

Preplanned Studies

Comparison of Work-related Musculoskeletal Disorders Between Flight Attendants and National Occupational Populations — China, 2018–2023

Tiebing Liu^{1,✉}; Xi Zhang^{1,✉}; Yiwei Song²; Xin Sun²; Zhongxu Wang²; Meibian Zhang²; Yanmin Qi¹; Qing Xu²; Mimi Yang²; Xinwei Guo²; Bing Qiu^{1,3,#}; Ning Jia^{2,#}

Summary

What is already known about this topic?

The risk of work-related musculoskeletal disorders (WMSDs) differs by industry. Flight attendants in China show a high prevalence of upper-limb WMSDs.

What is added by this report?

Compared with the National Occupational Group and Comparable Industry Subgroup, flight attendants had a higher prevalence of neck, shoulder, and lower back WMSDs. After adjustment for demographic, ergonomic, and work-organization factors using generalized linear mixed models, flight attendant occupation was not significantly associated with WMSDs compared with the Comparable Industry Subgroup (adjusted odds ratio=0.76, 95% confidence interval: 0.43, 1.34).

What are the implications for public health practice?

Prevention efforts can target modifiable ergonomic and work-organization factors, including cabin ergonomics, staffing, rest opportunities, and autonomy over work breaks.

mixed models were used.

Results: The prevalence of WMSDs (51.01%, 684/1,341) in flight attendants was higher than that in the National Occupational Group (37.31%, 32,563/87,268) and Comparable Industry Subgroup (45.46%, 7,376/16,224) ($P<0.001$), particularly in the neck, shoulders, and lower back. After adjustment for demographic, ergonomic, and work-organization factors, flight attendant occupation was not significantly associated with WMSDs compared with the Comparable Industry Subgroup. Working in uncomfortable postures, repetitive trunk movements, prolonged fixed-neck or bent-head postures, and working >8 h/day were associated with higher odds of developing WMSDs, whereas sufficient rest time and male sex were associated with lower odds.

Conclusion: Prevention efforts against WMSDs among flight attendants should consider improvements to cabin ergonomics, work scheduling, rest opportunities, and autonomy during work breaks.

ABSTRACT

Introduction: This study compared the prevalence of work-related musculoskeletal disorders (WMSDs) between civil aviation flight attendants and the national occupational population in China.

Methods: Data were obtained from a national cross-sectional survey conducted from 2018 to 2023, including 88,609 workers from 29 industries. Overall, 1,341 flight attendants were compared with the National Occupational Group ($n=87,268$) and a Comparable Industry Subgroup ($n=16,224$) selected from industries with >50% female workers and light-to-moderate physical workloads. Chi-square tests, multivariate logistic regression, and generalized linear

Work-related musculoskeletal disorders (WMSDs) are closely associated with adverse ergonomic exposures and represent a major global occupational health concern linked to substantial productivity loss, absenteeism, and increased workplace costs (1). The 2025 update of the Classification and Catalog of Occupational Diseases of China includes WMSDs as a new major category, thereby underscoring their significance. National occupational health surveillance data have identified civil aviation flight attendants as a high-risk group for WMSDs, with the age-standardized prevalence of upper extremity WMSDs in this population reaching 32.5%, ranking third among 21 major industries (2). Previous studies have reported high levels of WMSDs or musculoskeletal symptoms among aviation-related personnel, including female

Chinese flight attendants, long-haul international flight attendants, and flight security personnel (3–5).

Despite growing evidence of a higher WMSDs burden among flight attendants, research gaps remain. National occupational health surveys have historically focused on traditional manufacturing and heavy industries, leaving WMSDs in the aviation sector less thoroughly investigated (2). It remains unclear whether the increased prevalence among flight attendants is closely related to distinctive occupational exposures or broader demographic and socioeconomic characteristics. Therefore, direct comparison with national occupational populations, including similar industries, is needed to identify industry-specific factors associated with WMSDs and inform tailored preventive strategies.

