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Original article

Wrist and hand pain in orthopaedic physical therapists: A mixed-methods study

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A B S T R A C T

Background: Orthopaedic physical therapists (PTs) who perform manual therapy are at high risk for wrist and hand pain. Studies that examine the magnitude, scope and causes of wrist and hand pain are needed so that prevention programs can be developed.

Objectives: The objective of this study was to determine the magnitude, scope, and impact of wrist and hand pain in orthopaedic PTs and to identify potential strategies for prevention.

Design: This was a sequential, mixed methods study including quantitative and qualitative components.

Methods: The quantitative phase consisted of an online survey sent to members of the Academy of Orthopaedic Physical Therapy. The qualitative phase consisted of focus groups with Orthopaedic PTs who had wrist and hand pain.

Results: The survey included 962 PTs and the focus groups included 10 PTs. The one-year prevalence of wrist and hand pain was 75%. Increasing age, decreasing experience, female gender, performing more manual therapy and working more than 40 h per week were associated with an increased risk of moderate to severe wrist and hand pain. Soft-tissue mobilization was the most frequently cited causative factor. The most commonly mentioned strategy for prevention was altering body mechanics and technique. Focus group participants highlighted the importance of managing expectations for manual therapy by patients.

Conclusions: Formal injury prevention programs for PT students and PTs are urgently needed. These programs should focus on improving body mechanics and technique, attention to workload, careful selection of manual techniques, and managing expectations for manual therapy.

1. Introduction

Physical therapists (PTs) are at high risk for musculoskeletal pain (Cromie et al., 2000; Campo et al., 2008; Holder et al., 1999; Bork et al., 1996; Glover et al., 2005; Darragh et al., 2009; Gyer et al., 2018; Vieira et al., 2016). In inpatient settings (acute care, rehabilitation, long-term care) PTs are at risk for low back pain because of patient care that requires lifting patients (Cromie et al., 2000; Campo et al., 2008). In outpatient settings (private clinics or hospital based outpatient departments), PTs are at risk for wrist and hand pain because of patient care that requires manual therapy (Cromie et al., 2000; Campo et al., 2008; Bork et al., 1996; Rossettini et al., 2016; McMahon et al., 2006).

In studies of work-related pain in PTs, the prevalence of wrist and hand pain has varied depending on samples and methods. In a systematic review of wrist and hand pain in PTs, Gyer, Michael, and Inklebarger (Gyer et al., 2018) reported annual prevalence rates of wrist and hand pain ranging from 5 to 30%. In outpatient settings, the rates have been higher, particularly for thumb pain. Wajon and Ada (Wajon and Ada, 2003) reported that PTs working in specialized settings who perform spinal manual therapy had a very high prevalence of thumb pain (83%). Rossettini et al. (2016) reported a one-year prevalence of thumb pain of 49.3% in manual therapists.

The primary risk factor for wrist and hand pain is the performance of manual therapy techniques (Cromie et al., 2000; Campo et al., 2008; Darragh et al., 2009, 2012; McMahon et al., 2006). These techniques are taught in both entry-level and post-professional PT education programs. They require high forces that may result in substantial stress to the wrists and hands. Chiradejnant, Latimer and Maher (Chiradejnant et al., 2002) reported mean force levels of 194.8 N (44 lbs.) during grade IV applications of lumbar central posterior to anterior (PA) mobilizations. Snodgrass et al. (2009) reported mean peak force levels of 91.8 N (20.6 pounds) for PA mobilizations to C7. In clinical practice, busy clinical conditions, and the use of additional manual therapy techniques may result in even higher cumulative loads. These techniques may further predispose PTs to wrist and hand pain due to extreme joint angles, repetition, awkward postures, and compression (Cromie et al., 2000; Campo et al., 2008; Bork et al., 1996; Rossettini et al., 2016).

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In participatory ergonomics, workers are empowered and play a significant role in improving and redesigning their own work processes (Rivilis et al., 2008). Participatory ergonomics programs have been used in the manufacturing sector with demonstrated improvements in key occupational outcomes (Rivilis et al., 2008). PTs are uniquely suited to engage in participatory ergonomics to help limit wrist and hand pain. In addition to knowledge of their job tasks, they have knowledge of anatomy, kinesiology, ergonomics and musculoskeletal disorders. A study that leverages this expertise would provide an ideal foundation for intervention programs designed to prevent wrist and hand pain in this population.

The purpose of this project was to determine the scope and impact of wrist and hand pain in orthopaedic PTs as well as risk factors that could be targeted for intervention. We used a mixed-methods design that combined quantitative and qualitative data within one study. The mixed-methods design allowed for a deeper exploration of aspects of the work environment that cause and perpetuate wrist and hand pain. We intend to build upon the results to design prevention programs.

