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Work-Related Musculoskeletal Disorders of Dance Teachers in Germany: A Retrospective Cross-Sectional Study

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Abstract: Maintaining the health of the musculoskeletal system in movement-associated professions, such as dance teachers, is of great importance for a long-lasting professional practice. The aim of this study was to record work-related musculoskeletal disorders and the causes of these disorders for dance teachers in Germany. Using a retrospective cross-sectional survey, data on the occurrence of work-related musculoskeletal disorders were collected from n = 229 dance teachers (n = 181 women) aged 22 to 77 years using an online questionnaire. In addition, differences between sexes and among dance styles were also analysed. The 12-month prevalence was 60.7% (95% CI: 54.0–67.1%), and on average, there were 2.58 disorders per dance teacher per year (95% CI: 2.17–2.99). Work-related musculoskeletal disorders affected male and female dance teachers equally ($\varphi = 0.11$, $p = 0.088$ resp. $r = 0.080$, $p = 0.228$). Disorders were mainly registered in the lumbar spine (14.9%) and ankle (12.5%). The joint structures (29.9%) and the musculature (20.9%) were most frequently affected. Specific movements (18.7%) as well as fatigue and overload (15.2%) were mentioned as the most frequent causes irrespective of dance style. Dance teachers were not significantly differently affected for musculoskeletal disorders than the general working German population. Future studies should consider a prospective evaluation of such disorders and develop prevention strategies with consideration of sex- and dance style-specific circumstances.

Keywords: work-related musculoskeletal disorders; dance teacher; prevalence; ballet; contemporary dance

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1. Introduction

The main aim of dance teachers is to teach movement elements related to dance styles. Although almost everyone comes into contact with a person teaching dance at some point in their life [1]), studies on this professional group have been very limited. Valid numbers on the population of German dance teachers are not existent. As a minimum, it can be assumed that there are around 3,400 registered dance teachers in the Allgemeinen Deutschen Tanzlehrerverband (ADTV) and the Deutschen Berufsverband für Tanzpädagogik (DBfT e.V.) alone [1]. They are exposed to several work-related demands. These are both psychomental and physical [1,2]. The physical and mental loads vary greatly depending on the target group and the dance style [2]. With regard to the positive or negative effects of the occupation on health, contradictory findings are found [2–4]. Thus, dance teachers rate their profession equally as beneficial to their health and harmful to their musculoskeletal system [2]. The objective results show differences within the occupational group. Thus, cardiorespiratory fitness varies greatly [3]. Similarly, deficits in vitamin D (25(OH)D3 levels and serum ferritin concentrations were found for a large proportion of the dance teachers [3]. So far, it has not been clarified to what extent a potential healthy worker effect is also present in dance teachers. Initial studies have shown that the physical demands of teaching are high in some cases [2,5,6]. Similar to school teachers [7], particularly physical

education teachers [8–10] or professional athletes, such as dancers [11–17], the question of the occurrence of work-related musculoskeletal disorders (WMSDs) arises.

In terms of maintaining the health and working ability of such teachers, the assessment of prevalence, localisations, and possible causes of WMSDs must be attributed great importance in order to implement preventive strategies where necessary. Furthermore, the findings may also be of interest to other movement education professions, such as sports teachers, circus and theatre educators, and yoga and gymnastics instructors.

In a cross-sectional cohort study, WMSDs were recorded by conducting an online survey of dance teachers in Germany. The 12-month prevalence (P_{12M}), symptom localisation, cause attribution, and differences among dance styles of the DTs were investigated. In addition, differences between male and female DTs were considered, as sex differences were partially shown for professional dancers [15], and it could be assumed that a large proportion of DTs had a professional dance career in the past [2].

2. Materials and Methods

2.1. Study Design and Study Population

In a retrospective cross-sectional cohort study, DTs were surveyed with an online questionnaire. Participation in this study was voluntary, anonymous, and followed scientific–ethical criteria. The principles of the Declaration of Helsinki were considered, and a positive ethics vote (EA1/165/14) of the ethical committee of the university (Charité-Medical School, Berlin, Germany) was obtained before the studies began. Information about the study was given, and the participants' consent was collected prior to any participation in the questionnaire. To be included in the study, DTs had to meet the following criteria:

- at least 18 years of age;
- working as a DT is the main profession (financial livelihood);
- employed and/or freelance;
- focusing on theatrical dance (mainly classical dance (ballet), modern and jazz dance, or contemporary dance);
- teaching nonprofessional and/or (pre-)professional students;
- resident in Germany.

2.2. Work-Related Musculoskeletal Disorders Definition

Work-related musculoskeletal disorders were defined as all symptoms of body structures, such as bones, ligaments, tendons, muscles, or joints [18], that were perceived by the respondents as chronic and related to their own occupation and had newly occurred in the last 12 months. Data on acute injuries (e.g., accidental bone fractures) were not considered in this study.

