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Research

Soreness during non-music activities is associated with playing-related musculoskeletal problems: an observational study of 731 child and adolescent instrumentalists

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KEY WORDS

Instrument playing
Musculoskeletal problems
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ABSTRACT

Question: Is exposure to non-music-related activities associated with playing-related musculoskeletal problems in young instrumentalists? Is non-music-activity-related soreness associated with playing-related musculoskeletal problems in this group of instrumentalists? **Design:** Observational study using a questionnaire and physical measures. **Participants:** 859 instrumentalists aged 7 to 17 years from the School of Instrumental Music program. **Results:** Of the 731 respondents who completed the questionnaire adequately, 412 (56%) experienced instrument-playing problems; 219 (30%) had symptoms severe enough to interfere with normal playing. Children commonly reported moderate exposure to non-music-related activities, such as watching television (61%), vigorous physical activity (57%), writing (51%) and computer use (45%). Greater exposure to any non-music activity was not associated with playing problems, with odds ratios ranging from 1.01 (95% CI 0.7 to 1.5) for watching television to 2.08 (95% CI 0.5 to 3.3) for intensive hand activities. Four hundred and seventy eight (65%) children reported soreness related to non-music activities, such as vigorous physical activity (52%), writing (40%), computer use (28%), intensive hand activities (22%), electronic game use (17%) and watching television (15%). Non-music-activity-related soreness was significantly associated with instrument playing problems, adjusting for gender and age, with odds ratios ranging from 2.6 (95% CI 1.7 to 3.9) for soreness whilst watching television, to 4.3 (95% CI 2.6 to 7.1) for soreness during intensive hand activities. **Conclusion:** Non-music-activity-related soreness co-occurs significantly with playing problems in young instrumentalists. The finding of significant co-occurrence of music and non-music-related soreness in respondents in this study suggests that intervention targets for young instrumentalists could include risk factors previously identified in the general child and adolescent population, as well as music-specific risk factors. This is an important consideration for the assessment and management of the musculoskeletal health of young musicians. **[Ranelli S, Straker L, Smith A (2014) Soreness during non-music activities is associated with playing-related musculoskeletal problems: an observational study of 731 child and adolescent intrumentalists. *Journal of Physiotherapy* 60: 102–108]**.

Introduction

Activities of childhood and adolescence, such as vigorous physical activity, computer use and playing musical instruments, contribute to physical, cognitive and social development.[1,2] Positive and adverse health outcomes are associated with activity participation and may be influenced by levels of exposure. Musculoskeletal soreness has been reported with high exposures to: physical activity participation;[3] use of information and communication technology such computers and electronic games;[4] television viewing;[3,5] writing or other intensive hand activities such as needlework or handicraft.[6] Subsequently, position statements and evidence-based guidelines for children have been developed to ensure safe physical activity participation[7] and wise computer use.[1]

Learning a musical instrument is a common activity amongst children and adolescents. In 2005, 20% (520 500) of Australian children aged 5 to 14 years played a musical instrument outside of school hours.[8] Learning music promotes positive cognitive, social, emotional and physical development in children and contributes to positive life-long learning experiences.[9] However, playing a musical instrument is associated with rates of up to 67% of children having playing-related musculoskeletal problems,[10] which is similar to the rates of adult musicians.[11–13]

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The musculoskeletal problems of musicians include tendinopathies, nerve compression syndromes and focal dystonia, and are thought to have multiple risk factors.[14] These include: intrinsic factors (age, gender, psychosocial); extrinsic music-related factors (type of instrument, music exposure); extrinsic non-music-related factors (participation in activities of daily living, physical activity or computer use), with interactions between intrinsic and extrinsic factors (playing posture is influenced by physical attributes of instrument). There is limited research on playing-related musculoskeletal problems in children and adolescents, despite evidence that the development of musculoskeletal disorders commonly begins in adolescence.[15] Emerging evidence suggests that age,[16,17] gender,[13,16] psychosocial factors,[11,18] instrument type,[11,12,14,16,19,20] music exposure,[16,21] and playing posture[14] contribute to musculoskeletal problems in young instrumentalists. However, the relevance of participation in non-music activity is unclear.

Whilst a few instrumental studies have reported on non-music activity exposure in adults,[11,21–23] only one has examined the association with playing problems. Zaza[12] found no association between instrument playing problems and non-music activity participation – categorised as leisure activities (hobbies, physical activity), activities of daily living (house cleaning, child care, outside chores) and computer use – amongst 278 professional and tertiary music students.

Only three studies have reported on non-music activity exposure in young instrumentalists or soreness from these activities,[24–26] but none have investigated the relationship between either exposure to non-music-related activity or non-music-activity-related soreness with playing problems. In a cross-sectional survey of 425 music students, Shoup[26] found similar rates of playing problems in students who did and did not exercise. Dawson[24] reviewed the medical notes of 148 music students seen in a medical clinic over a five-year period and reported that 30% of the hand and upper extremity problems were due to sports-related trauma. In a cross-sectional study of 517 adolescent non-music and music students, Fry and Rowley[25] found that 71% of music students reported hand pain related to music playing and 6% reported hand pain from other activities such as pushing, lifting or carrying weights; 26% of non-music students reported hand pain due to writing. However, the music students were not questioned with regards to writing-related hand pain and therefore the relationship between writing-related hand pain and playing problems was not investigated.

