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Work-Related Musculoskeletal Disorders in Athletic Trainer

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Abstract *Introduction* Athletic trainers often work for elongated and irregular hours or days, and need to react in emergency situations. These professionals are at risk for work-related musculoskeletal disorders (WMSDs). This study investigated the WMSDs experienced by athletic trainers (ATs), plus related personal and occupational factors. *Methods* A customized questionnaire with subject's demographic and WMSDs information was constructed and administered in all accessible ATs in Taiwan. In addition to descriptive analysis of demographics and WMSDs, the relationship between personal/occupational-related factors and WMSD symptoms were also evaluated. *Results* A total of 146 effective questionnaires were returned. The results indicated that a 48.5% prevalence rate of athletic trainers in Taiwan, and these disorders are mainly located in low back (42%), finger (38%) and shoulder (26%) regions. Logistic regression revealed that average work hour (odds ratio (OR) = 1.834, 95% confidence interval (CI): 1.066–3.156) and continue education participation (OR = 0.346, 95% CI: 0.140–0.854) were the most significant predictors for WMSDs occurrence. Performing taping was the most significant predictor for the low back (OR = 28.274, 95% CI: 2.568–311.423) and finger (OR = 19.535, 95% CI:2.273–167.912) symptoms; while performing providing first aid (OR = 12.128, 95% CI:3.881–37.899) was the most significant predictor for the shoulder's. *Conclusion* This study revealed that athletic trainers in Taiwan area suffered from high rate of WMSDs, and the relationship between WMSDs and specific job features were reported. Preventive and therapeutic modifications of the work environment to decrease the occurrence of WMSDs are in need for athletic trainers and other similar professions. Further research examining safe patient handling ergonomics, proper equipment in the context of athletic training and professional development strategies must be pursued.

Keywords Musculoskeletal disorder · Athletic trainer · Prevalence · Risk factor

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Introduction

Athletic training is an allied health care profession that specializes in the prevention, assessment, treatment and rehabilitation of injuries and illnesses that occur to athletes and the physically active. Athletic trainers (ATs) work in athletic or clinical settings, and serve as a liaison to the athlete, coach, physician and other supplemental personnel providing care to people sustaining physical or emotional trauma. The expanding roles and responsibilities of AT have increased their job complexity and workload in the recent decades [1]. Similar to other medical professionals, these increasing job demands can negatively influence athletic trainer's health, thus led to a higher incidence of acquiring work-related disorders or injuries.

Work-related musculoskeletal disorders (WMSDs), defined as a subset of musculoskeletal disorders (MSDs) that arise out of occupational exposures, may lead to work time loss, work restriction, or may transfer to another job [2]. They have been reported among health care professionals whose job characteristics are similar to ATs'. Investigations of WMSDs among nursing staffs reported a prevalence rate around 70–90% [3–8]. Among the listed disorders, prevalence of low back pain (LBP) was the highest, followed by neck, shoulder and extremity pain [3, 5]. Studies of WMSDs in physical therapists revealed a prevalence rate around 30-90%, with LBP as the most frequent reported disorders [9–14]. Similar to ATs, these professionals require physical demands such as lifting, maintaining awkward positions for extended periods of time, and the stamina to work many hours [3, 9, 15]. However to date, almost no study has been published regarding WMSDs in ATs.

The consequences of WMSDs in health care professionals are adverse to their career. Cromie et al. [11] reported that 1/6 of the Australia physical therapists who worked in a physical therapy practice made career changes because of WMSDs. Salik and Ozcan [12] reported a decrease in patient contact time with therapists who suffered from WMSDs. In addition, change of work settings, increase time of sick leaves, frequent change of work positions, and avoid high physical demanding manual tasks etc. have been reported [9, 11, 13]. According to our observation, detrimental impacts resulted from WMSDs to the ATs, similar to the abovementioned situations occurred in physical therapists, are likely to occur in a greater scale.

There is a necessity to investigate the prevalence of WMSDs, and its relationship with ATs' occupation. Therefore, the purpose of this study was to survey the prevalence of WMSDs among ATs, and to investigate the relationships of WMSDs with ATs' occupational and personal factors.

