Conductors' occupational injuries: Prevalence, associated risk factors and a challenge for conducting pedagogy

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There is a well-established literature documenting the prevalence of playing-related injuries among instrumental music participants of all ages, from primary school students to collegiate and professional level musicians.[1—9] The kinds of Playing-Related Musculoskeletal Problems (PRMP) that have been documented vary. They range in type and severity, from mild or transient symptoms that may or may not affect performance to pain, weakness, or other symptoms that interfere with a player's ability to perform. These latter, identified as Playing Related Musculoskeletal Disorders (PRMD),[10] are common among instrumental musicians with lifetime prevalence rates as high as 70% -94% identified among professional orchestral players.[8, 11—18] For these musicians the consequences of PRMDs can be dire, ranging from loss of income to career-ending debilities.[19]

> The wear and tear of playing an instrument are unseen by the audience, yet the consequences are all too familiar to many professional musicians…For a soloist or a freelancer, there is no equivalent of baseball's disabled list—no performance, no income.[20]

As prevalence rates of musicians' injuries are becoming better documented in many areas of music performance, increasing attention has been given to understanding relationships between potential risk factors and exposures associated with the development of PRMD.[2, 13, 21] Since PRMD are often similar to work-related musculoskeletal disorders found in other occupations, multifactorial models from the field of occupational medicine have provided conceptual models in much of this research.[22—24] These models identify both intrinsic (individual to the performer) and extrinsic (activity related, work and other environmental characteristics) parameters as potential risk factors for the development of PRMD. Research showing associations of risk factors with PRMDs varies in the music medicine literature because of differing definitions, methodologies, and subject cohort characteristics (a more detailed review of this literature may be found in the work of Ranelli).[2—25] The following factors have been most commonly identified in existing research: age, gender, playing exposure, number of years playing (experience), instrument type, and location associations with specific instruments.

While there is a growing base of research regarding PRMDs for various professional instrumental musicians, little consideration has been afforded one group of musicians: conductors. With the exception of one prevalence study surveying 153 university choral conductors,[26] one article alluding to links between vocational activity and injuries experienced by conductors,[27] and abstracts from two conference presentations, commentary on conductors' injuries is found mainly in informal sources such as trade publications and newspaper articles. Although these are mostly anecdotal and case-based, they suggest that performance-related injuries are, as with other instrumental musicians, a common and serious problem among conductors. To date, no study has focused on conductors of instrumental ensembles, and risk factor associations have yet to be explored for PRMD among music conductors.

BACKGROUND AND PURPOSE

The unique role of conductors is to direct ensembles of musicians in a way that creates cohesive musical outcomes. Given conductors' important role in music making and the relative dearth of information regarding conductors' PRMPs and PRMDs, there is clearly need for studies that may provide information on both prevalence and risk factors for this group.

The current research undertakes to address this gap. Its aims are to:

1) Provide fundamental demographic and occupational activity information on conductors (with a focus on conductors of instrumental ensembles).

2) Establish clear prevalence rates for PRMDs among the conductors profiled in the research.

3) Identify general body locations of PRMD symptom sites and frequencies with which these areas are affected.

4) Examine possible associations with risk factors

and PRMDs commonly identified for other musicians in the music medicine literature — gender, age, and music exposure (amount of time spent conducting, amount of time spent practicing outside of rehearsals, total baton-in-hand hours, other music activities).

By providing foundational evidence on PRMDs among this group, the current research underscores the need for more research that might eventually increase understanding of the particular occupational conditions faced by conductors, and that might also investigate the development of injury prevention strategies for conducting students and professionals.

METHOD

A large online cross-sectional survey was used to gather vocational/workplace and injury data on music conductors. The survey was open from December 2012 to December 2013. The following organizations circulated e-mail invitations to participate in the study to their members: College Band Directors National Association, Conductors Guild, and Drum Corps International. These organizations were selected because their memberships: 1) include individuals of varied ages and years of experience; and 2) represent a wide variety of conductors who have been actively involved with diverse instrumental ensembles. Word of mouth provided a fourth avenue of participant recruitment. Participation in the survey was voluntary.

The survey used a three-step process and was modeled on the survey from the Sound Practice Project, a 5-year study involving baseline evaluation, development, and implementation of musician-specific work health and safety initiatives in Australian professional orchestras (used with kind permission of the authors: Ackermann, Driscoll, and Kenny). The current survey was designed so that respondents with no history of PRMD could undertake the survey in 10 minutes or less by completing the first section only. For those who self-identified as having PRMD, detailed information on at least one PRMD symptomatic area was required; more areas could be reported upon at the discretion of the respondent. The online process allowed participants to save partially finished surveys for later completion.