2.3. Questionnaire Design and Main Outcome Parameters

The survey was designed as a multidimensional semiopen online questionnaire (provided in German and English) for dance-specific professional groups. In addition to general anthropometric (age, height, and weight), sociodemographic (e.g., educational and professional qualifications and monthly income), and health-related characteristics [19], the questionnaire took into account categories of work-related musculoskeletal disorders. Following the Nordic Musculoskeletal Questionnaire [20] and recommendations by Liederbach et al. [21] for dance-specific implementation, the participants were asked to provide information on localisation, affected tissue structures, attribution of cause, and diagnosis of new musculoskeletal disorders in the last 12 months. The most important outcome parameters were the P_{12M} based on the mentioned WMSDs and the prevalence rate. The exposure was recorded via the average weekly teaching hours.

Possible main confounders for the occurrence of WMSDs could be exposure to other physically demanding work or leisure time activities, age, and injury history.

In order to eliminate fundamental problems with the survey instrument (e.g., comprehension or technical problems), a one-time prestudy was carried out on physical education teachers.

2.4. Testing Procedure

Participation in the survey was conducted over a period of three months. Access to the anonymous online survey was sent out to potential candidates with the support of the German Professional Association for Dance Education (DBfT e.V.), the Royal Academy of Dance (Germany), the Stiftung TANZ, and the Gemeinnütziger Verein für Tanzmedizin (ta.med e.V.). To increase the response rate, three reminders were sent throughout that period, and colleagues were asked to forward them. A final response rate could not be calculated due to the lack of information on the total population of German DTs. To date, the authors are not aware of any valid figures on the size of this professional group in Germany. Furthermore, it should be noted that the effects of the COVID-19 pandemic had no impact on this study, as the survey was conducted before the start of the pandemic.

2.5. Data Analysis and Statistical Analysis

The data processing was performed with Microsoft Excel 2010. Descriptive and analytical statistics were performed using IBM SPSS 25. To estimate a prevalence rate, the average teaching time per week was adjusted to a teaching year. For this purpose, the weekly hours were multiplied by the total number of weeks in a year, minus the average holiday period in Germany (approximately 13 weeks), and the WMSD occurrence was put in relation to 1000 teaching hours.

All tests were based on a two-sided test and a significance level of $\alpha = 0.05$. When multiple testing was present, as in the chi-square test to test for distributional differences among the three dance styles, an alpha correction ($p = 0.05$/test number) was applied to test for significant differences. Error probabilities that referred to corrected significance levels were marked with p_{corr}. In addition, Cramer's V was determined as the effect size. For the 2×2 chi-square tests in the context of testing for sex differences, Phi was calculated as the effect size with $\varphi = \sqrt{\chi^2/n}$ [22]. Ordinally scaled and non-normally distributed items were tested using Mann–Whitney U test. In addition to specifying the probability of error p, the strength of the effect was given as $r = z/\sqrt{n}$. Following Cohen [22], the effect sizes for V, φ, and r were classified into small ($\geq$0.10), medium ($\geq$0.30), and large effects ($\geq$0.50). The calculation of the P_{12M} was based on the binomial distribution with an estimation of the 95% confidence intervals according to Clopper–Pearson.

3. Results

3.1. Sample Characteristics

A total of n = 241 DTs participated in the survey, of which n = 229 were included in the statistical analysis. N = 12 participants were excluded because important anthropometric information (e.g., age) and/or information on WMSD occurrence was missing. The DTs were on average 43.1 years old (SD: 11.0, Min–Max: 22–77 years) and had a mean work experience of 14.0 years (SD: 10.0, Min–Max: 1–41 years). The male proportion of the sample was 21% (n = 48) and was slightly older than the female DTs ($p = 0.023$, r = 0.15). There was no difference ($p = 0.938$, Table 1) between the sexes in terms of work experience. Before becoming a DT, 82% (n = 188) were professional dancers. Based on the valid data (n = 209), the percentage of teachers in classical dance was 27%, 32% in modern and contemporary dance, and 41% for the combination of all dance styles.