Methods

Instrumentation

Since no specific tool was available for investigating WMSDs in ATs, the authors conceived and designed a questionnaire. The contents of this self-administered questionnaire were based upon the literatures reviewed that investigated WMSDs among nurses and physical therapists, plus necessary modifications made to fit with the characteristics of athletic training profession. Content validity was tested by four professors specialized in the field of athletic training and rehabilitation science (two in athletic training, one in rehabilitation science, and one in sports medicine). These experts reviewed the list of questions and made necessary modifications. A consensus was reached by these four experts with a CVI (content validity index) of 0.96. Interrater agreement (IRA) was also assessed for each item. The average IRA for the scale was 0.92.

The final questionnaire was composed of three domains—personal data, occupational data, and information regarding WMSDs. The personal part was designed to obtain general personal information (gender/age/marital status/number of children). The occupational data included job-related information (training background/employment status/years of experience/average work hours per week/average work hours in direct athlete care per week/sports type covered/exercise habit/continue education/work setting). Information regarding WMSDs (types/regions/most performed tasks/activity performed when injured/causes/coping strategies after occurrence) was also evaluated. WMSDs investigated in this study were referred to work-related injuries happened at any time during the AT's career, which lasted more than a day and affected daily activities.

To ensure the internal consistency of the questionnaire, we surveyed twenty college graduates from the Department of Athletic Training and Health in National Taiwan Sports University. Internal consistency was tested using Cronbach's alpha coefficient, which is based on all possible correlations between each item on the scale and the total score. The Cronbach's alpha coefficient was 0.94. The same group completed the questionnaire again after 2 weeks to evaluate the test–retest reliability of the questionnaire. The questionnaire had test–retest reliability above 0.75.

Sample and Procedure

According to the database of the national association of ATs and the National Sports University, there were a total of 287 people with AT-related training backgrounds in Taiwan by year 2006. This study intended to recruit all ATs in record. One of the authors was designated for the recruitment process and sent out a total of 221 questionnaires. The rest ATs either went abroad or moved and thus could not be reached. These subjects were first contacted via phone or email to request their consent for study. The participation of the subjects was in accordance with the Institutional Review Board procedures at the Chang-Gung Memorial Hospital. The questionnaire was delivered to the subjects by either one of two means: regular mail or email dependent upon the accessibility to the subjects. Along with the questionnaire, a cover letter was attached to explain the purpose of the study and to assure confidentiality. Ten days after the initial mailing, the author contacted the subjects to ascertain whether they received the mail and to encourage the subjects to respond to the survey. The investigators also answered any remaining questions that the subject had regarding study participation.

Data Processing and Analysis

In order to test whether differences existed between the personal demographic data of subjects using mail or email questionnaires, an independent t test (age/years of experience/number of children/average work hours per week/average work hours in direct athlete care per week) or Chi-square test were performed (gender/employment status/marital status/training background/sports type covered/exercise habit/continue education/work setting). No significant difference were found between the two sets of data, therefore we combined all the data for statistical analysis.

All questionnaires were analyzed using the Statistical Package for Social Sciences 14.0 (SPSS Inc., Chicago, IL) program. Descriptive analysis was used to reveal the response distribution for each question in subjects' personal data, occupational data, and variables of WMSDs. To determine the relationship between the personal/occupational factors and the occurrence of WMSDs, a backward logistic regression model was built. Variables that reached $P < 0.05$ were entered for the analysis. In addition, logistic regression was performed to examine the relationship between the most performed tasks in AT's occupation and the top three most affected body regions.

Results

Basic Demographics

A total of 146 complete and valid responses were collected. This accounted for a 66% response rate. We had almost equal numbers of survey instrument returned from two genders (72 male and 74 female), with an average age of 27.8 ± 5.1. Among them, 18.5% were married, and 87% had no children. One hundred and three out of 146 subjects held athletic training jobs when the survey was performed. Considering the ones who were not currently employed as ATs at the time might have deviations in answering the survey questions, the following results and analyses only included the data from current-employed ATs. Thirty-five percent of our current-employed respondents worked full time and 65% part-time. Additional information regarding their work-related data can be found in Table 1.