Data were obtained from the National Occupational Epidemiological Survey, a national cross-sectional study conducted in China between 2018 and 2023 (6). The survey included 88,609 active employees from 29 key industries across seven major geographic regions and nine national economic sectors: agriculture, mining, manufacturing, utilities, construction, trade, transportation, residential services, and health and social work. A stratified cluster sampling design was used to enhance representativeness. Industries were stratified according to their relevance to WMSDs, occupational population size, and national economic importance following the national occupational health monitoring framework. Representative enterprises were selected within each stratum and categorized as large (16.33%, 72/441), medium (10.88%, 48/441), small (41.27%, 182/441), or micro (31.52%, 139/441) enterprises. All on-duty workers at the selected enterprises were invited to participate.

Participants were eligible if they were aged ≥ 18 years and had worked in their current position for at least one year; those with congenital spinal deformities, a history of trauma, or non-occupational musculoskeletal disorders were excluded. Data were collected using a quality-controlled electronic questionnaire. Of the 91,560 respondents, 88,609 provided valid responses, with a response rate of 96.8%.

Furthermore, 1,341 civil aviation flight attendants were included in the study group, and the remaining 87,268 workers in other occupations were assigned to the National Occupational Group. An additional Comparable Industry Subgroup was constructed to improve comparability by selecting industries with a female workforce proportion of $>50\%$ and a light-to-moderate physical workload (Figure 1). This subgroup

included 16,224 participants from packaging and other printing services, healthcare, footwear manufacturing, toy manufacturing, and pharmaceutical manufacturing industries.

Following the guidelines of the National Institute for Occupational Safety and Health (NIOSH), WMSDs were defined as the presence of discomfort (e.g., pain, stiffness, burning, numbness, or tingling) that met the following criteria: occurrence within the past year, onset after starting the current job, no history of accidents or acute injuries affecting the specific site, and monthly frequency or duration exceeding one week. The anatomical regions were categorized as the neck, lower limbs (the hips, knees, and ankles), upper limbs (the shoulders, elbows, and wrists), and trunk (upper and lower back).

Statistical analyses were performed using SPSS (version 26.0, Armonk, NY, USA). Between-group comparisons of categorical variables were conducted using the chi-square or Fisher's exact tests, as appropriate. Variables that were significant in the univariate analyses ($P < 0.05$) were included in the multivariate logistic regression models. Generalized linear mixed models with a binomial distribution, logit link, and random intercepts for province-industry-workplace combinations were used to account for

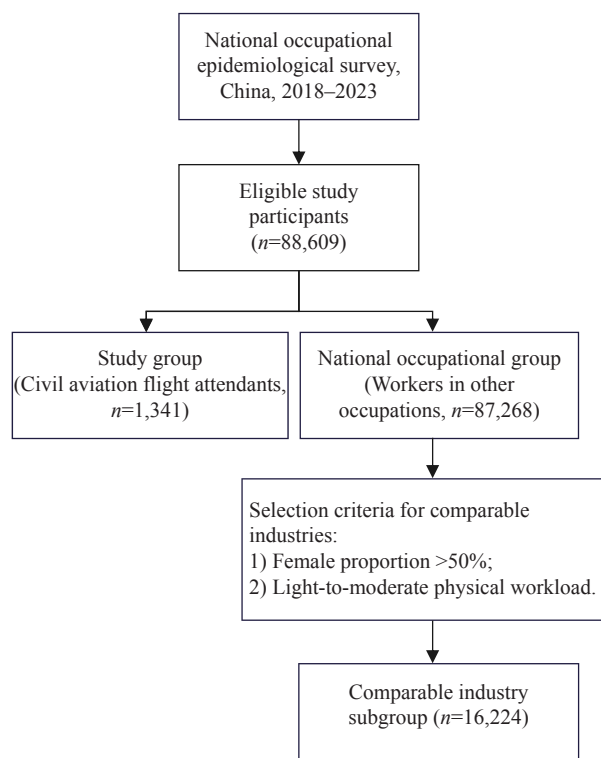


FIGURE 1. Flowchart of study population selection and group classification.

clustering. Results are reported as adjusted odds ratios (aORs) and 95% confidence intervals (CIs), with two-tailed $P < 0.05$ considered statistically significant.