1.1. Methods

1.1.1. Design

This was a mixed-methods study with a sequential, explanatory design including quantitative and qualitative components (Rauscher and Greenfield, 2009). The quantitative component was based on an online survey and the qualitative component was based on focus groups (Rauscher and Greenfield, 2009). In a sequential, explanatory design the emphasis is on one of the two components. Our emphasis was on the quantitative component which was intended to identify targets for intervention in a broad sample. The qualitative component was intended to provide deeper insights (that may not have been identified by the survey) by describing the experiences and environments of therapists with wrist and hand pain. Integration occurred during the qualitative analysis. Open ended comments from the survey were compared to and contrasted with focus group comments to highlight key differences without ignoring the overlap. Integration was completed during the interpretation of the full project results.

1.2. Quantitative phase

1.2.1. Participants

Participants were PTs who were members of the Academy of Orthopaedic Physical Therapy of the American Physical Therapy Association. As of January 1, 2017, there were 17,571 PT members of the Academy.

1.2.2. Procedures

Data were collected through Research Electronic Data Capture (REDCap) hosted at Mercy College. Research Electronic Data Capture is a secure, web-based application designed to support data capture for research studies (Harris et al., 2009). An open link to the REDCap survey was included in an email from the Academy sent to all members on February 1, 2017. Members had until March 1, 2017 to respond. To increase the response rate, interested participants were entered in a raffle for a $500 gift card.

1.2.3. Instrumentation

The REDCap survey included items related to demographics, professional background, work habits, manual therapy, and wrist and hand pain. The survey was pilot tested with 10 orthopaedic clinical specialists who provided feedback on the questionnaire to assess face and content validity. Changes were made in response to their feedback. The full survey is included in Appendix A. Wrist pain was assessed with items, a diagram, and case definitions, adapted from Campo et al. (2008) and the Nordic Musculoskeletal Questionaire (Kuorinka et al., 1987). A mild case was defined as wrist and hand pain in the past 12 months. A moderate case was defined as pain for more than 30 days in the last 12 months with an average intensity of 3/10 or higher on a numeric rating scale. A severe case was defined as pain lasting more than 90 days in the last 12 months with an average intensity of 5/10 or higher on a numeric rating scale. A similar case definition has demonstrated criterion validity resulting in significant differences in presenteeism and health-related quality of life (Campo and Darragh, 2012; Darragh and Campo, 2017). However, the duration and frequency dimensions of the definition were modified (to the format specified above) in response to feedback during pilot testing.

1.2.4. Data analysis

Demographics and work characteristics were summarized with descriptive statistics. The association between general risk factors and moderate wrist and hand pain was assessed using multiple logistic regression (Hosmer et al., 2013). We considered an initial model with age, experience, gender, hours worked per week, and percentage of the day spent on manual therapy. Odds ratios (OR) and 95% confidence intervals were reported for each predictor and represented the increase in odds associated with a one-unit change in continuous predictors or other categories against the reference category for nominal predictors. Regression modeling assumptions were met satisfactorily with one exception (hours worked per week) which was subsequently dichotomized at the median because of failure to meet the linearity assumption.

The survey included open ended questions related to causes and prevention of pain. Respondents with pain indicated what job tasks they thought most contributed to the development of wrist and hand pain. Respondents with pain were also asked how pain could be prevented. Respondents without pain were asked a similar question – how they have been able to avoid wrist and hand pain. These open-ended survey comments were coded independently by two investigators. Codes were developed independently and then discussed and revised in additional rounds of coding. For comments related to the cause of pain, interrater agreement was 95%. For comments related to prevention, interrater agreement was 84%. Disagreements were resolved by consensus after calculating reliability. We did not calculate the Kappa statistic for reliability because there were multiple codes per case.

Data were analyzed using STATA (IC) v 15 (Stata Corp, LP, College Station, TX) and QDA Miner Lite v 2.02 (Provalis Research, Montreal, Canada). Charts were developed with IBM SPSS Statistics for Windows v 24 (IBM Corp, Armonk, NY).

1.2.5. Research ethics

The materials and methods of this phase were approved by the institutional review board of Mercy College. The first page of the survey was an informed consent document. Participants could only continue to the survey if they consented to participate by clicking to agree.

1.3. Qualitative phase

1.3.1. Sampling

We used a purposive sampling technique to identify therapists from the local community (n = 10) who suffered from wrist pain in the past 12 months and were currently working in outpatient, orthopaedic settings. Snowball sampling was used to identify additional participants.