Playing-related musculoskeletal problems and their risk factors need to be better understood in young instrumentalists. Therefore, the research questions for this study were:

1. What is the level of child instrumentalists' participation in non-music activities within the last month and do these differ by gender or age?
2. What is the experience of non-music-activity-related soreness of child instrumentalists within the last month and does this differ by gender or age?
3. Is there an association between non-music-activity exposure within the last month and playing problems, after accounting for any age and gender differences?
4. Is there an association between reports of non-music-activity-related soreness within the last month and playing problems, after accounting for any age and gender differences?

Method

Design

A cross-sectional questionnaire and anthropometric measures survey were conducted between August and December 2003. The questionnaire used in this study was *The Young People's Activity Questionnaire*,[27] which was modified by the addition of music-specific questions[28] and also contained general questions regarding the music student's age, gender and year at school. The questionnaire is presented in Appendix 1 (see the eAddenda). Questions regarding non-music activities covered watching television, use of computers and electronic games, vigorous physical activities, and intensive hand activities such as art and hand writing. The questions evaluated frequency of participation (nil, monthly, weekly, 2 to 3 times a week, daily), duration of each episode ($<$ 30 minutes, 30 to 60 minutes, 1 to 2 hours, 2 to 5 hours, $>$ 5 hours) and the soreness related to each non-music activity (nil, monthly, weekly, 2 to 3 times a week, daily) within the last month. The questionnaire focused on the experience of playing-related musculoskeletal problems within the past month, which were categorised as symptoms or disorders, as detailed under *Outcome measures* below. For both music-related and non-music-related activities, children indicated the location of their symptoms on a body diagram. Findings on the prevalence, frequency and impact of playing problems,[10] the influence of age, gender and music exposure on playing problems,[16,18] and the location of playing problems and associated risk factors[29] are published elsewhere.

The questionnaire was completed in a scheduled music class with the supervision of the instrumental teacher and took approximately 20 minutes to complete. Height was measured using a wall tape and a digital scale measured weight. One author (SR) performed anthropometric measures and was present during questionnaire completion to answer queries.

Participants

The School of Instrumental Music program in Perth, Western Australia, had 1274 students enrolled at the time of data collection. Due to examinations, career events or industrial action by educators, 350 students were unavailable. Of the remaining 924 students, 65 declined to participate, so a total of 859 students were given the questionnaire to complete. Because some questions pertaining to the experience of playing problems were unanswered, 128 questionnaires were deemed incomplete. Therefore, 731 students (460 females) aged 7 to 17 years completed the questionnaire and survey appropriately. The school selection process ensured a representative range of instrument types, socioeconomic areas and age groups, as presented in Figure 1. Further details of the cohort are reported elsewhere.[18] All instrumental classes at the selected schools were sampled, with no exclusion criteria.

Outcome measures

Primary outcome: Respondents could indicate playing-related musculoskeletal symptoms (ie, the experience of mild aches and pains, experienced during and following playing, that may or may not affect performance). These were elicited by the question: 'In the last month, did you feel any soreness anywhere when you played a musical instrument?'

Secondary outcome: Respondents could also indicate playing-related musculoskeletal disorders (ie, the experience of pain, weakness, lack of control, numbness, tingling or other symptoms that interfered with the ability to play the instrument as usual). These were elicited by the question: 'Did you feel any instrument-playing-related soreness, tingling or weakness that stopped you from playing your instrument as well as you usually play?'

The definitions that were used for disorders best determine rates of serious problems in adults.[12] However, symptoms were chosen as the primary outcome because symptoms in children should be acknowledged early, so that the relevant risk factors can