The overall prevalence of WMSDs was 51.01% (684/1,341, standardized: 51.47%) among flight attendants, higher than 37.31% (32,563/87,268, standardized: 36.66%) in the National Occupational Group and 45.46% (7,376/16,224, standardized: 44.57%) in the Comparable Industry Subgroup (all $P < 0.001$) in Figure 2 and Supplementary Table S1 (available at <https://weekly.chinacdc.cn/>). Flight attendants also had a significantly higher prevalence of neck, shoulder, and lower back WMSDs than both reference groups (all $P < 0.05$). The demographic and key occupational characteristics of the three groups are listed in Table 1, and detailed work posture profiles are listed in Supplementary Table S2 (available at <https://weekly.chinacdc.cn/>).

Generalized linear mixed models were used to identify the factors associated with WMSDs in any body region among flight attendants and workers in a Comparable Industry Subgroup (Figure 3). After adjustment for demographic, ergonomic, and work-organization factors and clustering by province-industry-workplace, being a flight attendant was not

significantly associated with WMSDs compared with being in the Comparable Industry Subgroup (aOR=0.76, 95% CI: 0.43, 1.34). In the combined study population, working in uncomfortable postures was associated with higher odds of WMSDs, with aORs of 1.73, 2.31, and 2.10 for sometimes, often, and very frequently, respectively. Other associated factors included repetitive truncal movements (aOR=1.24), prolonged fixed-neck posture (aOR=1.23), prolonged bent-head posture (aOR=1.18), and working >8 h/day (aOR=1.15). Sufficient rest time and male sex were associated with lower odds of developing WMSDs (aOR=0.72 for both). Stratified analyses by sex, rest time, and daily working hours showed generally consistent patterns, and no significant interaction was observed between occupation group and working in uncomfortable postures ($P > 0.05$).

Region-specific multivariate logistic regression analyses restricted to flight attendants showed that female sex, working in uncomfortable postures, and working >8 h/day were associated with higher odds of developing WMSDs across anatomical regions. Sufficient rest was associated with lower odds of WMSDs in the neck, trunk, and any-region models. Understaffing was associated with higher odds of neck