Table 1. General sample characteristics for total group, female, and male participants.

	n	Mean	SD	Range	Z-Score	*p*-Value	Effect Size r
Age (yrs)							
Total	229	43.1	11.0	22.0–77.0	−2.278	0.023 *	0.151
Females	181	42.0	10.5	22.0–68.0			
Males	48	47.1	12.2	22.0–77.0			
Height (cm)							
Total	229	170.0	7.7	145.0–195.0	−7.763	<0.000 *	0.513
Females	181	167.8	6.2	145.0–183.0			
Males	48	178.0	7.5	156.0–195.0			
Weight (kg)							
Total	229	61.6	10.7	40.0–100.0	−8.384	<0.000 *	0.554
Females	181	58.3	8.2	40.0–89.0			
Males	48	74.2	9.8	54.0–100.0			
BMI (kg *m^{-2})							
Total	229	21.2	2.7	17.0–33.0	−6.610	<0.000 *	0.437
Females	181	20.7	2.4	17.0–33.0			
Males	48	23.4	2.6	19.0–31.0			
Teaching experience (yrs)							
Total	227	14.0	10.0	1.0–41.0	−0.077	0.938	0.005
Females	180	14.0	10.3	1.0–41.0			
Males	47	13.9	9.2	1.0–40.0			
Weekly teaching time (hrs)							
Total	203	18.4	10.1	2.0–50.0	−0.444	0.657	0.031
Females	166	18.0	9.5	2.0–44.0			
Males	37	20.0	12.4	3.0–50.0			

Note: Testing for sex differences was based on the Mann–Whitney U test. Significant differences (* $p < 0.05$) are marked with an asterisk; BMI = body mass index.

3.2. WMSD Occurrence

Out of n = 229 DTs, n = 139 DTs (60.7%) reported having been affected by one or more WMSDs in the last year. Thus, the P_{12M} for the total sample was 60.7% (95% CI: 54.0–67.1%). When subdivided into sexes, the P_{12M} for females was 63.5% (95% CI: 56.1–70.5) and for males 50.0% (95% CI: 36.2–64.8%) with no significant difference ($\varphi = 0.11$, $p = 0.088$). Similarly, no differences among dance styles on the P_{12M} could be found. The P_{12M} was 59.0% (95% CI: 45.0–71.9%) in classical dance, 64.2% (95% CI: 51.5–75.5%) in modern and contemporary dance, and 60.5% (95% CI: 49.3–70.8%) in the combination of both categories.

A total of n = 591 WMSDs (male vs. female: n = 120 vs. 470) were registered. This corresponds to an average of 2.58 WMSD/DT/year (95% CI: 2.17–2.99) in the total sample, 2.60 WMSD/DT/year (95% CI: 2.17–3.03) for female DTs, and 2.50 WMSD/DT/year (95% CI: 1.35–3.65) for male DTs. No difference (r = 0.080, $p = 0.228$) in WMSD occurrence was found between male and female DTs. For the total sample, an annual exposure time of 15,926 h could be estimated. From this, an exposure-related prevalence rate of 3.71 WMSDs per 1000 teaching hours could be derived.

3.3. WMSD Localisation

Most WMSDs (Figure 1) were in the lower extremity (40.8% total, 35.8% male, and 42.0% female) followed by the spine/torso (35.2% total, 39.2% male, and 34.2% female). The lumbar spine was most frequently affected with 14.9% (17.5% male, 14.2% female).