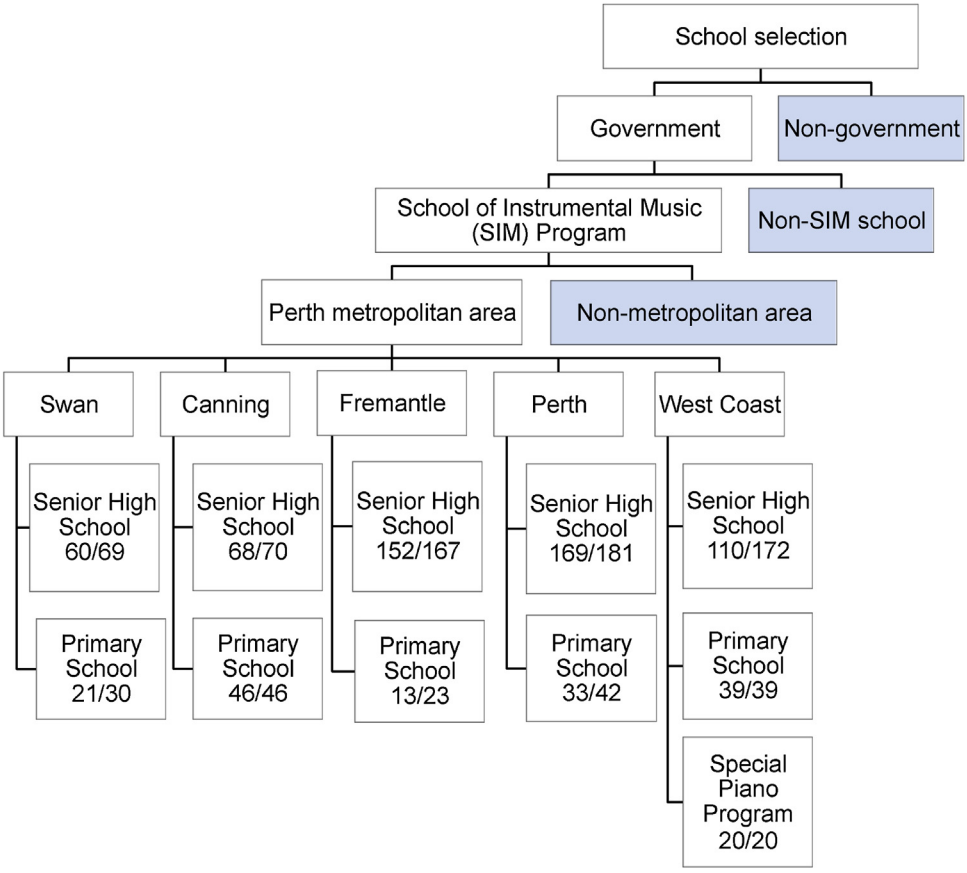

Figure 1. Selection of schools and participants for the study.

be identified and the appropriate intervention programs can be implemented to prevent development of disorders.[13]

Data analysis

A descriptive analysis was performed to characterise the non-music activities of the sample. To ensure adequate numbers for analysis, some categories of variables were combined, as presented in Table 1. A new variable – non-music-activity exposure – combined the frequency of participation and usual duration of participation, to establish categories of pattern of participation (eg, daily for 1 to 2 hours), and an exposure matrix[27] assigned levels of exposure (low, moderate-low, moderate, high) for the patterns of non-music-activity participation, as presented in Table 2.

Chi-square analysis was used to examine differences between males and females for categorical variables. ANOVA and bivariate Pearson correlation analysis examined the relationship between age and categorical variables. A series of logistic regression models were estimated with playing symptoms or playing disorders as the outcome variable. Firstly, univariable models estimated the unadjusted effect of non-music-activity exposure and activity-related soreness on the primary and secondary outcomes (ie, playing symptoms and playing disorders). Secondly, multivariable models estimated the independent association of all variables (non-music-activity exposure and activity-related soreness) with the primary and secondary outcomes accounting for age and gender. Thirdly, a final multivariable model included all variables significantly associated with the primary and secondary outcomes adjusted for age and gender, to examine the independent contribution of those factors to playing symptoms and playing disorders.

Results

Flow of participants through the study

From the 859 students who were given the survey, 731 (85%) questionnaires were fully completed, including 559/659 (85%) at secondary schools and 172/200 (86%) at primary schools, as presented in Figure 1. Of the 731 respondents, 489 (67%) reported a lifetime prevalence of playing symptoms, 412 (56%) reported symptoms within the past month, and 219 (30%) reported a playing disorder, that is, they were unable to play their instrument as usual due to the symptoms. The most-commonly reported locations for problems were the right (24%) and left (23%) hands, followed by the neck (16%) and the right shoulder (14%). Females (OR 1.6, 95% CI 1.1 to 2.4) and older children (OR 1.2, 95% CI 1.1 to 1.3) were more likely to report problems.

What is the level of child instrumentalist's participation in non-music activities within the last month and do these differ by gender or age?

Descriptive statistics for the non-music-activity frequency, duration and soreness are listed in Table 1. Frequencies of respondents in the exposure variable, which was derived from the reported frequency and duration according to the matrix in Table 2, are presented in Table 3. Respondents commonly reported moderate exposure to watching television (61%), vigorous physical activity (57%), writing (51%) and computer use (45%), as presented in Table 3. Only half of the respondents reported playing electronic games (52%) and participating in intensive hand activities (54%), with respondents commonly reporting low exposure to electronic

Table 1
Number of respondents reporting each category of frequency and duration for non-music-activity exposure, and frequency of non-music-related soreness.