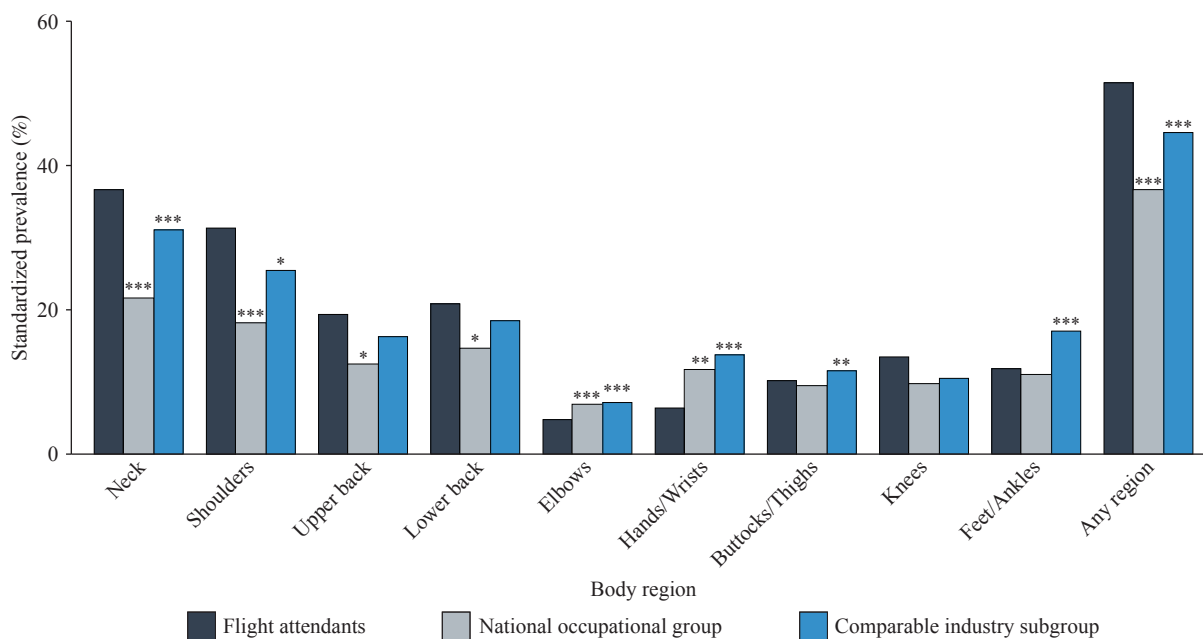


FIGURE 2. Standardized prevalence of work-related musculoskeletal disorders (WMSDs) by body region among flight attendants and comparison groups.

Note: Bars show the standardized prevalence of WMSDs by body region among flight attendants, the National Occupational Group, and the Comparable Industry Subgroup. The standardized prevalence was calculated based on the age distribution of the 18–60-year-old population in China's seventh national population census. Statistical significance was determined by comparison with the flight attendant group as the reference.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ compared with the flight attendant group (reference).

TABLE 1. Demographic characteristics and key occupational factors among flight attendants and comparison groups, China, 2018–2023.

Variable	Flight attendants (n=1,341) (%)	National occupational group (n=87,268) (%)	Comparable industry subgroup (n=16,224) (%)
Sex			
Men	295 (22.00)	59,694 (68.40)***	3,964 (24.43)*
Women	1,046 (78.00)	27,574 (31.60)	12,260 (75.57)
Age group (years)			
<25	335 (24.98)	14,014 (16.06)***	4,918 (30.31)***
25–34	837 (62.42)	33,499 (38.39)	3,214 (19.81)
35–44	120 (8.95)	22,052 (25.27)	4,973 (30.65)
≥45	49 (3.65)	17,703 (20.29)	3,119 (19.22)
Service duration (years)			
<5	684 (51.01)	43,780 (50.17)***	6,781 (41.80)***
5–9	372 (27.74)	20,336 (23.30)	4,629 (28.53)
10–14	186 (13.87)	13,177 (15.10)	2,684 (16.54)
≥15	99 (7.38)	9,975 (11.43)	2,130 (13.13)
Prolonged standing at work			
Rarely/never	47 (3.50)	14,275 (16.36)***	3,868 (23.84)***
Sometimes	206 (15.36)	20,487 (23.48)	4,923 (30.34)
Often	572 (42.65)	28,593 (32.76)	4,441 (27.37)
Very frequently	516 (38.48)	23,913 (27.40)	2,992 (18.44)
Prolonged squatting/kneeling at work			
Rarely/never	311 (23.19)	53,205 (60.97)***	11,017 (67.91)***
Sometimes	477 (35.57)	23,968 (27.46)	4,036 (24.88)
Often	348 (25.95)	6,828 (7.82)	831 (5.12)
Very frequently	205 (15.29)	3,267 (3.74)	340 (2.10)
Carrying objects >5 kg at work			
Rarely/never	128 (9.55)	32,042 (36.72)***	7,699 (47.45)***
Sometimes	462 (34.45)	31,456 (36.05)	5,995 (36.95)
Often	471 (35.12)	15,745 (18.04)	1,787 (11.01)
Very frequently	280 (20.88)	8,025 (9.20)	743 (4.58)
Working in uncomfortable postures			
Rarely/never	258 (19.24)	41,803 (47.90)***	7,984 (49.21)***
Sometimes	581 (43.33)	31,626 (36.24)	5,538 (34.13)
Often	329 (24.53)	9,135 (10.47)	1,873 (11.54)
Very frequently	173 (12.90)	4,704 (5.39)	829 (5.11)
Sufficient rest time			
Yes	369 (27.52)	44,858 (51.40)***	7,408 (45.66)***
No	972 (72.48)	42,410 (48.60)	8,816 (54.34)
Autonomy over work breaks			
Yes	61 (4.55)	19,335 (22.16)***	2,616 (16.12)***
No	1,280 (95.45)	67,933 (77.84)	13,608 (83.88)
Department understaffing			
Yes	734 (54.74)	37,872 (43.40)***	8,557 (52.74)
No	607 (45.26)	49,396 (56.60)	7,667 (47.26)

Abbreviation: WMSDs=work-related musculoskeletal disorders.