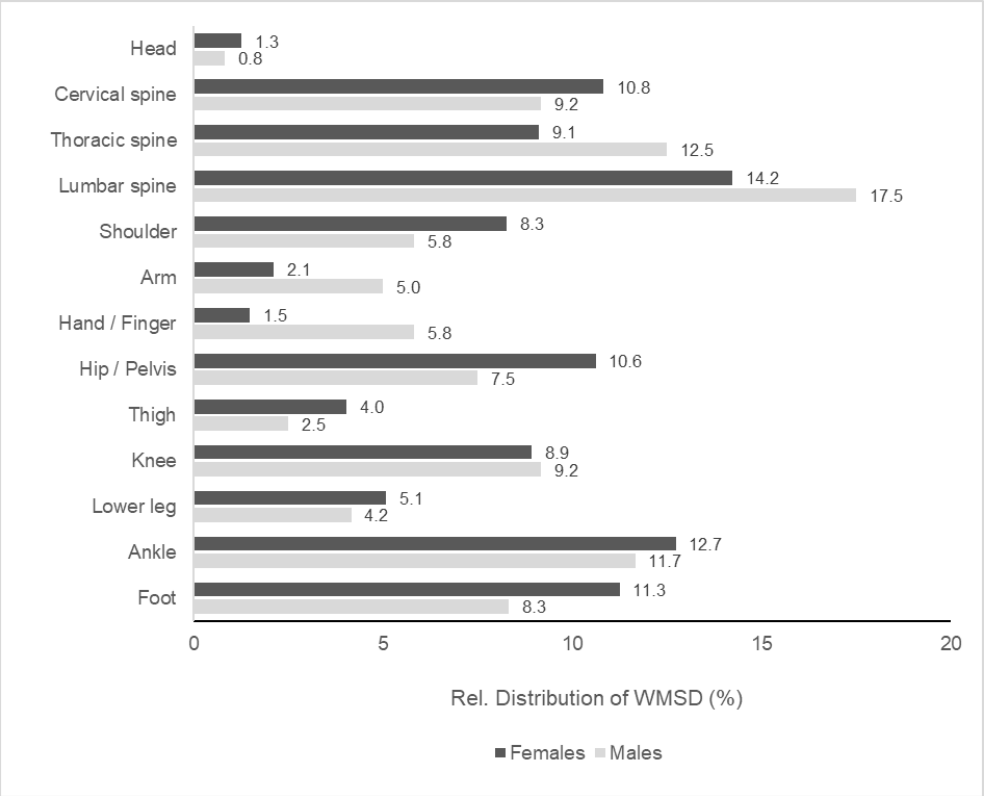

Figure 1. WMSD localisation by sex. Note: Shown are the relative distributions (number of symptoms in the specific body region in relation to the total number of symptoms) of WMSD (%) for men and women. There were no significant distribution differences.

For all body regions, no sex-specific differences between men and women could be found. There was only a statistical tendency ($p = 0.064$) for a more frequent occurrence of WMSDs in the area of the hands in men. Among the dance styles taught, there were no significant differences in WMSD localisation between DTs (Figure 2).

3.4. Affected Tissues

The most frequent disorders were recorded in joint structures (Figure 3). This was true for both men and women. In this context, arthritic disorders were registered by 17.8% (male vs. female: 24.5% vs. 16.1%) of the respondents.

Muscular structures were the second most frequently mentioned disorders by the participants. Joint and muscle structures were affected in total 50.8% (male vs. female: 52.5% vs. 50.3%). For 13.9% of the WMSDs, no assignment of a tissue structure could be made. Men were significantly more likely ($p = 0.005$, $\varphi = 0.11$) than women to report having WMSDs in the joints, menisci ($p = 0.040$, $\varphi = 0.08$), and ligamentous structures ($p = 0.025$, $\varphi = 0.09$). Women reported a significantly ($p = 0.010$, $\varphi = 0.10$) higher proportion of muscular disorders (Figure 3). Furthermore, WMSDs of tendons were significantly more frequent in female DTs ($p = 0.034$, $\varphi = 0.08$), as were WMSDs that could not be assigned to any structure ($p = 0.044$, $\varphi = 0.08$).

In some cases, differences could be found among the dance styles in terms of the affected structures. (Figure 4). The proportion of joint injuries in contemporary dance is significantly lower ($p_{corr} = 0.001$, $V = 0.13$) than in the other two dance styles. It was similar with the muscular WMSDs in classical dance. DTs in ballet were affected significantly less often ($p_{corr} = 0.005$, $V = 0.11$). In contemporary dance, there was a significantly increased ($p_{corr} = 0.005$, $V = 0.12$) proportion of WMSDs (19.5%) that could not be assigned to any tissue structure. Furthermore, bone structures were significantly more often affected ($p_{corr} = 0.007$, $V = 0.10$) in classical dance than in the other two groups.