	Number of respondents (% of respondents)					
	Television/video	Writing/drawing	Electronic games	Computer use	Hand intensive activities	Vigorous physical activity
Frequency of exposure	(n = 729)	(n = 727)	(n = 728)	(n = 729)	(n = 724)	(n = 729)
nil	11 (2)	8 (1)	349 (50)	39 (5)	326 (45)	71 (210
1/mth	[14 (2)	[14 (2)	[97 (13)	[47 (7)	[68 (9)	[14 (2)
1/wk	54 (7)]	24 (3)]	103 (14)]	143 (20)]	116 (16)]	122 (17)]
2–3/wk	174 (24)	60 (8)	[119 (16)	303 (42)	[155 (21)	334 (46)
daily	476 (65)	621 (85)	60 (8)]	197 (27)	59 (8)]	188 (26)
Duration of each exposure	(n = 729)	(n = 727)	(n = 728)	(n = 729)	(n = 724)	(n = 727)
0 min	12 (2)	9 (1)	350 (48)	49 (7)	324 (45)	70 (10)
< 30 min	89 (12)	160 (22)	129 (18)	153 (21)	121 (17)	68 (9)
30–60 min	224 (34)	275 (38)	141 (19)	263 (36)	175 (24)	290 (40)
1–2 hr	245 (34)	110 (15)	[70 (10)	172 (24)	85 (12)	229 (32)
2–5 hr	[119 (16)	[92 (13)	36 (5)	[74 (10)	[18 (3)	[63 (9)
5+hr	20 (3)]	81 (11)]	2 (1)]	18 (3)]	1 (1)]	7 (1)]
Frequency of soreness	(n = 710)	(n = 714)	(n = 378)	(n = 685)	(n = 401)	(n = 658)
nil	602 (85)	428 (60)	313 (83)	496 (72)	312 (78)	314 (48)
1/mth	[56 (8)	[113 (16)	[40 (11)	[102 (15)	[51 (13)	134 (20)
1/wk	26 (4)	93 (13)	15 (4)	58 (9)	22 (5)	130 (20)
2–3/wk	19 (3)	46 (6)	6 (2)	14 (2)	12 (3)	[61 (9)
daily	7 (1)]	34 (5)]	4 (1)]	15 (2)]	4 (1)]	19 (3)]

To ensure adequate numbers for the analysis, the bracketed categories were pooled prior to regression analyses.

games (23%) and moderate exposure to intensive hand activities (22%), as presented in Table 3.

Significantly more males reported high-exposure levels for watching television ($\chi^2 = 10.5$, $p = 0.03$), computer use ($\chi^2 = 11.9$, $p = 0.018$) and electronic game use ($\chi^2 = 94.7$, $p < 0.001$) than females, but there was no evidence of gender differences for exposure to writing, intensive hand activities and vigorous physical activities. For watching television ($F = 2.4$, $p = 0.05$), computer use ($F = 10.7$, $p < 0.001$), electronic game use ($F = 3.2$, $p = 0.014$) and writing ($F = 13.3$, $p < 0.001$), there was a significant association with age – with younger respondents reporting higher exposure levels than older respondents – but there was no association between age and exposure to intensive hand activities and vigorous physical activity.

What is the experience of non-music-activity-related soreness of child instrumentalists within the last month and do these differ by gender or age?

Many respondents reported soreness with vigorous physical activities (52%), writing (40%), and computer use (28%), whilst fewer respondents reported soreness with intensive hand activities (22%), electronic game use (17%) and watching television (15%), as presented in Table 1. More females reported soreness than males with writing ($\chi^2 = 26.2$, $p < 0.001$), computer use ($\chi^2 = 5.6$, $p = 0.018$), watching television ($\chi^2 = 6.9$, $p = 0.009$) and intensive hand activities ($\chi^2 = 3.9$, $p < 0.001$). Reports of soreness increased with increasing age for writing ($F = 17.4$, $p < 0.001$), computer use ($F = 10.4$, $p = 0.001$) and vigorous physical activities ($F = 25.3$, $p < 0.001$).

Table 2
Non-music-activity exposure matrix.[27]

Frequency	Duration					
	nil	< 30 min	30 to 60 min	1 to 2 hr	2 to 5 hr	> 5 hr
nil						
monthly		low	low	mod-low	high	high
weekly		low	low	mod-low	high	high
2 to 3/wk		mod-low	mod	mod	high	high
daily		mod-low	mod	mod	high	high

Is there an association between non-music-activity exposure within the last month and playing problems, after accounting for any age and gender differences?

As the majority of respondents participated in non-music-related activities at moderate levels of exposure, as presented in Table 3, this exposure category was used as the referent category in univariable logistic regression analysis. There was no significant association between any non-music-activity exposure and playing problems (OR 0.50 to 2.08), as presented in Table 3.

Is there an association between reports of non-music-activity-related soreness within the last month and playing problems, after accounting for any age and gender differences?

The report of soreness from all the non-music activities was significantly associated with increased odds for both playing symptoms and playing disorders (OR 2.34 to 4.27), as presented in Table 4. Given the consistent relationships, a count variable – 'number of reported activity-soreness experiences' – was created to assess if there was an additive association of non-music-activity-related soreness. Only activities with majority participation (watching television, writing, computer use and vigorous physical activities) were used to create this count variable. The number of respondents who complained of soreness with 0, 1, 2, 3 or 4 activities was calculated, and is presented in Table 4. In the univariate analysis, the number of reported soreness experiences was significantly associated with both playing symptoms and playing disorders, with an increased count of soreness experience associated with increasing prevalence of playing symptoms and playing disorders, as presented in Figure 2. In a multivariable logistic regression model, the number of reported soreness experiences remained significantly associated with increased odds for both playing symptoms and playing disorders, as presented in Table 5.