* $P<0.05$, *** $P<0.001$ compared with the flight attendant group (reference).

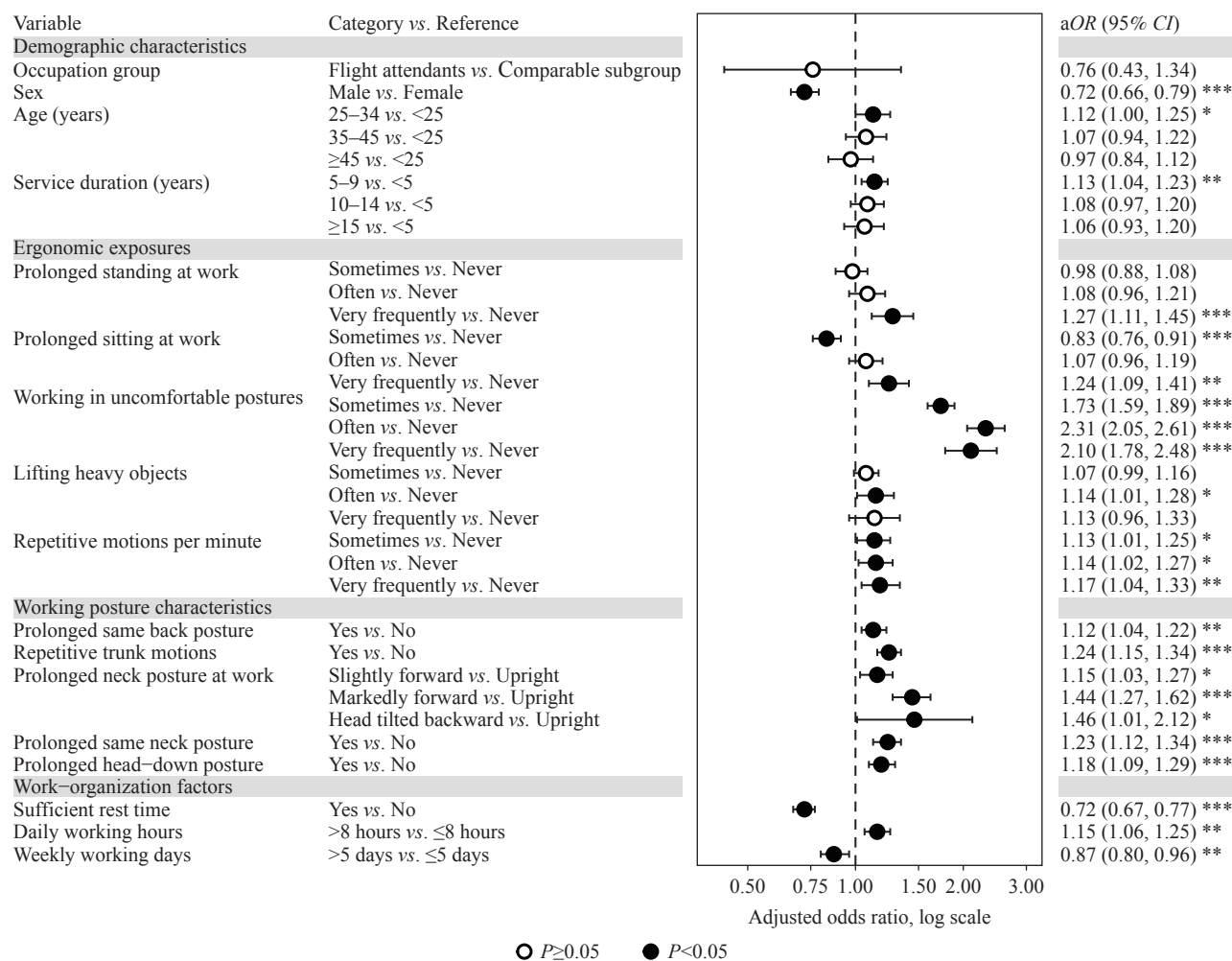


FIGURE 3. Adjusted odds ratios for factors associated with work-related musculoskeletal disorders (WMSDs) in the generalized linear mixed model.