The first section of 17 survey questions gathered descriptive data in the following five areas:

1) personal demographics including gender, age, handedness, and which hand was used to hold the conducting baton.

2) professional background including educational qualifications, number of years active as a conductor, current employment status, and title of current position.

3) current conducting activities, including number of hours weekly spent conducting, number of hours weekly spent practicing conducting, types of ensembles conducted, and proficiency/levels of these ensembles.

4) music performance activity other than conducting (as an instrumentalist/vocalist), including primary instrument, secondary instrument, and weekly hours spent practicing and performing in these capacities.

5) injury prevalence data, including whether the injury caused pain or affected the respondent's ability to conduct (PRMP), whether these injuries were believed to be caused by conducting (PRMD), or were from other causes, and what additional factors respondents believed may have contributed to the injury.

The second section of the survey (questions 18 to 23) gathered information on symptom location(s) for respondents who identified as having had a performance-related problem that was perceived to have been caused, in whole or in part, by their conducting activities (PRMD). Participants selected and ranked up to four problem areas from the following list: head and neck, right arm, left arm, torso/trunk, pelvis/hip, right leg, and left leg.

The third and final section of the survey gathered more detailed information about identified symptomatic areas including: locational specificity, information on any existing professional diagnoses, how long the symptoms had been a problem, severity of the symptoms, persistence of symptoms, qualitative descriptors of the symptoms, whether conducting activity was making symptoms worse, and information on which working conditions that the participants felt may have led to the PRMD.

The current study reports on the first two sections

of the survey only (Appendix A). Data analysis and variables of interest are presented for lifetime prevalence of PRMDs calculated as a percentage of the whole. A set of logistic regression analyses were performed to investigate the effect of each variable on PRMD significance. All statistical analyses were performed in SPSS (version 22.0.0.0). Participants provided informed consent by clicking to continue the survey after presentation of study information. Confidentiality was ensured by assigning a unique number identifier to each respondent. Names of participants were not recorded.

RESULTS

In total, 404 conductors responded to the survey, and 287 of these respondents completed the survey: 41 (14.3%) female and 246 (85.7%) male. Only completed surveys (n=287) were used in the current study. Respondents aged between 16 and 93 (mean 43.5 years, SD 15.2). Females (mean 34.7, SD 12.4) were significantly younger (t=-4.137, df=285, p≤0.001) than males (mean 45.0, SD 15.2). 30 (73.2%) female respondents were 40 years of age or younger and none were represented in age groups older than 65. Table 1 shows ages of respondents grouped by age in 5-year increments.

21 (51.2%) female respondents reported 10 years or fewer conducting experience compared to 90 (36.6%) for males (χ^2=8.813, df=7, p=0.226), (Table 2). 242 (84.3%) respondents were right-handed, 35 (12.2%) were left-handed and 10 (3.5%) were ambidextrous. All but three respondents (99.0%) used their right hand to hold the conducting baton. Two hundred eighty-five of the respondents conducted at least one instrumental ensemble; two respondents conducted choirs only.

(Table 1 and 2)

Table 3 documents conducting activity by ensemble type, number, and general level of the ensemble. All respondents conducted at least one ensemble, and most conducted more than one. Four types of conducting activity for both genders were represented most often: band (65.9%), orchestra (43.2%), marching or athletic band (33.1%), and chamber ensemble (30.7%). The majority of respondents conducted at least one college/university ensemble (68.3%) and the vast majority of activity occurred at the high school

TABLE 1. Conductors' Ages

Years of Age	Female (n=41)	Male (n=246)	Total (n=287)	Total %
≤20	5	8	13	4.5
21 to 25	6	24	30	10.5
26 to 30	7	18	25	8.7
31 to 35	6	22	28	9.8
36 to 40	6	25	31	10.8
41 to 45	2	27	29	10.1
46 to 50	2	29	31	10.8
51 to 55	4	30	34	11.8
56 to 60	2	27	29	10.1
61 to 65	1	14	15	5.2
66 to 70	0	14	14	4.9
≥70	0	8	8	2.8
Total	41	246	287	100.0
Mean	34.7	45.0	43.5	
SD	12.4	15.2	15.2	