Discussion

This study found a high prevalence of instrument playing problems, particularly in the hand, neck and shoulder, amongst young instrumentalists. A third of the respondents were unable to

Table 3
Unadjusted odds ratio (95% CI) for playing-related musculoskeletal symptoms and playing-related musculoskeletal disorders with non-music-activity exposure (n = 731).

Non-music activity	Exposure category	Overall		Playing-related musculoskeletal symptoms				Playing-related musculoskeletal disorders			
		n	%	n	%	OR	CI	n	%	OR	CI
Television/videos	low	55	8	33	8	1.21	0.7 to 2.2	20	9	1.57	0.9 to 2.8
	moderate-low	92	13	56	14	1.26	0.8 to 1.9	34	15	1.61	1.0 to 2.6
	moderate	445	61	246	60	1.00		119	54	1.00	
	high	139	19	77	19	1.01	0.7 to 1.5	46	21	1.36	0.9 to 2.0
Writing	nil	13	2	7	2	0.87	0.3 to 2.6	4	2	1.02	0.3 to 3.4
	low	35	5	14	3	0.50	0.2 to 1.0	9	4	0.79	0.4 to 1.8
	moderate-low	137	19	74	18	0.87	0.6 to 1.3	37	17	0.85	0.6 to 1.3
	moderate	373	51	214	52	1.00		113	52	1.00	
	high	173	24	103	25	1.10	0.8 to 1.6	56	26	1.10	0.7 to 1.6
Electronic games	nil	353	48	206	50	1.40	0.9 to 2.1	112	51	1.25	0.8 to 1.9
	low	169	23	98	24	1.38	0.9 to 2.2	52	24	1.19	0.7 to 2.0
	moderate-low	53	7	26	6	0.96	0.5 to 1.8	13	6	0.87	0.4 to 1.8
	moderate	118	16	59	14	1.00		32	15	1.00	
	high	38	5	23	6	1.53	0.7 to 3.2	10	5	0.96	0.4 to 2.2
Computer use	nil	51	7	22	5	0.62	0.3 to 1.1	12	6	0.71	0.4 to 1.4
	low	152	21	95	23	1.35	0.9 to 2.0	49	22	1.10	0.7 to 1.7
	moderate-low	108	15	60	15	1.02	0.7 to 1.6	29	13	0.85	0.5 to 1.4
	moderate	328	45	181	44	1.00		99	45	1.00	
	high	92	13	54	13	1.15	0.7 to 1.8	30	14	1.12	0.7 to 1.8
Intensive hand activities	nil	333	46	185	45	0.90	0.6 to 1.3	96	44	0.93	0.6 to 1.4
	low	152	21	83	20	0.87	0.6 to 1.4	42	19	0.88	0.5 to 1.4
	moderate-low	65	9	38	9	1.02	0.6 to 1.8	23	11	1.26	0.7 to 2.3
	moderate	162	22	94	23	1.00		49	22	1.00	
	high	19	3	12	3	1.24	0.5 to 3.3	9	4	2.08	0.8 to 5.4
Vigorous physical activity	nil	75	10	43	10	1.14	0.7 to 1.9	20	9	0.85	0.5 to 1.5
	low	88	12	56	14	1.48	0.9 to 2.4	24	11	0.88	0.5 to 1.5
	moderate-low	83	11	44	11	0.95	0.6 to 1.5	26	12	1.07	0.6 to 1.8
	moderate	415	57	225	55	1.00		124	57	1.00	
	high	70	10	44	11	1.43	0.8 to 2.4	25	11	1.30	0.8 to 2.2

Table 4
Adjusted odds ratio (95% CI) for playing-related musculoskeletal symptoms and playing-related musculoskeletal disorders with non-music-activity-related soreness.

Non-music-activity-related soreness	Playing-related musculoskeletal symptoms				Playing-related musculoskeletal disorders			
	n	%	OR	CI	n	%	OR	CI
Television/videos (n = 108)	86	80	3.41	2.06 to 5.65	53	49	2.57	1.68 to 3.94
Writing (n = 286)	212	74	3.09	2.22 to 4.33	137	22	3.83	2.70 to 5.43
Electronic games (n = 65)	48	74	1.10	0.98 to 1.23	33	51	3.21	1.84 to 5.59
Computer use (n = 189)	138	73	2.34	1.61 to 3.34	88	47	2.52	1.76 to 3.59
Intensive hand activities (n = 89)	67	75	2.64	1.54 to 4.51	51	57	4.27	2.58 to 7.05
Vigorous physical activity (n = 344)	241	70	3.09	2.22 to 4.29	140	41	2.64	1.84 to 3.79
Number of soreness experiences								
nil (n = 253)	87	34	1.00		33	13	1.00	
1 (n = 200)	112	56	2.43	1.66 to 3.56	53	27	2.40	1.48 to 3.89
2 (n = 145)	106	73	5.19	3.31 to 8.13	60	41	4.71	2.87 to 7.71
3 (n = 95)	75	79	7.16	4.10 to 12.49	47	50	6.53	3.79 to 11.24
4 (n = 38)	32	84	10.18	4.10 to 25.27	26	68	14.44	6.65 to 31.38
total (n = 731)	412				219			

Table 5
Adjusted odds ratios (95% CI) in final multivariable model of relationship between playing-related musculoskeletal symptoms and playing-related musculoskeletal disorders and correlates.