Note: The forest plot shows the adjusted odds ratios (aORs) and 95% confidence intervals (CIs) for factors associated with WMSDs in any body region among flight attendants and workers in the Comparable Industry Subgroup. The generalized linear mixed model included fixed effects for demographic characteristics, ergonomic exposures, and work-organization factors, with a random intercept specified for the combination of province, industry, and workplace. The dashed vertical line indicates an aOR of 1.0.

and upper limb WMSDs, whereas autonomy over work breaks was associated with lower odds. The detailed region-specific results are listed in [Supplementary Table S3](https://weekly.chinacdc.cn/) (available at <https://weekly.chinacdc.cn/>).

DISCUSSION

This study found that civil aviation flight attendants had a prevalence of WMSDs, particularly in the neck, shoulders, and lower back, higher than that in both the National Occupational Group and the Comparable Industry Subgroup. Conversely, elbow and hand/wrist WMSDs were less common among flight attendants than among comparison workers. This distinct

anatomical distribution suggests that WMSDs among flight attendants may be related to cabin-specific ergonomic and work-organization exposures, rather than reflecting a uniform increase across all body regions.

A key finding of the generalized linear mixed model was that flight attendant occupation was no longer significantly associated with WMSDs after adjusting for demographic, ergonomic, and work-organization factors when compared with the Comparable Industry Subgroup. This finding highlights the importance of ergonomics and work-organization exposures in interpreting the higher prevalence among flight attendants, who reported higher frequencies of working in uncomfortable postures, repetitive truncal

movements, prolonged static neck postures, extended daily working hours, and insufficient rest. All of these factors were independently associated with WMSDs and may serve as prevention targets. Region-specific models among flight attendants showed similar patterns, further supporting prevention efforts that consider both cabin-related postural demands and work-organization measures, including adequate staffing, optimized scheduling, and protected rest opportunities.

The findings in this study are subject to at least three limitations. First, because of its cross-sectional design, causal relationships between occupational exposures and WMSDs could not be established. Second, both WMSDs and occupational exposures were assessed using self-reported questionnaire data, which may have introduced recall and reporting bias. Differential symptom awareness across occupational groups cannot be excluded. Third, although the Comparable Industry Subgroup showed improved comparability in terms of sex distribution and physical workload, residual confounding may have remained because occupation-specific factors, such as cabin environmental conditions, circadian disruption, and psychosocial demands, were not measured.

This study suggests several practical options for preventing WMSDs among flight attendants. Routine occupational health surveillance may help to identify high-prevalence groups and monitor trends. Cabin ergonomic improvements aimed at reducing awkward trunk and neck postures can be combined with administrative measures, including adequate staffing, sufficient rest between flights, and greater autonomy over work breaks. Ergonomic training and targeted exercise programs may provide additional support when integrated into broader preventive efforts.

Conflicts of interest: No conflicts of interest.

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Ethical statement: The Medical Ethics Review Committee of the National Institute of Occupational Health and Poison Control, Chinese Center for Disease Control and Prevention, approved this study (Approval No.: NIOHP202122). All participants provided informed consent.

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Corresponding authors: Ning Jia, jianing@niohp.chinacdc.cn; Bing Qiu, qiubing@mhzyy.cn.

¹ Civil Aviation Medicine Center, Civil Aviation Administration of China (Civil Aviation General Hospital), Beijing, China; ² National Institute of Occupational Health and Poison Control, Chinese Center for Disease Control and Prevention & Chinese Academy of Preventive Medicine, Beijing, China; ³ Civil Aviation University of China, Tianjin, China.

* Joint first authors.