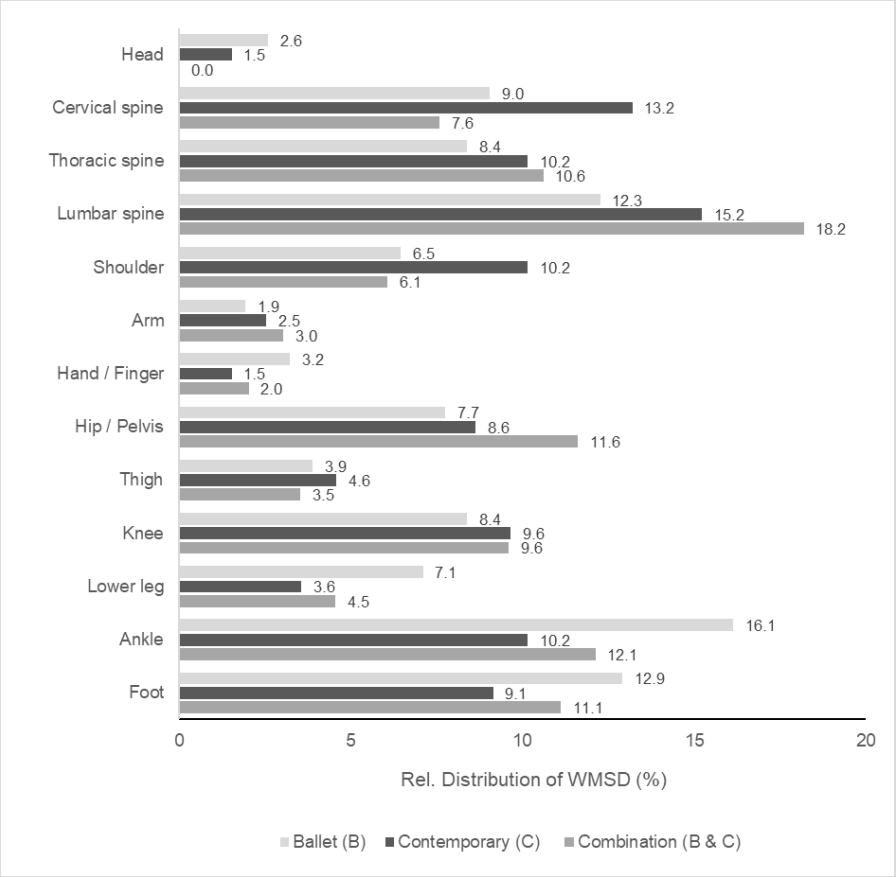

Figure 2. WMSD localisation by dance style. Note: Shown are the relative distributions (number of symptoms for the specific body region in relation to the total number of symptoms) of WMSD (%) for the three dance style categories: ballet, contemporary dance, and the combination of ballet and contemporary dance. There were no significant distribution differences.

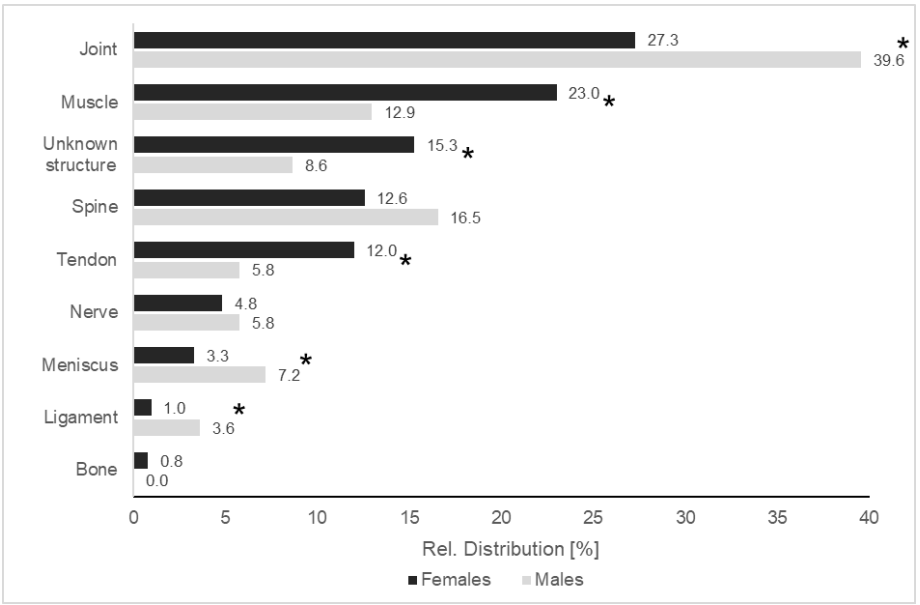

Figure 3. Affected tissue by sex. Note: Shown are the relative distribution (number of symptoms for the specific tissue in relation to the total number of symptoms) differences between men and women for the different tissue types. Significant differences are marked with an asterisk.