Variables	Playing-related musculoskeletal symptoms			Playing-related musculoskeletal disorders		
	OR	CI	*p*	OR	CI	*p*
Age (yr)	1.14	1.05 to 1.25	0.003	1.15	1.04 to 1.27	0.006
Gender (female)	1.30	0.93 to 1.82	0.119	1.14	0.78 to 1.65	0.505
Number of soreness experiences						
nil (n = 253)	1.00			1.00		
1 (n = 200)	2.22	1.50 to 3.29	<0.001	2.31	1.41 to 3.79	<0.001
2 (n = 145)	4.58	2.87 to 7.31	<0.001	4.38	2.61 to 7.34	<0.001
3 (n = 95)	6.59	3.72 to 11.69	<0.001	6.69	3.78 to 11.84	<0.001
4 (n = 38)	9.10	3.60 to 23.02	<0.001	13.73	6.16 to 30.58	<0.001

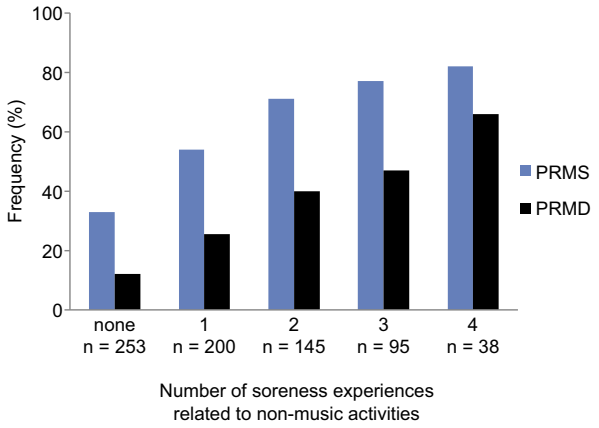

Figure 2. The prevalence of playing-related musculoskeletal symptoms (PRMS) and playing-related musculoskeletal disorders (PRMD) and number of non-music soreness experiences.

play their musical instrument as usual in the last month due to their symptoms. Young instrumentalists typically had moderate exposure to common non-music activities of childhood and adolescence, and two thirds reported soreness relating to non-music activities. Whilst exposure to non-music activities was not associated with playing problems, non-music-activity soreness was significantly associated with increased odds for playing problems.

Young instrumentalists in this study participated in a variety of non-music activities and it was expected that exposure from contemporaneous activity participation would be associated with playing problems. For example, static postures and repetitive actions of the hand during writing and other intensive hand activities are similar to those experienced when playing stringed instruments,[14] potentially increasing the load on tissues to beyond their capacity and leading to soreness. Potential reasons for the lack of any observed association in this study include the heterogeneity of activities, inadequate characterisation of exposure and that children may cease participation in these mainly leisure non-music activities when symptoms begin. The range of activities studied were perhaps varied enough to provide sufficient task variation, which has been found to decrease the risk for work-related musculoskeletal problems.[30] The study questionnaire was perhaps insufficiently sensitive in determining exposure data. For example, categories used to identify duration and frequency were large (ie, < 30 minutes or 30 to 60 minutes, and weekly or monthly), as presented in Table 1. This study relied on self-report to enter specific time units and specific sessions during the day for participation, therefore, exposure may have been under (or over) reported, which could have potentially influenced the analysis.[31] Direct measurement of posture and muscle activity could provide more reliable methods of data collection.[32]

Activity-related soreness was significantly associated with increased odds for playing problems for each non-music activity and remained significant after controlling for gender and age; this is consistent with other studies on pain in adults and adolescents.[33,34] In adults, pain at other musculoskeletal sites was predictive of subsequent occurrence of back pain.[33] The co-occurrence of musculoskeletal pains at different anatomical locations are common in children[35] and adolescents,[34,36] with the reported experience of 'other' musculoskeletal pains being a risk factor for the occurrence and persistence of neck pain in children.[37]

Other than pathologies associated with multiple pain sites (eg, idiopathic juvenile arthritis), there are several reported explanations for the co-occurrence of pain. The individual's general pain vulnerability influenced by mechanisms of pain perception and processing[38] may, for example, via central sensitisation, be responsible for the experience of pain independent to the initial nociceptive stimulus. The shared psychosocial risk factors, such as depressive mood, stress and the experience of pain by other family members, have been linked to low back pain,[39] neck and upper limb pain in children and adolescents.[34,37] The shared physical risk factors of concurrent activities, such as prolonged static postures adopted by children and adolescents while watching television[5] and during computer use,[4] have been associated with spinal pain.