TABLE 2. Years of conducting experience

Female (n=41)	%	Male (n=246)	%	Total	%
13	31.7%	59	24.0%	13	4.5%
8	19.5%	31	12.6%	30	10.5%
6	14.6%	25	10.2%	25	8.7%
6	14.6%	25	10.2%	28	9.8%
3	7.3%	38	15.4%	31	10.8%
3	7.3%	27	11.0%	29	10.1%
1	2.4%	28	11.4%	31	10.8%
1	2.4%	13	5.3%	34	11.8%
41	100.0 %	246	100.0 %	287	100.0 %
13.1		17.0		16.3	
9.5		11.4		11.2	

levels or above (94.0%). Highest degree qualifications achieved by respondents were: Doctorate 137 (47.7%), Master's 87 (30.3%), Bachelor's 38 (13.2%) and Other 25 (8.7%). The largest cohort in the "Other" category was 16 (5.6%) and represented participants with incomplete undergraduate degree standing. The remainder were individuals with conservatory, licentiate, or other diplomas. Regarding employment status, 192 (66.9%) respondents were employed full-time by one employer, 14 (4.9%) were employed part-time by one employer, 36 (12.5%) were part-time with more than one employer, 27 (9.4%) were self-employed, and 18 (6.3%) were currently unemployed.

(Table 3 next page)

TABLE 3. Conducting activity: ensemble type, level, number

	Female	% females (n=41)	Male	% males (n=246)	Total	% total (n=287)
Types of ensembles						
Band	24	58.5%	165	67.1%	189	65.9%
Choir	8	19.5%	42	17.1%	50	17.4%
Orchestra	14	34.1%	110	44.7%	124	43.2%
Marching or Athletic Band	19	46.3%	76	30.9%	95	33.1%
Chamber Ensemble	9	22.0%	79	32.1%	88	30.7%
Jazz Ensemble	3	7.3%	39	15.9%	42	14.6%
Percussion Ensemble	2	4.9%	9	3.7%	11	3.8%
Other Ensemble	1	2.4%	19	7.7%	20	7.0%
Total	80		539		619	
Conducting activity - number of ensembles per participant						
1	14	34.1%	80	32.5%	94	32.8%
2	17	41.5%	80	32.5%	97	33.8%
3	8	19.5%	54	22.0%	62	21.6%
≥4	2	4.9%	32	13.0%	34	11.8%
Level of ensemble						
Elementary	2	4.9%	11	4.5%	13	4.5%
Middle school	4	9.8%	16	6.5%	20	7.0%
High school	17	41.5%	79	32.1%	96	33.4%
College/university	24	58.5%	172	69.9%	196	68.3%
Adult professional	9	22.0%	65	26.4%	74	25.8%
Adult semi-professional	10	24.4%	60	24.4%	70	24.4%
Adult amateur	10	24.4%	66	26.8%	76	26.5%

Note: percentages are expressed in terms of the subject population N=287 (f=41, m=246)

TABLE 4. Weekly activity hours reported

		female	% females (n=41)	male	% males (n=246)	Total	% total (n=287)
Conducting hours (with ensemble)							
	0 to 3	12	29.3%	35	14.2%	47	16.4%
	4 to 6	5	12.2%	73	29.7%	78	27.2%
	7 to 10	12	29.3%	71	28.9%	83	28.9%
	11 to 15	4	9.8%	34	13.8%	38	13.2%
	16 to 20	1	2.4%	11	4.5%	12	4.2%
	≥21	7	17.1%	22	8.9%	29	10.1%
	Total	41	100.0%	246	100.0%	287	100.0%
Practicing hours (without ensemble)							
	0	6	14.6%	41	16.7%	47	16.4%
	1	14	34.1%	94	38.2%	108	37.6%
	2	12	29.3%	57	23.2%	69	24.0%
	3	3	7.3%	23	9.3%	26	9.1%
	4	3	7.3%	10	4.1%	13	4.5%
	5	2	4.9%	6	2.4%	8	2.8%
	more than 5	1	2.4%	15	6.1%	16	5.6%
	Total	41	100.0%	246	100.0%	287	100.0%
Total baton-in-hand hours							
	0 to 3	10	24.4%	24	9.8%	34	11.8%
	4 to 6	4	9.8%	51	20.7%	55	19.2%
	7 to 10	10	24.4%	67	27.2%	77	26.8%
	11 to 15	8	19.5%	64	26.0%	72	25.1%
	16 to 20	2	4.9%	15	6.1%	17	5.9%
	≥21	7	17.1%	25	10.2%	32	11.1%
	Total	41	100.0%	246	100.0%	287	100.0%