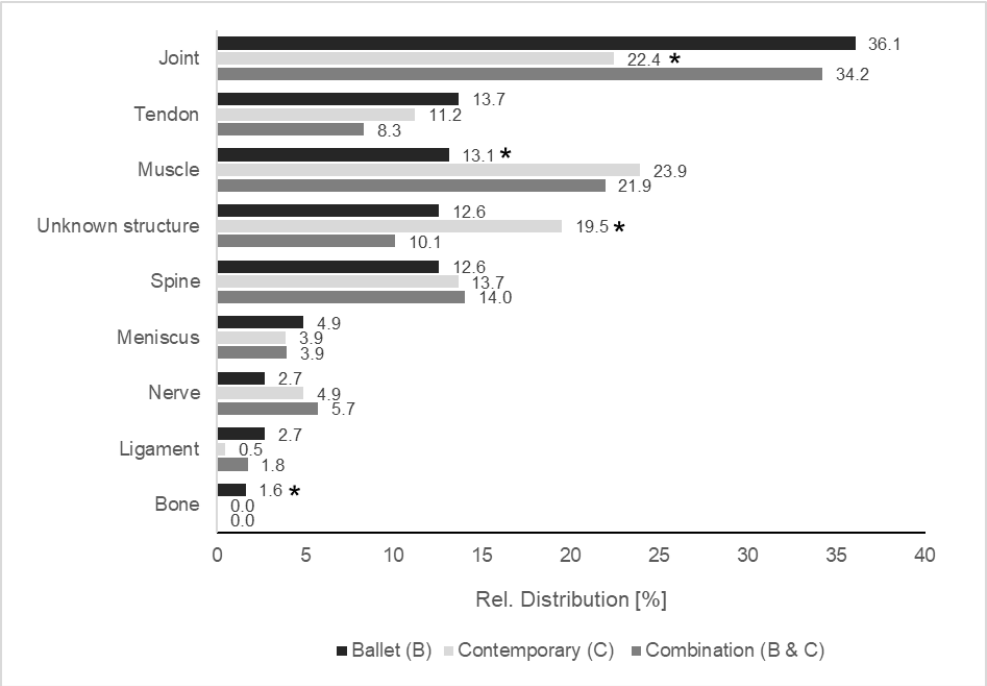

Figure 4. Affected tissue by dance style. Note: The relative distributions (number of symptoms for the specific tissue in relation to the total number of symptoms) of WMSD (%) for the different tissue types among the three dance style categories: ballet, contemporary dance, and the combination of ballet and contemporary dance are illustrated. Significant differences are marked with an asterisk.

3.5. Subjective Cause Attribution

A total of n = 1165 circumstances were registered for the occurrence of WMSDs. Specific movement execution was one of the most frequent causes among both men (22.4%) and women (17.2%) (Figure 5). There was a very small significant difference between the sexes ($p = 0.041$, r = 0.06). In second place for male DTs were both floor conditions (11.0%) and dance choreography (11.0%). These two circumstances were mentioned significantly less by the female DTs (floor: $p = 0.002$, $\varphi = 0.09$, choreography: $p = 0.033$, $\varphi = 0.06$). Women reported fatigue and overload (18.9%) as the most common cause. This circumstance was one of the largest sex-related differences ($p < 0.001$, $\varphi = 0.16$). In third place after specific movement execution, the women recorded stress in combination with expectations. There was no difference between women and men in this characteristic. The biggest sex difference was found for the role of the partner. This complaint was hardly relevant for female DTs (1.0%) and was reported significantly (($p < 0.001$, $\varphi = 0.19$) more often by male DTs (8.0%). Other sex differences were seen in physical conditions ($p = 0.002$, $\varphi = 0.09$) and diet ($p = 0.025$, $\varphi = 0.07$).

The dance style orientation showed no differences in the two most frequently mentioned causes of symptoms (specific movement execution and fatigue and overload states). In some other causal attributions, dance style-specific correlations could be found. Thus, the floor played a significantly more important role as a cause in classical dance than in the other two dance styles ($p_{corr} = 0.001$, V = 0.10). Footwear as a cause was mentioned significantly more often in classical dance ($p_{corr} < 0.001$) and significantly less often in contemporary dance ($p_{corr} = 0.004$), showing a small overall effect (V = 0.12). There was also a dance style-specific small correlation (V = 0.11) with stress in relation to expectations. Thus, the attributions were significantly lower in classical dance ($p_{corr} = 0.004$) and significantly higher in contemporary dance ($p_{corr} < 0.001$). Furthermore, in classical dance, the partner was registered as a significant ($p_{corr} = 0.005$, V = 0.09) cause. DTs in classical dance reported nutrition significantly more often ($p_{corr} < 0.001$, V = 0.10) as a cause than their colleagues in the other two dance styles. Similarly, drinking behaviour is mentioned significantly more

often (p_{corr} = 0.001) by DTs in classical dance and significantly less often (p_{corr} < 0.001) by DTs with a dance style combination (V = 0.11). In the climate and lighting conditions, DTs from classical dance assumed a significant influencing factor (p_{corr} = 0.007, V = 0.08). Props and equipment as influencing factors played a more significant role in contemporary dance (p_{corr} < 0.001, V = 0.11) compared to the other two dance styles. For the other characteristics of cause attribution, no differences among dance styles could be found (Figure 6).