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Prevalence of WMSDs by body region among flight attendants and comparison groups, China, 2018–2023.

Body regions	Flight attendants (n=1,341)			National occupational group (n=87,268)			Comparable industry subgroup (n=16,224)		
	Number	Actual prevalence rate (%)	Standardized prevalence rate (%)	Number	Actual prevalence rate (%)	Standardized prevalence rate (%)	Number	Actual prevalence rate (%)	Standardized prevalence rate (%)
Neck	494	36.84	36.65	19,341	22.16	21.64***	5,134	31.64	31.08***
Shoulders	382	28.49	31.33	16,153	18.51	18.20***	4,166	25.67	25.46*
Upper Back	202	15.06	19.36	11,213	12.85	12.49*	2,673	16.48	16.28
Lower Back	273	20.36	20.83	12,921	14.81	14.68*	3,038	18.73	18.49
Elbows	52	3.88	4.78	5,922	6.79	6.91***	1,123	6.92	7.15***
Hands/Wrists	93	6.94	6.39	10,345	11.85	11.73**	2,168	13.36	13.76***
Buttocks/Thighs	119	8.87	10.18	8,324	9.54	9.49	1,926	11.87	11.55**
Knees	140	10.44	13.47	8,465	9.70	9.77	1,678	10.34	10.50
Feet/Ankles	153	11.41	11.84	10,256	11.75	11.04	2,908	17.92	17.05***
Any Region	684	51.01	51.47	32,563	37.31	36.66***	7,376	45.46	44.57***

Note: Standardized prevalence rate based on the age distribution of the 18–60 year age group in China's seventh national population census.

Abbreviation: WMSDs=work-related musculoskeletal disorders.

* $P<0.05$, ** $P<0.01$, *** $P<0.001$, compared with the flight attendant group (reference).

SUPPLEMENTARY TABLE S2. Working posture characteristics among flight attendants and comparison groups, China, 2018–2023.

Variable	Flight attendants (n=1,341) (%)	National occupational group (n=87,268) (%)	Comparable industry subgroup (n=16,224) (%)
Back posture at work			
Upright	440 (32.81)	30,397 (34.83)	4,811 (29.65)***
Slight bend	731 (54.51)	46,241 (52.99)	9,695 (59.76)
Significant bend	170 (12.68)	10,630 (12.18)	1,718 (10.59)
Frequent bending with twisting			
Yes	760 (56.67)	36,081 (41.35)***	6,076 (37.45)***
No	581 (43.33)	51,187 (58.65)	10,148 (62.55)
Repetitive trunk/waist/back movements			
Yes	964 (71.89)	43,639 (50.01)***	8,416 (51.87)***
No	377 (28.11)	43,629 (49.99)	7,808 (48.13)
Prolonged bent posture			
Yes	605 (45.12)	23,925 (27.42)***	5,045 (31.10)***
No	736 (54.88)	63,343 (72.58)	11,179 (68.90)
Neck posture at work			
Upright	226 (16.85)	16,372 (18.76)*	2,235 (13.78)**
Slightly forward	733 (54.66)	46,491 (53.27)	9,208 (56.76)
Significantly forward	363 (27.07)	22,169 (25.40)	4,654 (28.69)
Tilted back	19 (1.42)	2,236 (2.56)	127 (0.78)
Prolonged head-down posture			
Yes	720 (53.69)	41,174 (47.18)***	10,195 (62.84)***
No	621 (46.31)	46,094 (52.82)	6,029 (37.16)
Wrist edge contact			
Yes	533 (39.75)	29,538 (33.85)***	5,283 (32.57)***
No	808 (60.25)	57,730 (66.15)	10,941 (67.44)
Hand pinching/clutching tasks			
Yes	1,014 (75.62)	66,779 (76.52)	12,220 (75.32)
No	327 (24.38)	20,489 (23.48)	4,004 (24.68)
Ability to change leg posture			
Yes	793 (59.13)	67,785 (77.67)***	11,826 (72.89)***
No	548 (40.87)	19,483 (22.33)	4,398 (27.11)
Prolonged knee-bent posture			
Yes	578 (43.10)	27,138 (31.10)***	6,074 (37.44)***
No	763 (56.90)	60,130 (68.90)	10,150 (62.56)
Repetitive lower limb/ankle movements			
Yes	807 (60.18)	33,700 (38.62)***	6,304 (38.86)***
No	534 (39.82)	53,568 (61.38)	9,920 (61.14)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ compared with the flight attendant group (reference).