Weekly physical exposure for conducting activities is documented in Table 4. In addition to hours spent in front of an ensemble, the number of hours spent practicing the gestures of conducting outside of rehearsals was documented for each respondent as well as total baton-in-hand hours (ensemble hours + practice hours). The majority of respondents, 161 (56.1%), conduct in front of their ensembles between 4 and 10 hours per week. 224 (78.0%) respondents practiced conducting gestures without the presence of an ensemble for two hours or less per week. 238 (83.0%) of all respondents reported total baton-in-hand hours of 15 h/wk or fewer with the largest cohort, 77 (27.8%), reporting total weekly baton-in-hand activity of 7 to 10 hours. There was a significant difference between gender and weekly conducting hours with an ensemble (χ^2=11.892, df=5, p=0.036). This difference lies in the 0–6 hours of weekly activity ranges; 12 (29.3%) females compared to 35 (14.2%) males spent 0–3 hours, and 5 (12.2%) females compared to 73 (29.6%) males spent 4–6 hours weekly conducting an ensemble. There were no significant differences between genders in practicing (without the ensemble) hours (χ^2=3.361, df=6, p=0.762). In terms of the total baton -in-hand hours differences between genders approaches significance (χ^2=10.854, df=5, p=0.054). Similar to findings for hours conducting an ensemble, the differences lie in the 0–6 hour ranges with more females in the 0–3 h/week range for total baton in-hand activity and more males in the 4–6 h/week range.

(Table 4 previous page)

In addition to activities as a conductor, 186 (64.8%) respondents reported performing as an instrumentalist or vocalist. 159 (55.4%) identified as performing on more than one instrument (having a primary and a secondary instrument). Primary instruments and exposure hours are reported in Table 5. There was no significant difference between genders in terms of hours of activity weekly as an instrumentalist/vocalist (χ^2=7.397, df=4, p=0.116); thus these activities are reported in the aggregate.

TABLE 5. Instrumental/vocal performance activities

		No.	%
Primary instrument			
flute		10	3.5
oboe		2	0.7
clarinet/saxophone		30	10.5
bassoon		3	1
trumpet		43	15
French horn		11	3.8
trombone		19	6.6
tuba/euphonium		17	5.9
percussion		5	1.7
violin		5	1.7
viola		2	0.7
cello/bass		5	1.7
piano		21	7.3
voice		10	3.5
guitar		3	1
no primary instrument		101	35.2
	Total	287	100
Hours of activity weekly			
0 to 5		193	67.2
6 to 10		60	20.9
11 to 15		21	7.3
16 to 20		4	1.4
more than 20		9	3.1
	Total	287	100

PAST OR CURRENT PAIN SYMPTOMS

One hundred ninety-three (193) (67.2%) respondents reported having had at least one musculoskeletal problem (PRMP) where pain or injury had interfered with their conducting. 165 (57.5%) of these identified conducting activities as being in whole or in part the cause of the problem (PRMD). 20 (7.0%) identified the problem to be unrelated to their conducting activities, and 8 (2.3%) were unsure whether the injury was connected with their conducting activities. Of the 165 respondents who identified as having a PRMD, 85 identified factors in addition to conducting that may have contributed to their PRMD. These factors can be group into six general categories.

PREVALENCE OF PRMD AND GENDER

As shown in Fig. 1, lifetime prevalence of playing-related musculoskeletal *problems* (PRMP) is higher among females (70.7%, 29/41) than males (66.7%, 164/246) [χ^2=0.264, df=1, p=0.608] while lifetime

prevalence of playing-related musculoskeletal *disorders (*PRMD) is lower among females (51.2%, 21/41) than males (58.5%, 144/246) (χ^2=0.770, df=1, p=0.380]), but neither effect is significant.

TABLE 6. PRMD - other contributing factors

	no.	% (n=287)
Physical Activities	36	12.5
IT related (computer work)	9	3.1
Other music Related	14	4.9
Accident	13	4.5
Sedentary Behavior	6	2.1
Aging	7	2.4
Total	85	30