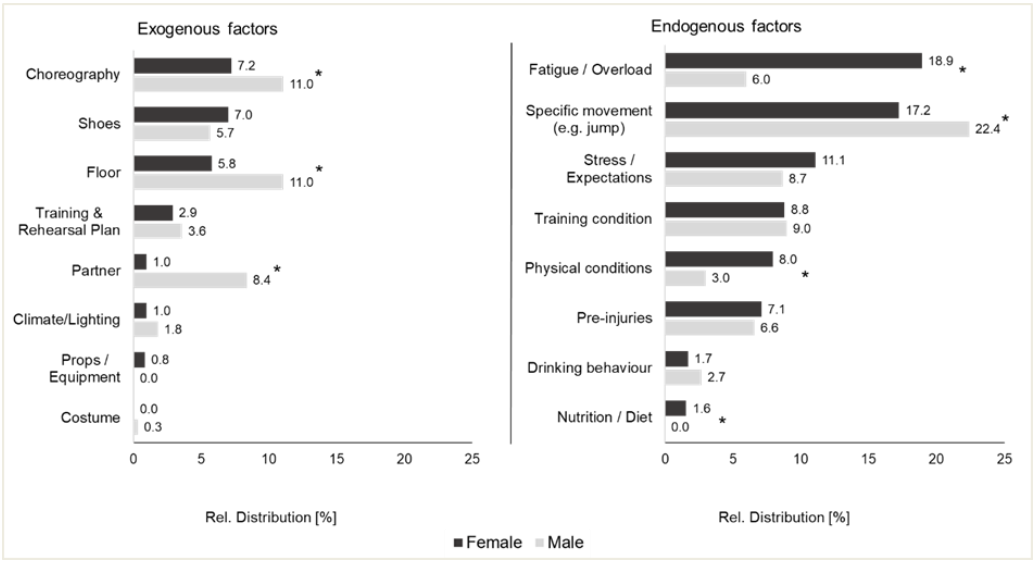

Figure 5. Circumstances of WMSDs depending on the sex. Note: Shown are exogenous (on the left side) and endogenous (on the right side) factors as potential causes of WMSDs for men and women. Relative frequencies are based on the number of the specific factors in relation to the total number of all circumstances for the corresponding sex. Significant distribution differences are marked with an asterisk.

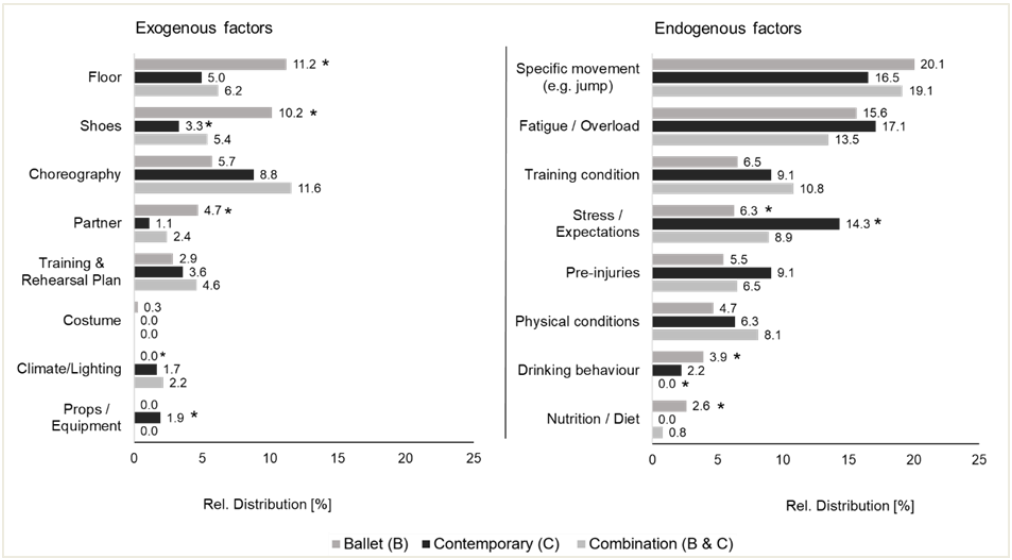

Figure 6. Circumstances of WMSDs depending on the dance style. Note: The relative distributions of exogenous (on the left side) and endogenous (on the right side) factors as potential causes of WMSDs in the three dance style categories: ballet, contemporary dance, and the combination of ballet and contemporary dance are illustrated. Relative frequencies are based on the number of the specific factors in relation to the total number of all circumstances for the corresponding dance style. Significant distribution differences are marked with an asterisk.

4. Discussion

Based on the P_{12M} for the total sample, more than every second DT had at least one WMSD in the last 12 months. Furthermore, there were no statistically relevant differences among the dance styles taught and between the sexes. Compared to physical education teachers covering a similar age range, DTs were about twice as likely to experience WMSDs (2.58 vs. 1.23 WMSD/teacher/year) [10]. This seems alarming because the prevalence for physical education teachers in Goossens et al. [10] consisted of acute and chronic injuries, and the prevalence values in other studies [8,9] were significantly lower.

Compared to the German general population (15 to 64 years, coverage years 2013) [23], DTs showed neither a significantly higher nor lower occurrence of WMSDs (P_{12M}: 61% vs. 66%). Based solely on the occurrence of disorders, the profession of a DT does not appear to be more harmful or more beneficial to health. However, the prevalence rate suggests a clearer need for action. For dancers, the incidence of injury ranged from only 1.03 to 1.29 injuries per 1000 h of dance [14]. It should be noted, however, that even in this younger population, there was a high proportion of overuse injuries (65.9%) [14]. Accordingly, the development of prevention and coping strategies should be given more importance, especially when taking into consideration that most DTs can hardly compensate for financial losses caused by absence [4] and are dependent on working until retirement age [19].