Table 1 Subject's work-related information ($n = 103$)

Variables	Items	Count	Percentage (%)
Training background	College AT degree	90	87.4
	National special short-term program	6	5.8
	Foreign-trained	4	3.9
	Others	3	2.9
Employment status	Full-time	36	35
	Part-time	67	65
Years as AT	0–5	68	66
	6–10	24	23.3
	11–15	8	7.8
	16–20	3	2.9
Average work hours (h/week)	≦10	23	22.3
	11–20	22	21.4
	21–30	7	6.8
	31–40	6	5.8
	41–50	12	11.7
	51–60	10	9.7
	61–70	8	7.7
	>70	15	14.6
Average work hours in direct athlete care (h/week)	≦10	26	25.2
	11–20	23	22.3
	21–30	10	9.7
	31–40	10	9.7
	41–50	9	8.7
	51–60	8	7.8
	61–70	5	4.9
	>70	12	11.7
Sports type	Balls	72	69.9
	Combats	9	8.7
	Athletics	14	13.6
	Water sports	0	0
Exercise habit	Yes	64	62.1
	No	39	37.9
Continue education	Yes	60	58.3
	No	43	41.7
Work setting	Training field	47	19.4
	Hospital/clinic	16	6.6
	Game field	72	29.8
	Training room	52	21.5
	Fitness club	3	1.2
	School	44	18.2
	Rehabilitation center	1	0.4
	Others	7	2.9

Work-related Musculoskeletal Disorder Information

Prevalence

The WMSDs in this study defined as a subset of musculoskeletal disorders that arise while the respondent was performing AT jobs [2]. Fifty out of 103 current employed respondents reported they suffered WMSDs, indicating a 48.5% prevalence rate. A 55.6% prevalence rate was found for full-time ATs, and a 44.8% rate was found for part-time employed. Chi-square test results revealed no difference between the full- and part-time ATs regarding prevalence

Table 2 Prevalence rate of work-related musculoskeletal disorders

	Subjects suffered with WMSDs	Total subjects	Prevalence rate (%)
Total ATs	50	103	48.5
Full-time ATs*	20	36	55.6
Part-time ATs*	30	67	44.8

* Chi-square test: $\chi^2 = 2.50$, $P = 0.15$

rate ($\chi^2 = 2.50$, $P = 0.15$). The statistical details are shown in Table 2.

Relationships Between WMSDs and Personal- and Occupational-related Variables

Results from logistic regression model revealed that AT's average work hours per week and whether they participated in continue education courses revealed to be the significant predictors for the occurrence of WMSDs. Among them, continue education produced an odds ratio (OR) of 0.346 (95% CI: 0.140–0.854; Table 3), which implied a decrease in the odds of 65.4%. Respondents who said they participated longer continue education hours were 65.4% less likely to acquired WMSDs. Average work hours per week, on the other hand, produced an odds ratio of 1.834 (95% CI: 1.066–3.156), which indicated that an increase in the odds of 83.4%. Survey respondents who worked more than 40 h per week were 83.4% more likely to suffer from WMSDs.

Relationship between Affected Body Regions and the most Performed Tasks

A complete list of information regarding WMSDs is revealed in Table 4. For the types, overuse was reported the highest (68.0%) among our respondents, followed by sprain (30.0%) and tendonitis/tenosynovitis (24.0%). As to the body regions, our respondents reported the highest rate in the low back (42.0%), followed by finger (38.0%) and shoulder (26.0%).

The most frequently performed job tasks were injury evaluation (25.4%), taping (22.7%), and manual therapy (17.8%). The top three activities performed when injured were performing manual therapy (27.5%), maintaining a fixed posture for a long time (22.1%), and doing repetitive movement (22.1%). The top three causes were performing one specific task repetitively (27.3%), working with a tired body (22.7%) and working in an awkward position within a limited space (14.9%). Furthermore, coping strategies used after the occurrence of WMSDs included frequent posture change (18.2%), body mechanics modification (17.1%), rest (15.5%), and decreasing the use of manual therapy technique (11.6%).