1.3.2. Data collection

Data were collected in three focus groups of 5, 3, and 2 participants respectively that were conducted in June 2017. Groups were facilitated by a researcher with experience in running focus groups. A second researcher took notes and helped to facilitate. Prior to the focus groups, participants completed the survey that was used in the quantitative phase of the study. The focus groups were recorded, transcribed, and then checked against the recordings.

1.3.3. Focus group questions

We used four questions and followed-up with specific probes when needed. The primary questions were: 1. Tell us about your wrist and hand pain. 2. What do you think led to this wrist and hand pain? 3. How has this affected your work? and 4. What about prevention?

1.3.4. Data analysis

The qualitative analysis followed a descriptive, qualitative approach (Colorafi and Evans, 2016; Willis et al., 2016; Neergaard et al., 2009). Descriptive, qualitative studies offer a flexible approach that is ideal for health sciences research and mixed method studies (Neergaard et al., 2009). We analyzed the focus group transcripts using content analysis. Two investigators read through the transcripts, took notes and discussed the results. The transcripts were then reviewed by both investigators simultaneously to identify units of meaning (a phrase, sentence or multiple sentences). Units of meaning were then coded independently using an open coding process to develop preliminary codebooks. These were discussed and revised until consensus was reached. The units of meaning were coded again with the revised codebook, collapsing, revising, and categorizing codes as necessary. The investigators discussed the codes and categories again until consensus was reached. In a final round of coding, units of meaning were coded as individual cases. After this round, interrater reliability was calculated and determined to be good (agreement = 86%, Cohen's kappa = .85). Final disagreements were resolved by consensus after checking reliability. Data were coded using QDA Miner Lite (Provalis Research, Montreal, Canada) and calculations were performed in STATA v 15 (Statacorp, LLC, College Station, TX).

1.3.5. Strategies to improve validity

Prior to the focus groups, the two coding investigators reflected on their biases and their potential effect on the methods and interpretation of the results (bracketing). Triangulation strategies included triangulation of observers (two facilitators), analysis (two analysts), and methods (qualitative and quantitative data). The investigators debriefed after each focus group to compare impressions and determine if saturation was reached. An audit trail of all meetings and discussions was maintained.

1.3.6. Research ethics

The materials and methods of this phase (independent from the prior IRB) were approved by the IRB of Mercy College. All participants read and signed informed consent prior to participation.

2. Results

Participant characteristics for both phases are described in Table 1. In response to the survey email, 1011 PTs replied. Two did not consent, 3 were not working at the time of the survey, and 44 stopped the survey too early to yield usable responses (n = 962). Focus group participants were younger and had fewer years of experience than survey respondents.

2.1. Quantitative results

2.1.1. Wrist and hand pain

Outcomes are summarized in Table 2. The one-year prevalence of wrist, hand or thumb pain was 74.8%. The thumb was the region with the highest prevalence (52.5%). Females had a higher prevalence of pain (80.6%) than males (66.2%) and a higher prevalence of moderate pain (28.7%) than males (18.1%). About half of the cases were bilateral (50.7%).

2.1.2. Associations between work characteristics and pain

Results from the logistic regression analysis are summarized in Table 3. Older age, fewer years of experience, female gender and working more than 40 h per week were associated with increased odds of wrist and hand pain. Performance of manual therapy for more than 75% of the work day was associated with odds of wrist and hand pain that were 3.69 times as high as performance of manual therapy for 0–25% of the workday after controlling for age, gender, experience and work hours. Pairwise interactions between age, experience, gender and hours per week were not significant.

Table 1
Participant characteristics.

Characteristic	Survey	Focus Groups
N	962	10
Age in Years, mean (SD)	42.6 (11.9)	41.6 (11.7)
Experience in Years, mean (SD)	16.7 (12.3)	10.8 (10.6)
Years at Current Position, mean (SD)	10.3 (10.0)	4.9 (6.7)
Hours per Week, mean (SD)	38.7 (9.7)	43.5 (13.8)
Patients per Day, mean (SD)	10.9 (6.2)	14.5 (5.0)
Gender		
Female N (%)	576 (60.1%)	4 (40.0%)
Male N (%)	382 (39.9%)	6 (60.0%)
Setting*		
Private outpatient office	481 (50.1%)	7 (70.0%)
Health System/Hospital Outpatient	337 (35.1%)	3 (30.0%)
Academic Institution	66 (6.9%)	
Board Certification		
Orthopaedic	407 (42.3%)	2 (20.0%)
Sports	36 (3.7%)	
Geriatrics	8 (0.8%)	
Neurologic	3 (0.3%)	
Women's Health	2 (0.2%)	
Clinical Electrophysiology	1 (0.2%)	
Pediatric	1 (0.1%)	

Table 2
Prevalence of wrist, hand and thumb pain.