WMSDs were most common in the lumbar spine, closely followed by symptoms in the ankles and feet. Compared with the localisations of acute injuries after occupational accidents among teachers, there were only partial similarities. According to Wanke et al. [24], for female DTs, the most common acute injuries were in the ankle area (25%), followed by the hands (16.7%) and for male DTs, in the knees (23.5%) and hands (23.5%). Surprisingly, the lumbar spine (female vs. male: 4.2% vs. 0.0%) and feet (female vs. male: 4.2% vs. 5.9%) were hardly affected at all [24].

It is remarkable that similar regions of symptoms could be shown for DTs as regions of injury for professional dancers. In classical dance, the highest prevalence of injury was recorded in the feet (0.25, 95% CI: 0.04–0.46), cervical spine (0.24, 95% CI: −0.08–0.56), and ankle joints (0.21, 95% CI: 0.04–0.38) [15]. As already noted by Smith et al. [15], it remains unclear to what extent acute injuries in active careers become chronic WMSDs in retirement. In the sample surveyed, four fifths of the participants stated that they had been professional dancers in the past. A statistical test within the framework of this study could not be carried out due to a too small subgroup without a dance career. In contrast to the acute injuries of professional dancers, where sex-specific differences in frequency in the area of the ankle and spine could be shown [25], these could not be proven for DTs. Furthermore, there were no differences in the localisation-related performance probability among the taught dance styles (Figure 2).

The sex and the taught dance styles showed partial correlations with the affected tissue structures of WMSDs. Surprisingly, the male DTs were significantly more often affected by joint disorders and the female DTs significantly more often by muscular disorders (Figure 3). Compared to the acute injuries of professional dancers, a similar trend emerged. The joint structures were most frequently affected before the musculature [25,26]. Among sports teachers, most acute injuries were found in the musculature (43%) followed by the joints (20%) [10].

It could be observed that mainly endogenous factors were given as causes of disorders before exogenous factors. Similar observations could also be found among physical education teachers. For this group, movement demonstrations and pupil support were recorded as the most common injury circumstances [10]. Thus, both physical education teachers and DTs attributed their occurrence of symptoms primarily to the direct physical work of their profession. The results show that there were significant differences in the causal attributions of female and male DTs (Figure 5). Men considered specific movement patterns to be the main cause of their WMSDs. Women, on the other hand, perceived fatigue and overload states to be just as important influencing factors as dance-specific movement executions. This could be explained by any previous experiences with acute

injuries and their causes within one's own dance career, which could partly differ between male and female dancers [25,26]. All DTs, regardless of their dance style, agreed that specific movement patterns and fatigue or overload were the most common causes of their WMSD occurrence. In addition, a significant risk component was attributed to the floor and footwear in ballet, while stress related to expectations was mentioned significantly more often in contemporary dance classes (Figure 6).

Of course, there were limitations to this study that need to be taken into account. The survey was based on a retrospective self-assessments of DTs over the past 12 months. Thus, the assessments of the WMSDs cannot be equated with an exact medical diagnosis. Compared to a survey by medically trained staff, deviating prevalence figures are possible [27]. It has been partly described in the literature that dancers tend to underreport and ignore symptoms [19,28,29]. Apart from that, the authors do not assume a strong bias based on response distortion because of the voluntary participation. Furthermore, it should be noted that due to the cross-sectional study design, no robust statements can be made about cause–effect relationships. This also applies to the self-reports on possible causes of WMSDs in relation to work-relatedness, which are limited in their precision and validity.

Moreover, it must be assumed that this occupational group has a low degree of organisation and, due to its predominantly freelance character, a high degree of individuality, which makes studies with close monitoring considerably more difficult. Thus, for example, the recording of acute or chronic WMSDs by medical staff as in organised professional sports or large commercial enterprises is unrealistic. To the best of the authors' knowledge, this is the first study to provide comprehensive data on the occurrence and circumstances of WMSDs in DTs within a national cohort.

5. Conclusions

In conclusion, DTs have neither an increased nor a decreased occupational risk of contracting WMSDs, but an equally high risk. Given that one's own body is a dance teacher's professional capital, efforts to reduce WMSD occurrence should be seriously pursued. In this context, future studies should investigate the influence of injury during a dancer's professional career on the development of chronic disorders later in life in order to take preventative action before entering the profession as a DT. Based on the explorative survey results, reflections should be made on a more objective and prospective WMSD recording. In addition, more attention could be paid to the differentiated recording and evaluation of endogenous work factors. Building on this, topics on how to deal individually with one's own physical and mental loads in the sense of coping strategies could be integrated into training curricula.

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Institutional Review Board Statement: This study was performed in line with the principles of the Declaration of Helsinki. A positive ethics vote (EA1/165/14) of the ethical committee of the university (Charité Medical School, Berlin, Germany) was obtained.

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

Data Availability Statement: Not applicable.

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

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