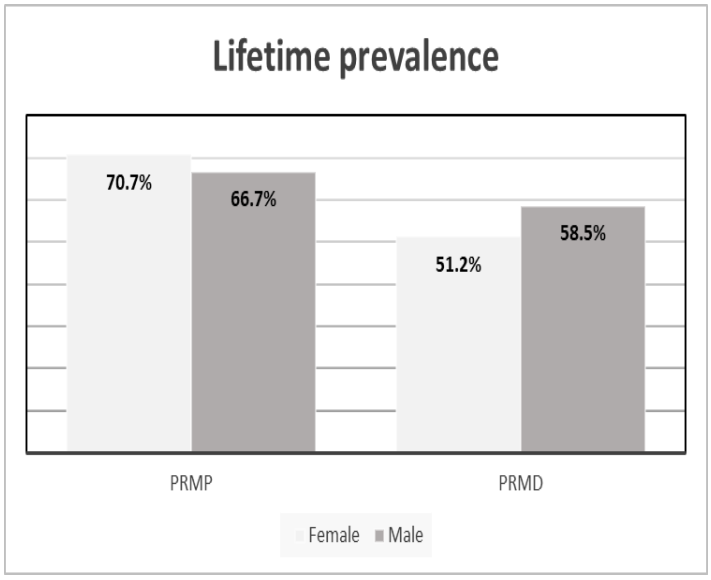

FIGURE1. Lifetime prevalence of PRMP and PRMD for females and males

PREVALENCE AND HANDEDNESS

Table 7 shows that left-handed conductors experience higher rates of injury than either right-handed or ambi-dextrous conductors. This relationship, however, was not found to be significant.

Table 7. Handedness and injury prevalence

		Have you experienced PRMD?			
		No	Yes	Percent with PRMD	Total
Handedness	Right Handed	82	160	66.1 %	242
	Left Handed	9	26	74.3 %	35
	Ambi-dextrous	3	7	70%	10
Total		94	193	67.2 %	287

Table 8 documents PRMD (n=165) prevalence by number and general regions of the problem as reported by respondents. Since respondents could choose to report on as many as four different problem areas, those who identified more than one problem area were required to rank them in terms of their severity with respect to limiting conducting activities. 117 (40.8%) respondents identified a PRMD the right (conducting) arm; 80 (27.9%) reported this to be their highest (#1) ranked PRMD. PRMDs in torso/trunk are reported by 61 (21.3%) respondents and in the head/neck area by 54 (18.8%). These latter two regions of PRMD ranked as the most important problem for 36 (12.5%) and 32 (11.1%) respondents, respectively. 44 (15.3%) identified a PRMD in the left arm, with rankings almost equally distributed among 1st, 2nd, and 3rd most serious problem areas for these respondents. Combined, pelvis, and leg PRMD affected less than 6% of the subject population.

(Table 8 next page)

PREVALENCE OF PRMD AND MUSIC ACTIVITY EXPOSURE

Four categories of activity exposure are identified in the current research:

1) weekly hours conducting an ensemble,

DISCUSSION

On the surface, the general demographic characteristics of survey respondents seem to indicate that some things have not changed much since the 1986 article of Harriet Simons [26]. Her subject population was found to be 83% male, while the current survey identifies 85.7% as male. Although respondents were self-

TABLE 8. Region of injury: totals and severity rankings

Injury region		Severity ranking of injury region				Total reporting the region (n=287)
		1st	2nd	3rd	4th	
Head and neck	No.	32	21	1	0	54
	%	11.1%	7.3%	0.3%	0.0%	18.8%
Right arm	No.	80	31	6	0	117
	%	27.9%	10.8%	2.1%	0.0%	40.8%
Left arm	No.	14	15	13	2	44
	%	4.9%	5.2%	4.5%	0.7%	15.3%
Torso/trunk	No.	36	18	5	2	61
	%	12.5%	6.3%	1.7%	0.7%	21.3%
Pelvis/hips	No.	2	4	3	3	12
	%	0.7%	1.4%	1.0%	1.0%	4.2%
Right leg	No.	0	2	1	0	3
	%	0.0%	0.7%	0.3%	0.0%	1.0%
Left leg	No.	1	1	0	0	2
	%	0.3%	0.3%	0.0%	0.0%	0.7%
		165	92	29	7	

2) weekly hours practicing the gestures of conducting without the presence of an ensemble,
3) total baton-in-hand hours, and
4) weekly hours involved playing and performing on an instrument/voice.

Fig. 2 shows the proportion of respondents reporting lifetime prevalence of PRMD, grouped by weekly hours of activity conducting an ensemble. The proportion of respondents reporting PRMD increases with increased activity, however the effect is not significant (χ^2=1.296, df=5, p=0.935). Likewise, there was neither significant interaction effect between PRMD and weekly hours practicing the gestures conducting without the presence of an ensemble (χ^2=7.352, df=6, p=0.290), nor total baton-in-hand hours (χ^2=1.538, df=5, p=0.909), nor exposure playing and performing on an instrument/voice (χ^2=4.264, df=4, p=.371), nor which instrument respondents performed on (χ^2=12.702, df=15, p=.625).