The relationships between the three most affected body regions and the most performed tasks were further examined via logistic regression models. Taping produced the highest odds ratio for the low back (OR = 28.278, 95% CI: 2.568–311.423), Table 5) and finger (OR = 19.535, 95% CI: 2.273-167.912), but it was not significant for the shoulder. Performing first aid was found to be a significant factor associated with all three most affected body

Table 3 Last two steps of the backward logistic regression model examining the effects of personal- and occupational-related variables on WMSDs

	Variables in the equation				Significance	Exp (*B*)	95.0% CI for Exp (*B*)	
	B	SE	Wald	*df*			Lower	Upper
Training background	1.230	0.795	2.397	1	0.122	3.422	0.721	16.242
Continue education	−0.812	0.475	2.923	1	0.087	0.444	0.175	1.126
Average work hours in direct athlete care	−0.517	0.296	3.058	1	0.080	0.596	0.334	1.064
Average work hours	0.565	0.279	4.092	1	0.043*	1.760	1.018	3.042
Constant	−0.502	1.217	0.170	1	0.680	0.605		
Continue education	−1.062	0.461	5.297	1	0.021*	0.346	0.140	0.854
Average work hours in direct athlete care	−0.556	0.292	3.621	1	0.057	0.573	0.323	1.017
Average work hours	0.607	0.277	4.795	1	0.029*	1.834	1.066	3.156
Constant	1.234	0.783	2.484	1	0.115	3.434		

CI confidence interval

* $P < 0.05$

Table 4 Variables related to WMSDs

Variables	Contents	Number of occurrence (%)
Types	Strain	16 (16.0)
	Sprain	31 (30.0)
	Dislocation	14 (14.0)
	Fracture	2 (2.0)
	Osteoarthritis	12 (12.0)
	Tendinitis	25 (24.0)
	Overuse	70 (68.0)
	Contusion	12 (12.0)
	Blister	2 (2.0)
	Abrasion/cut	14 (14.0)
	Laceration	6 (6.0)
	Others	12 (12.0)
Body regions	Neck	16 (16.0)
	Shoulder	27 (26.0)
	Upper arm	6 (6.0)
	Elbow	2 (2.0)
	Forearm	2 (2.0)
	Wrist	19 (18.0)
	Palm	2 (2.0)
	Finger	39 (38.0)
	Chest	2 (2.0)
	Abdomen	2 (2.0)
	Upper back	8 (8.0)
	Lower back	43 (42.0)
	Hip	4 (4.0)
	Thigh	10 (10.0)
	Knee	19 (18.0)
	Lower leg	2 (2.0)
	Ankle	16 (16.0)
	Foot	4 (4.0)
	Toe	2 (2.0)
	Others	2 (2.0)
Most performed tasks	Taping	75 (22.7)
	First aid	24 (7.3)
	Injury evaluation	84 (25.4)
	Modality therapy	32 (9.7)
	Manual therapy	59 (17.8)
	Administration	13 (3.9)
	Athletic education	40 (12.1)
	Others	4 (1.2)
Activity performed when injured	Operating machines	2 (1.3)
	Doing repetitive movement	33 (22.1)
	Bending or twisting body	11 (7.4)
	Fall or trip	10 (6.7)
	Maintaining a fixed posture for a long time	33 (22.1)
	Instructing athletes	5 (3.4)
	Perform manual therapy	41 (27.5)
	Lifting	2 (1.3)
Abrupt rushing or sprinting	4 (2.7)	
Others	8 (5.4)	
Causes	Working with a tried body	23 (22.7)
	Facility defect	11 (10.4)
	Sudden unexpected movements of athlete	7 (7.1)
	Working in an awkward position	15 (14.9)
	Limited time	9 (8.4)
	Performing one specific task repetitively	28 (27.3)
	Others	9 (9.1)
Coping strategies after occurrence	No specific action or limit	5 (4.4)
	Avoid lifting	2 (2.2)
	Use of assistive devices	9 (8.8)
	Request athlete's concentration during treatment	3 (3.3)
	Seek for help	8 (7.7)
	Body mechanic modification	18 (17.1)
	Modify work time/hours	2 (2.2)
	Decreasing the use of manual therapy technique	12 (11.6)
	Increase rest time	16 (15.5)
	Stop working when symptoms rise	6 (6.1)
	Frequent posture change	19 (18.2)
	Increase administration work and reduce direct contact with athletes	3 (2.8)

regions (OR(95% CI) = 15.618(3.197–76.291)/5.587(1.726–18.085)/12.128(3.881–37.899) for low back/finger/shoulder). Manual therapy was found to be a significant factor associated with shoulder symptoms (OR = 3.498, 95% CI: 0.979–12.495), but was not for the low back and fingers. All other task variables were not significant factors in this logistic regression model for the most affected regions.