SUPPLEMENTARY TABLE S3. Factors associated with region-specific work-related musculoskeletal disorders among flight attendants in multivariable logistic regression analyses, China, 2018–2023.

Body region	Variable	Coefficient	Wald χ^2	OR (95% CI)	P
Neck	Gender				
	Men	–	–	1.00	–
	Women	0.837	22.84	2.31 (1.64, 3.26)	<0.001
	Service duration (years)				
	<5	–	–	1.00	–
	25–29	–0.881	4.53	0.42 (0.18, 0.93)	0.033
	Working in uncomfortable postures				
	Rarely/never	–	–	1.00	–
	Sometimes	0.650	10.36	1.92 (1.29, 2.85)	0.001
	Often	1.070	23.94	2.92 (1.90, 4.47)	<0.001
	Very frequently	1.171	22.72	3.23 (1.99, 5.22)	<0.001
	Number of working hours per day				
	≤8	–	–	1.00	–
	>8	0.390	8.07	1.48 (1.13, 1.93)	0.005
	Sufficient rest time				
	No	–	–	1.00	–
Trunk (lower back, upper back)	Yes	–0.573	10.97	0.56 (0.40, 0.79)	0.001
	Autonomy over work breaks				
	No	–	–	1.00	–
	Yes	–0.855	4.22	0.43 (0.19, 0.96)	0.040
	Department understaffing				
	No	–	–	1.00	–
	Yes	0.349	6.18	1.42 (1.08, 1.87)	0.013
	Gender				
	Men	–	–	1.00	–
	Women	0.641	8.55	1.90 (1.24, 2.92)	0.003
	Working in uncomfortable postures				
	Rarely/never	–	–	1.00	–
	Often	0.689	6.31	1.99 (1.16, 3.41)	0.012
	Very frequently	0.787	6.96	2.20 (1.22, 3.95)	0.008
	Number of working hours per day				
	≤8	–	–	1.00	–
	>8	0.531	10.25	1.70 (1.23, 2.35)	0.001
Upper limbs (shoulders, hands/wrists, elbows)	Sufficient rest time				
	No	–	–	1.00	–
	Yes	–0.720	9.76	0.49 (0.31, 0.77)	0.002
	Gender				
	Men	–	–	1.00	–
	Women	1.290	38.86	3.63 (2.42, 5.45)	<0.001
	Marital status				
	Unmarried	–	–	1.00	–
	Living alone	–1.237	4.74	0.29 (0.10, 0.88)	0.030

Continued

Body region	Variable	Coefficient	Wald χ^2	OR (95% CI)	P
Upper limbs (shoulders, hands/wrists, elbows)	Working in uncomfortable postures				
	Rarely/never	–	–	1.00	–
	Sometimes	0.482	5.21	1.62 (1.07, 2.45)	0.022
	Often	0.956	18.03	2.60 (1.67, 4.05)	<0.001
	Very frequently	0.952	14.09	2.59 (1.58, 4.26)	<0.001
	Number of working hours per day				
	≤8	–	–	1.00	–
	>8	0.495	11.75	1.64 (1.24, 2.18)	0.001
	Autonomy over work breaks				
	No	–	–	1.00	–
	Yes	–1.296	6.98	0.27 (0.11, 0.72)	0.008
	Department understaffing				
	No	–	–	1.00	–
	Yes	0.386	7.21	1.47 (1.11, 1.95)	0.007
	Wrist placement on hard edges				
	No	–	–	1.00	–
	Yes	0.267	4.07	1.31 (1.01, 1.69)	0.044

Note: All factors listed in the table were statistically significant ($P<0.05$).