In the current study, there was insufficient evidence to support the supposition that exposure to physical risk factors inherent in non-music activities contributes to playing problems. The current study provides evidence that the number of reported soreness experiences is associated with an increased risk of playing problems, and suggests that altered pain processing and psychological risk factors may be important. However, this study did not identify the time of onset of non-music or music-related soreness, so the temporal relationship between the two cannot be determined. Due to the cross-sectional design of the study, it is unknown whether children with activity-related soreness go on to develop playing problems or whether children with playing problems subsequently report activity-related soreness. However, 35% of respondents with playing problems did not report non-music-activity-related soreness. Furthermore, whether the locations of symptoms and problems were common or different across music and non-music related soreness was not determined, which may also be informative regarding potential mechanisms for the associations observed.

The present study included a large representative sample of young instrumentalists and controlled for age and gender. Future longitudinal studies are required to clarify the non-music-activity-related soreness and to elucidate any underlying causal relationship with instrument-playing problems.

More than half of the music students surveyed experienced symptoms relating to playing their musical instruments, with 30% having symptoms severe enough to interfere with normal playing. Almost two thirds of the music students reported soreness, which was related to non-music activities. Soreness with non-music activities was associated with increased odds for playing problems, which suggests common mechanisms. It is important that the reported experience of soreness in children and adolescents is not trivialised, and that the appropriate intervention strategies are implemented to address the known risk factors in order to prevent the development of more chronic disabling disorders in young instrumentalists.

What is already known on this topic: In children and adolescents learning instrumental music, there is little research on the influence of non-music activity exposure and non-music-activity-related soreness with playing problems.
What this study adds: Non-music-activity-related soreness is associated with the experience of playing problems in children and adolescent instrumentalists. Greater exposure to any particular non-music activity is not associated with greater risk of instrument playing problems.

eAddenda: Appendix 1 is can be found online at doi:10.1016/j.jphys.2014.05.005

Ethics approval: The Curtin University Human Research Ethics Committee (HR234/2002) approved this study. Participants and their parent or guardian provided informed assent/consent before data collection began.