Discussion

Since 1980, researchers have been studying the issues regarding AT's psychological stress and burnout [16–21]. On the other hand, physical injuries have rarely been discussed. Parts of the reasons for this imbalance might originate from the reluctance for compromising the self-esteem and professional images which these people live on. Similar to other physically demanding healthcare professionals such as physical therapists and nurses, athletic

Table 5 Summary of logistic regression models for the three most frequent affected body regions

Body region	Factor	The backward stepwise logistic regression model for WMSDS							
		Variables in the equation							
		B	SE	Wald	*df*	Significance	Odds ratio	95.0% CI for Exp (*B*)	
								Lower	Upper
Low back	Taping	3.342	1.224	7.455	1	0.006**	28.278	2.568	311.423
	First aid	2.748	0.809	11.535	1	0.001**	15.618	3.197	76.291
	Constant	−3.989	1.206	10.934	1	0.001*	0.019		
Finger	Taping	2.972	1.098	7.333	1	0.007**	19.535	2.273	167.912
	First aid	1.720	0.599	8.241	1	0.004**	5.587	1.726	18.085
	Constant	−3.660	1.070	11.704	1	0.001**	0.026		
Shoulder	First aid	2.496	0.581	18.428	1	0.000**	12.128	3.881	37.899
	manual	1.252	0.650	3.715	1	0.045*	3.498	1.979	12.495
	Constant	−2.678	0.574	21.754	1	0.000**	0.069		

CI confidence interval

*$P < 0.05$

**$P < 0.01$

trainers not only experience high psychological load, but also high physical demand. Researchers stated that athletic trainers need to respond to emergency situations, thus are subject to a unique set of stressors, including high athlete to athletic trainer ratio, minimal financial support, role conflict and ambiguity, long work hours, multiple job duties, etc. [18–23]. These factors not only cause psychological burnout, but they can also lead to physical injuries.

Prevalence of WMSDs

The prevalence rate of WMSDs among ATs in this study was approximately 50% (48.5%), which meant that WMSDs could occur in one out of two ATs therefore attention should be paid. Compared to previous literature, this 50% rate was somewhat lower than those found within other medical professionals such as nurses and physical therapists [4–7, 9, 11, 12, 14, 24]. Because of the differences in injury definition and the timing of injury occurrence, care should be taken when comparing the prevalence rate with other study results. This study surveyed WMSD occurrence in ATs while they performed their job duties. There are a couple of reasons that might contribute to the relatively lower injury prevalence rate in this study. First, most of the ATs in Taiwan worked part-time in addition to other jobs. If we only considered those who worked full-time (no less than 40 h per week), this prevalence rate would be 55.6%, very close to rates found among physical therapists and nurses. Second, a majority of our ATs worked part-time, therefore we asked for the injuries that happened while they were performing their AT job duties. However, some overuse injuries may occur accumulatively while they perform other jobs. We were not able to register these injuries with the design of our questionnaire. Last but not least, most of our ATs were in their 20–30 s, younger compared to other study populations. This might also contribute to the difference found in the prevalence rate.

As to the affected body regions, low back was ranked the first (42.0%). This finding was similar to the results in Bork et al. (1996) for physical therapists (45.0%) and Trinkoff et al. (2002) for nurses (47.0%) [4, 13]. The job duties for these health care professionals involve frequent lifting and manipulations in standing for long hours, therefore the lower back area was more prone to be injured [15]. In addition, athletic trainers have to react to emergency situation frequently [21], and the results of our regression analysis did reveal that performing first aid was a significant predictor for the low back disorders. Performing taping was also found a significant predictor for low back symptoms. Most taping instructional manuals instruct ATs to position the subjects in appropriate positions before they perform the tasks [25, 26]. However, in a field where equipments and time are limited, ATs need to compromise with the situations. Since taping was the second most performed task, ATs might position themselves in inappropriate positions while performing time-limited taping techniques. There were 14.9% surveyed ATs reported that working in an awkward position might be the reason for their WMSDs.