(Figure 2 next page)

PREVALENCE OF PRMD AND AGE

Logistic regression shows lifetime prevalence of PRMD to increase significantly with age (f=2.178, df=285, t=-3.185, p=.002). Fig. 3 shows the proportion of respondents reporting lifetime prevalence of PRMD, grouped by decade. Prevalence increases significantly with age with a moderate effect (χ^2=16.349, df=5, p=0.006, Cramer's V=0.239). Regression analysis shows the odds ratio risk of PRMD to increase by 2.6% for every year of age (confidence interval: 1.009, 1.043; p<0.002).

(Figure 3 next page)

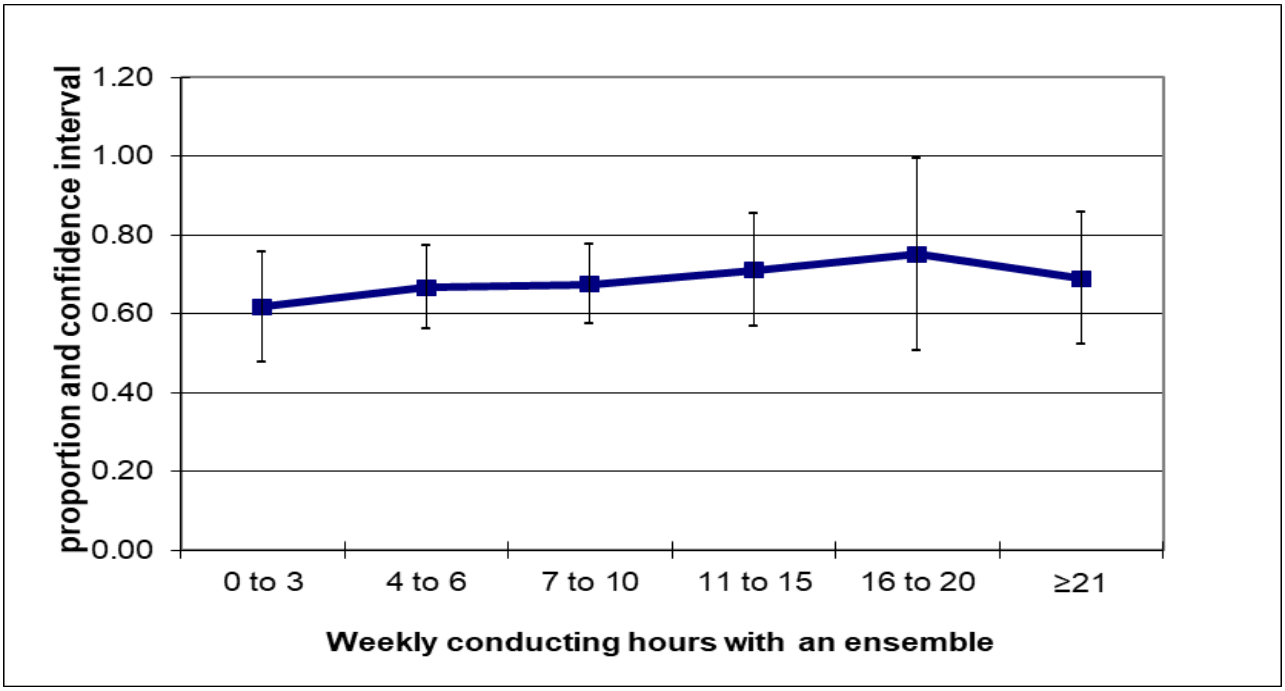

FIGURE 2. Proportion of respondents reporting lifetime PRMD prevalence weekly hours conducting activity in front of an ensemble, with 95% confidence intervals.