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References

1. Straker L, Maslen B, Burgess-Limerick R, Johnson P, Dennerlein J. Evidence-based guidelines for the wise use of computers by children: Physical development guidelines. *Ergonomics.* 2010;54(4):458–477.
2. Strong WB, Malina RM, Blimkie CJR. Evidence based physical activity for school-age youth. *J Pediatr.* 2005;146(6):732–737.
3. Auvinen J, Tammelin T, Taimela S, Zitting P, Karppinen J. Neck and shoulder pains in relation to physical activity and sedentary activities in adolescence. *Spine.* 2007;32(9):1038–1044.
4. Hakala PT, Rimpela AH, Saarni LA, Salminen JJ. Frequent computer-related activities increase the risk of neck-shoulder and low back pain in adolescents. *Eur J PubHealth.* 2006;16(5):536–541.
5. Balagué F, Troussier B, Salminen JJ. Non-specific low back pain in children and adolescents: risk factors. *Eur Spine J.* 1999;8(6):429.
6. Niemi S, Levoska S, Kemila J, Rekola K, Keinanen-Kiukaanniemi S. Neck and Shoulder Symptoms and Leisure Time Activities in High School Students. *J Orthop Sports Phys Ther.* 1996;24(1):25–29.
7. Faigenbaum A, Kraemer WJ, Blimkie CJR, Jeffreys I, Micheli LJ, Nitka M, et al. Youth resistance training: updated position statement paper from the national strength and conditioning association. *J Strength Cond Res.* 2009;23(5 Suppl):S60–S79.
8. ABS. No 18. Children's participation in cultural and leisure activities 2006. [Electronic]: Australian Bureau of Statistics; 2006 [cited 2007 15th October 2007]; Available from: http://www.culturaldata.gov.au/publications/statistics
9. Hallam S. *The power of music: its impact on the intellectual, social and personal development of children and young people*. London: Institute of Education, University of London; 2001.
10. Ranelli S, Straker L, Smith A. Prevalence of Playing-Related Musculoskeletal Symptoms and Disorders in Children Learning Instrumental Music. *Med Probl Perform Art.* 2008;23(4):178–185.
11. Fishbein M, Middlestadt S, Ottati V, Straus S, Ellis A. Medical problems among ICSOM musicians: Overview of a national survey. *Med Probl Perform Art.* 1988;3(1):1–8. [reprinted from Senza Sordino, 1987 August].
12. Zaza C. *Musicians' Playing-Related Musculoskeletal Disorders: An examination of physical, psychological, and behavioural factors [Doctor of Philosophy]*. Waterloo: University of Waterloo; 1995.
13. Zaza C, Farewell VT. Musicians' playing-related musculoskeletal disorders: an examination of risk factors. *Am J Ind Med.* 1997;32:292–300.
14. Brandfonbrener A. Epidemiology and risk factors. In: Tubiana R, Amadio PC, eds. In: *Medical Problems of the Instrumentalist Musician*. London: Martin Dunitz; 2000: 171–194.
15. Perry M, Smith A, Straker L, Coleman J, O'Sullivan P. Reliability of sagittal photographic spinal posture assessment in adolescents. *Adv Physiother.* 2008;10(2):66–75.
16. Ranelli S, Smith A, Straker L. Playing-related musculoskeletal problems in child instrumentalists: The influence of gender, age and instrument exposure. *Int J Music Educ.* 2011;29(1):28–44.
17. Warrington J, Winspur I, Steinwede D. Upper extremity problems in musicians related to age. *Med Probl Perform Art.* 2002;17(3):131–134.
18. Ranelli S, Straker L, Smith A. The influence of music practice on playing-related musculoskeletal problems (PRMP) in children learning instrumental music. *Int J Music Educ.* 2011. accepted for publication 3rd July 2013.
19. Cayea D, Manchester R. Instrument-specific rates of upper-extremity injuries in music students. *Med Probl Perform Art.* 1998;13(1):19–25.
20. Lockwood AH. Medical problems of musicians. *New Engl J Med.* 1989;320(4):221–227.
21. Manchester R, Flieder D. Further observations on the epidemiology of hand injuries in music students. *Med Probl Perform Art.* 1991;6(1):11–14.
22. Fjellman-Wiklund A, Sundelin G. Musculoskeletal discomfort of music teachers: An eight-year perspective and psychosocial work factors. *In J Occup Environ Health.* 1998;4(2):89–98.
23. Zetterberg C, Backlund H, Karlsson J, Werner H, Olsson L. Musculoskeletal problems among male and female music students. *Med Probl Perform Art.* 1998;13(4):160–166.
24. Dawson W. Hand and upper extremity problems in musicians: epidemiology and diagnosis. *Med Probl Perform Art.* 1988;3(1):19–22.
25. Fry HJ, Rowley GL. Music related upper limb pain in schoolchildren. *Ann Rheum Dis.* 1989;48(12):998–1002.
26. Shoup D. Survey of performance-related problems among high school and junior high school musicians. *Med Probl Perform Art.* 1995;10(3):100–105.
27. Harris C. *Musculoskeletal outcomes in children using computers: a model representing the relationships between user correlates, computer exposure and musculoskeletal outcomes [Ph. D.]*. Perth: Curtin University; 2010.
28. Ranelli S. *Playing-related musculoskeletal problems in children learning instrumental music: Prevalence and associated potential risk factors [Doctoral Thesis]*. Curtin University Library: Curtin University; 2012.
29. Ranelli S, Straker L, Smith A. Playing-related musculoskeletal problems in children learning instrumental music: the association of problem location, and gender, age and music exposure factors. *Med Probl Perform Art.* 2011;26(3):123–139.
30. Mathiassen SE. Diversity and variation in biomechanical exposure: What is it, and why would we like to know? *Appl Ergonom.* 2006;37(4):419–427.
31. Wiktorin C, Karlqvist L, Winkel J. Validity of self-reported exposures to work postures and manual materials handling. Stockholm MUSIC I Study Group. *Scand J Work Environ Health.* 1993;19(3):208–214.
32. Ciccarelli ML. *Variation of posture and muscle activity during information and communication technology use by adults and school children [Ph.D.]*. Perth: Curtin University of Technology; 2008.
33. Papageorgiou AC, Croft PR, Thomas E, Ferry S, Jayson Iv M, Silman AJ. Influence of previous pain experience on the episode incidence of low back pain: results from the South Manchester Back Pain Study. *Pain.* 1996;66(2–3):181–185.
34. Mikkelsson M, Salminen JJ, Kautiainen H. Non-specific musculoskeletal pain in preadolescents. Prevalence and 1-year persistence. *Pain.* 1997;73(1):29–35.
35. El-Metwally A, Salminen JJ, Auvinen JP, Kautiainen H, Mikkelsson M. Prognosis of non-specific musculoskeletal pain in preadolescents: A prospective 4-year follow-up study till adolescence. *Pain.* 2004;110:550–559.
36. Auvinen JP, Paananen MVJ, Tammelin TH, Taimela SP, Mutanen POA, Zitting PJ, et al. Musculoskeletal pain combinations in adolescents. *Spine.* 2009;34(11):1192–1197.
37. Stahl M, Kautiainen H, El-Metwally A, Hakkinen A, Ylinen J, Salminen JJ, et al. Non-specific neck pain in schoolchildren: Prognosis and risk factors for occurrence and persistence. A 4-year follow-up study. *Pain.* 2008;137:316–322.
38. Woolf CJ. Central sensitization: Implications for the diagnosis and treatment of pain. *Pain.* 2011;152:S2–S15.
39. Balague F, Skovron ML, Nordin M, Dutoit G, Pol LR, Waldburger M. Low back pain in schoolchildren. A study of familial and psychological factors. *Spine.* 1995;20(11):1265–1270.