The second most affected area was finger (38.0%), and this finding was ranked the same with the results from West and Gardner (2001) for physical therapist [14], but higher than most other studies in physical therapist [9–11]. Logistic regression revealed that taping was a significant

predictor for finger symptoms. Taping technique involved repetitive tearing, tensioning and adjustment of the tape by finger movements [26], and it was the second most performed task reported; therefore, the relationship between taping and finger symptoms was apparent. Performing first aid, possibly because of its emergent nature, was also a significant predictor for finger symptoms. In addition, finger was frequently used for palpating a variety of tissues of various depths during physical examination, as well as for manipulating these tissues during many treatments.

The third most affected was shoulder (26.0%). This ranked the same with most WMSD studies for nurses [4, 6, 7]. Manual therapy utilized skilled, specific hands-on techniques such as palpation, massage, mobilization, stretch to evaluate and treat subjects, and shoulders provided both the stabilization and movement while performing these techniques. Another significant predictor for shoulder symptoms was first aid, similar to the findings for low back and finger regions.

Among the ATs we surveyed, most of them hurt themselves while performing manual therapy (27.5%), doing repetitive movement (22.1%) and maintaining a fixed posture for a long time (22.1%). These findings were quite similar to the activity types that caused WMSDs in physical therapists and nurses. Bork et al. (1996), Holder et al. (1999) and Salik and Ozcan (2004) researched WMSDs in physical therapists, and found the main reasons which caused WMSDs were handling too many patients per day, maintaining a fixed posture, doing repetitive movement and performing manual therapy [9, 12, 13]. Lusted et al. (1996) and Yip (2001) surveyed nurses and found lifting, doing repetitive movement and maintaining a fixed posture were the activities that caused injuries [27, 28].

In addition, as to the causes for WMSDs, most of our surveyed ATs got injured while they were performing one specific task repetitively (27.3%). This might be the main reason why our ATs demonstrated a high rate of overuse injuries. The 2nd ranked self-reported reason that led to WMSDs was working with a tried body. A feeling of tiredness usually came from long work hours and psychological stress. Long work hours were found to significantly correlate with WMSDs in this study. Psychological stress has a negative influence onto physical health therefore would also contribute to WMSDs. [16–21]. Working in an awkward position within a limited space was ranked the 3rd. Technique modification might be considered when the space is limited to avoid injuries.

Coping strategies after the occurrence of WMSDs was also reported. Similar to those found with physical therapists and nurses [3, 7, 11, 13], our ATs coped their symptoms by frequent posture change (18.2%), body mechanics modification (17.1%), rest (15.5%), and decreasing manual therapy technique (11.6%) and so on. Whether these common coping strategies were effective needs further investigation.

Relationship between WMSDs and Personal- and Occupational-related Variables

For all the variables we investigated upon, average work hours per week and whether they participated in continue education courses were significant predictors for the occurrence of WMSDs. Our results indicated that prevalence rate of WMSDs increased in ATs who worked more than 40 h per week. There were 36.3% ATs in our survey worked over 40 h per week. Eriksen (2003) investigated the relationship between work hours and neck problems among nurses and found nurses who worked over 36 h per week suffered more neck injuries. Cromie et al. (2000) observed that thumb injury among their surveyed physical therapists increased as the manual therapy hour increased. Darragh et al. (2009) found therapists with injuries worked approximately 2–4 h more per week than those without injuries [29]. The above-mentioned and the present studies revealed a common tendency- long work hours lead to more injuries. Legislatively, Article 30 in Taiwan Labor Standard Act clearly states that a worker shall not have regular working time in excess of 8 h a day and 84 h every 2 weeks. Even that, most of the ATs still work long hours to keep their jobs and make better livings. The governing bodies or institutes should be notified upon this phenomenon.