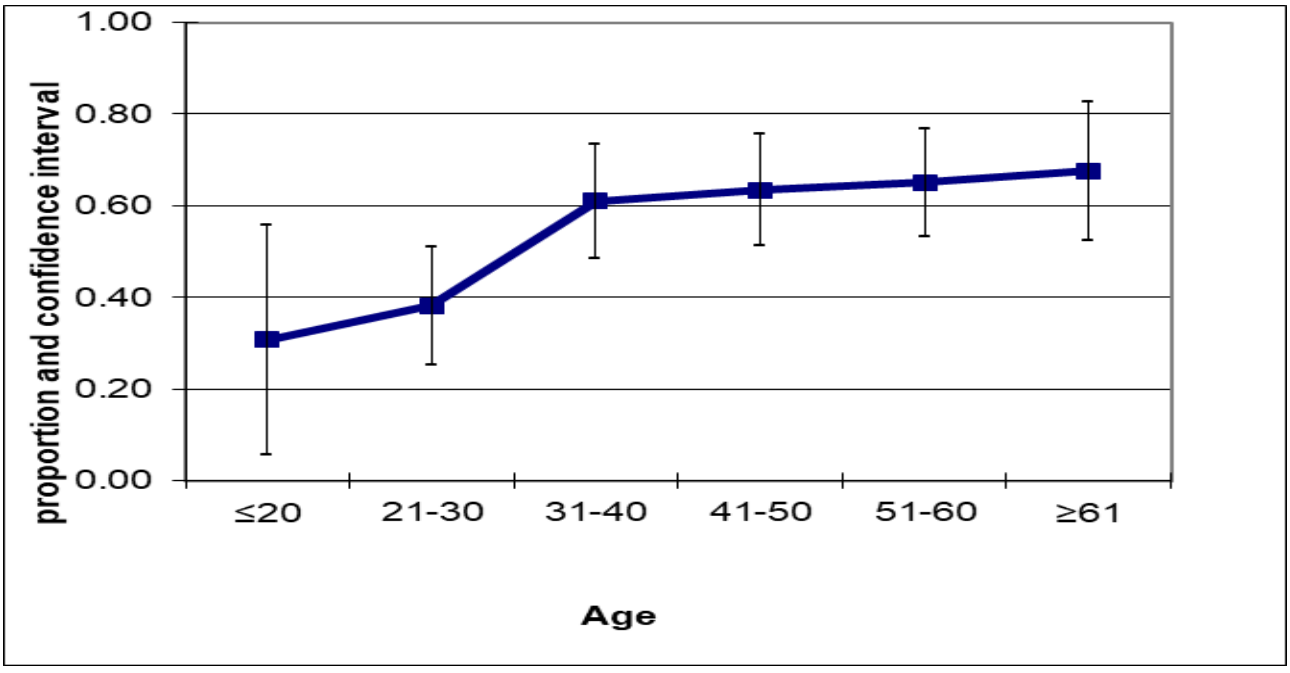

FIGURE 3. Proportion of respondents reporting lifetime PRMD prevalence across age groups, with 95% confidence intervals.

selecting and thus may not be a precise representation of the general population of conductors, these statistics do little to dispel the existing consensus that conducting (and, particularly, instrumental music conducting) has historically been a male dominated field. In terms of reporting results, the relatively low rates of female respondents limit some gender-based statistical comparisons. In this regard, where statistical measures are challenged, a look at overall trends provides perspective for discussion. As a final consideration, it is important to acknowledge that conductors usually start their musical training as an instrumentalist or vocalist. Many conductors lead dual careers as performers, so exposure to risk factors associated with their instrumental performance activities will be a confounding factor in the development of PRMD.

There are also points to consider in the fourth movement. At figure 93 a slight increase (as marked) in tempo works well. At figure 103 the tempo can relax a bit, as the metronome marks suggest. It is a good idea to hold the tempo slightly at figure 112, as this passage can rush and lose rhythmic control. Both Copland and Bernstein hold the tempo back at figure 117. There and at rehearsal 129 Copland slows the tempo beyond the metric modulation of the quarter-note becoming the eighth -note. Holding back the tempo a little more at each figure from 124 through 126 (as marked at 126) works very well.

Conducting is an aerobic art, whereby a conductor communicates temporal instructions (among many other things) to an ensemble of musicians using non-verbal cues. In a typical instrumental ensemble, such as an orchestra or band, players are arranged in approximately a 180° semi-circle in front of the conductor. Optimizing the visibility of conducting gestures to the various parts of an ensemble requires conductors to be dynamic in the use of their full bodies during rehearsal and performance, moving to face and address the sections of the ensemble within this 180° semi-circle while using their gestures to communicate expressive content. Thus, it is not unexpected that the results of the current survey indicate a high lifetime prevalence of PRMP and PRMD to exist among respondents. Fully 67.2% of participants in this study reported having had pain (PRMP) while conducting and 85.3% of those (57.5% of the entire subject population) indicated the activity of conducting to be wholly or partially responsible for the identified pain and discomfort (PRMD).

With regard to gender differences, on average female respondents were about 11 years younger than males. Females were, in the majority, in an earlier career stage (51.2% with 10 years or less conducting experience) than their male counterparts (63.4% with more than 10 years conducting experience). The current survey cannot distinguish whether these statistics represent an increase in the number of female conductors entering the profession in the last ten years, or whether they reflect a higher attrition rate of females from the profession. This notwithstanding, there was no significant difference between gender and: 1) the types of ensemble conducted, 2) number of ensembles conducted, or 3) level of ensembles. A slightly higher rate of PRMD was found for male respondents (58.5%) compared to females (51.2%). Although this contradicts previous research on PRMD prevalence where gender has been established as an injury risk factor,[28] this finding might be explained by the 11-year differential in mean ages between male and female participants in the survey.

