these regions may be less systematically affected, they warrant continued observation in future research.

Limitations

The use of a self-administered questionnaire may have introduced recall bias, as participants reported MSDs over the past 12 months. Self-assessment could also lead to over- or underestimation of prevalence. These limitations were accepted to utilize the validated and widely used NMQ questionnaire. Additionally, the study design did not link participants to specific cardiac centers or collect data on workplace conditions, such as tasks, equipment, or schedules. MSD intensity and duration were also not recorded, limiting severity assessment. As the first nationwide survey on MSD prevalence among perfusionists, comparisons with prior research were difficult. Future studies should therefore incorporate ergonomic workplace assessments, direct observations, and movement analyses to identify causal risk factors and guide the development of targeted interventions.

5. Conclusions

This nationwide study revealed a high prevalence of MSDs among perfusionists in Germany, with 86% reporting symptoms in at least one body region within the last 12 months. Age and years of professional experience were identified as risk factors. Occupational risk factors previously described in other healthcare professions, such as prolonged static postures, non-neutral working positions and equipment handling are also likely relevant in developing MSDs in perfusionists. The lower back and neck affected more than half of the participants and were associated with the aforementioned risks, underscoring the need for preventive measures, ergonomic interventions and task-specific assessments. Body regions with moderate and low prevalence rates (shoulders, upper back, hands, knees, hips, and ankles) warrant further investigation, as occupational overexposure cannot be ruled out. In times of workforce shortages in healthcare, maintaining the health of perfusionists is essential to retain experienced staff and ensure long-term sustainability of this highly specialized profession.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

MSD	Musculoskeletal disorder
NMQ	Nordic Musculoskeletal Questionnaire
HLM	Heart-lung machine
OR	Operating room
FB*MSB	Fragebogen zu Muskel-Skelett-Beschwerden
YoE	Years of experience
BMI	Body-mass-index
CI	Confidence interval
SD	Standard deviation

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