Moreover, our results indicated that participating in continue education helped in decreasing the prevalence of WMSDs. To the authors knowledge, no research has investigated the influence of continue education participation and its relationship with WMSDs in athletic trainers or other similar profession such as physical therapists. Continue education courses for AT cover areas such as basic principles regarding anatomy and physiology, to clinical applications including skill refinement. Whether these knowledge increased AT's awareness in body mechanics and injury managements needs further investigation. Nonetheless, Bork [13] and Scholey and Hair [30] observed that physical therapists' knowledge and expertise did not grant them immunity from WMSDs. Therefore, special-designed continue education courses and specific trainings on management of WMSDs are likely better ways to minimize this problem. However, follow-up studies about suchlike implementations' efficacies and costs are warranted.

Taiwan is one of the pioneer countries that built the athletic training profession based on the model of the United States, including its educational curricula. From a macro viewpoint, this new profession moderately benefits the elite athletes and general active population in Taiwan and contributes to sports medicine industry in recent years. However, according to our clinical observation and the

results from this study, WMSDs of ATs have become a noticeable worry of this young profession. According to the authors' review, there is very limited information upon ATs' WMSDs in USA, nor in other countries. This study revealed that WMSDs of ATs were similar to those found among nurses and physical therapists, but demonstrated job-specific characteristics. We hope these findings would help develop management strategies, and be a reference for other countries.

Limitations

One limitation *of this study* was that some of our part-time ATs had other jobs, and these jobs *would affect* their chances of getting WMSDs. For example, a stressful job would tire *one's* body, which would in turn affect his health. In addition, jobs that use similar muscle groups with those most performed work items by ATs would inevitably lead to muscle overuse. We did run statistical tests and no difference was found between the full- and part-time ATs regarding the prevalence rate, and their affected body regions and types demonstrated similar rankings. However, jobs other than athletic training could still impose extra load onto these part-time ATs, therefore the results should be interpreted with caution.

In addition, AT's job contents and work hours could vary on an as-need basis. Because of *one's* job demand, a part-time AT could increase his work hours during game seasons, and a full-time AT could become overload. These could interfere with the data, as a part-time AT might report an injury that he/she acquired from a full-time game coverage.

Furthermore, in order to include all forms of injuries which could occur within ATs' career, problems such as blisters and lacerations were included in our investigation. Blisters and lacerations may sound trivial. However, they are significant injuries and problems that ATs encounter from taping athletes and operating tools. They can be considered as analogies to needle injuries of nurses. Although the percentages of these injuries were comparatively low, they might possibly result in an inflated estimate of prevalence.

One more finding needs to be interpreted with caution. Based on double the recommended number of 10 cases per independent variable for logistic regression recommended by Hosmer and Lemeshow (2001) [31], the 103 cases available for the analysis did not satisfy the recommended sample size of 160 (8 independent variables times 20 cases per variable). This could be a reason why wide confidence intervals existed for tapping (for low back and finger areas) with statistical significance. Future studies with larger sample sizes are recommended in order to obtain greater precision.

Our data did not question why those used-to-be ATs left their career. Previous literature revealed that 1/6 of their surveyed therapists made career change because of WMSDs. There might be a possibility that those used-to-be ATs in this study suffered from WMSDs and left their career as consequences, however this needs to be confirmed via future research. Furthermore, although this study has investigated the coping strategies ATs chose after injury occurrence, more specific statistics such as the percentage of work time loss or the severity of disability is required for clinical application.

Conclusions

To the author's knowledge, none of the studies have investigated work-related musculoskeletal disorders (WMSDs) in athletic trainers. This study was the first attempt to survey the athletic trainers regarding the prevalence of WMSDs, and those related personal and job factors. The results indicated a 48.5% prevalence rate of WMSDs among athletic trainers in Taiwan, and these disorders were significantly predictable by the average work hours per week and continue education participation. Low back, finger and shoulder were the top three most affected regions, and their occurrence could be predicted by certain job features such as performing taping or first aid. The current results could provide relevant professional organizations general insights to WMSDs in athletic trainers, and hopefully bring more attention to AT career-related health issues. Further research examining safe patient handling ergonomics, proper equipment in the context of athletic training and professional development strategies is warranted.

Conflict of interest The authors did not have any financial and personal relationship with other people or organization that could inappropriately influence this work.

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