When it comes to who specifically is reporting pain and injury while conducting, there are no significant relationships in the rate of injury/pain and several potential dependent variables. There were no differences found between sex, type of ensemble conducted, number of ensembles conducted, and level of ensemble conducted. Nor were there any significant differences found between weekly hours conducted, hours practicing conducting, baton-in-hand hours, type of primary instrument, hours practicing one's primary instrument, or handedness. These results, in effect, dramatically reduce the number of possible dependent variables to explore as causal sources of injury.

Indeed, age was the only variable of significance ($p = .002$). Regression analysis shows the odds ratio risk of PRMD to increase by 2.6% for every year of age. As seen in Figure 2, the large increase in risk of PRMD between ages of 21 and 40 may reflect employment characteristics at what would be an early stage of a conductor's career; in an effort to establish a reputation, early-stage conductors might be inclined to accept engagements notwithstanding typical considerations of scheduling, travel, and workload.

This finding is particularly of interest when interpreted in light of recent work by Kenny et al. (2018) [(29)]. In their study, results showed older mu-

sicians to not have a higher prevalence of problems, but the authors speculated that "dwindling numbers in the older age groups may suggest a '"survivor" effect, whereby those who develop significant age-related decrements may cease professional performance at earlier age."

There has long been anecdotal evidence that the physical act of conducting can have negative impact on the musculoskeletal systems. In order to prevent such injury, renowned wind ensemble conductor, Dr. Frederick Fennell (1978)[30] suggests stretching and calisthenics for conductors prior to their rehearsals and performances. While some recent research questions whether stretching and other warm-up activities are beneficial to performance or prevent injuries,[31] clinical consensus of current best practice suggests that that such warmups and exercises need to be tailored and targeted with consideration of performance demands.[32]

The data analysis regarding specificity of injury location is particularly relevant to possible avenues of future research. The most commonly reported location of injury was the right arm (nearly three times that of the left arm) followed by torso/trunk and head/neck. While 12.3% of respondents indicated that they were left-handed, and 3.5% were ambidextrous, 99% of respondents used the baton in their right hand. This is consistent with current conducting pedagogy. Although left-handedness was not shown to be significantly related with PRMP in this current study, we believe this is likely due to the small number of left-handed respondents. This notwithstanding, the high prevalence of right arm injuries (40.8% of respondents) indicates that an examination of conducting habits, conducting biomechanics, postural considerations that support right arm movements during conducting, and conducting pedagogy is warranted.

The results of the current study indicate that most conductors face pain and discomfort that is associated with the activity of conducting (PRMD). This represents a significant departure from Simmons (1986), where 64% of her subject population claimed conducting had *not* "adversely affected health in terms of causing musculoskeletal disorders or pain."[26] The current study seems to refute claims that "conductors are notoriously long-lived and relatively free of musculoskeletal problems."[33]

The current research provides evidence that PRMD are a prevalent and pervasive problem among conductors. Its findings open several avenues for future PRMD research pertaining to conductors. For example, are the high rates of injury reported in the current study an artifact of a shift from a "don't tell" musical culture to one where admission of injury is starting to be less stigmatized? ;[1, 33—35] or has there been a change in the working conditions for conductors? If the physical act of conducting is the source of injury and pain, are these exacerbated by specific choices of gestures or stylistic approaches to conducting? If the only identifiable causal relationship is between injury and age, what health-promoting strategies can conductors adopt that are specific to the athletic demands of their art? And, given the unequivocal results of the current study, perhaps the most pressing question of all becomes "what is the responsibility of pedagogy in fostering vocational health literacy, and best practices at foundational levels of teaching and learning the art of conducting"? Examination of these questions have significant implications for current pedagogical practices. Ultimately, the music performance and research community must work together with increasing effort and investment to help address performance-related musculoskeletal disorders among musicians.

CONCLUSION

Despite increasing research attention being devoted to the health and wellness of performing musicians, there is currently very little information regarding the performance health of conductors. Despite increasing research attention being devoted to the health and wellness of performing musicians, there has been little information regarding the performance health of conductors. The current study offers the first quantitative research to report on PRMD prevalence and associated risk factors for instrumental conductors, offering robust evidence that conductors experience high rates of occupational injuries (PRMD). With more than 2/3 of conductors reporting problems and 57.5% of conductors reporting PRMD, the current study underscores the need for music pedagogy to include instruction on injury risks and encourage thought and investment in research that might lead to the development of vocation-specific prevention strategies.

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