Pain		Survey	Focus Groups
Severity	None	242 (25.2%)	
	Minor	485 (50.4%)	4 (40.0%)
	Moderate	192 (20.0%)	6 (60.0%)
	Major	43 (4.5%)	
Location	Wrist	417 (43.4%)	6 (60.0%)
	Hand	219 (22.8%)	8 (80.0%)
	Thumb	505 (52.5%)	7 (70.0%)
Side[a]	Left	105 (14.6%)	1 (10%)
	Right	250 (34.7%)	3 (30%)
	Bilateral	365 (50.7%)	6 (60%)

[a] Percentage of cases with wrist pain. All other percentages represent the percentage of the full sample.

Table 3
Risk factors for moderate wrist and hand pain.

Predictor	Format	Prevalence	Odds Ratio (95%CI)	*P*
Age (years)	Mean centered		1.08 (1.04–1.13)	< .01
Experience (years)	Mean centered		0.96 (0.93–1.00	.04
Gender	0 (Male)		2.10 (1.50–2.94)	< .01
	1 (Female)			
Male	Reference	18.1%	1.00	
Female		28.7%	2.10 (1.49–2.96)	< .01
Hours per week	0 (< =40)			
	1 (> 40)			
< =40 h	Reference	22.3%	1.00	
> 40 h		31.9%	1.72 (1.19–2.47)	< .01
Manual Therapy	(% of workday)			
0–25%	Reference	15.3%	1.00	
26–50%	0 (No), 1 (Yes)	21.3%	1.71 (1.05–2.79)	
51–75%	0 (No), 1 (Yes)	28.5%	2.42 (1.47–3.97)	< .01
76–100%	0 (No), 1 (Yes)	38.9%	3.69 (2.13–6.40)	< .01

Table 4
Task difficulty, coping strategies and impact of pain.

Effect of Wrist or Hand Pain	Likert Response Summaries				
Difficulty of Task while in Pain	Very Easy	Easy	Neutral	Difficult	Very Difficult
PROM/muscle stretching	298 (45%)	189 (28%)	106 (16%)	68 (10%)	5 (1%)
Documentation/notes	246 (35%)	151 (21%)	175 (25%)	125 (18%)	13 (2%)
Peripheral joint mobilization	118 (18%)	165 (25%)	174 (26%)	182 (27%)	29 (4%)
Spinal joint mobilization	65 (11%)	87 (14%)	169 (27%)	245 (40%)	49 (8%)
Soft tissue mobilization	39 (6%)	90 (13%)	152 (23%)	322 (48%)	65 (10%)
Frequency of Strategy	Never	Rarely	Sometimes	Often	Always
Worked fewer hours	653 (92%)	32 (5%)	14 (2%)	6 (1%)	4 (1%)
Treated fewer patients	641 (91%)	34 (5%)	18 (3%)	9 (1%)	4 (1%)
Used a brace/splint	428 (60%)	83 (12%)	98 (14%)	77 (11%)	25 (4%)
Performed fewer manual techniques	193 (27%)	156 (22%)	250 (35%)	94 (13%)	17 (2%)
Avoided specific manual techniques	143 (20%)	132 (19%)	254 (36%)	149 (21%)	30 (4%)
Altered body mechanics/technique	54 (8%)	45 (6%)	214 (30%)	277 (39%)	117 (17%)

Impact of Pain	Strongly Disagree	Disagree	Agree	Strongly Agree
Has reduced quality of care	326 (46%)	259 (36%)	116 (16%)	9 (1%)
Has reduced job satisfaction	258 (37%)	253 (36%)	170 (24%)	23 (3%)
Will limit longevity in career	166 (24%)	268 (38%)	218 (31%)	50 (7%)
Will limit longevity in setting	164 (23%)	215 (30%)	260 (37%)	69 (10%)

2.1.3. Task difficulty, coping strategies and impact of pain

Responses to Likert items are summarized in Table 4. Soft-tissue work was identified as the task that was most difficult to perform while in pain. Altering body mechanics and technique was the most frequent strategy to mitigate or prevent pain. The most common impact of pain was a concern that wrist and hand pain would limit longevity in the current setting.

2.1.4. Causes of pain

Fig. 1 summarizes the coding of open-ended responses to the question “What work task(s) do you feel contributed most to the development of your wrist and hand pain?" Soft-tissue mobilization was the most commonly cited task.

2.1.5. Strategies to avoid pain

Fig. 2 summarizes the responses and analysis of the open-ended questions based on prevention. The most common preventive strategy was body mechanics and technique followed by use of tools and devices, performing less manual therapy, education, and stretching, strengthening and conditioning. Category definitions are included in Appendix B.

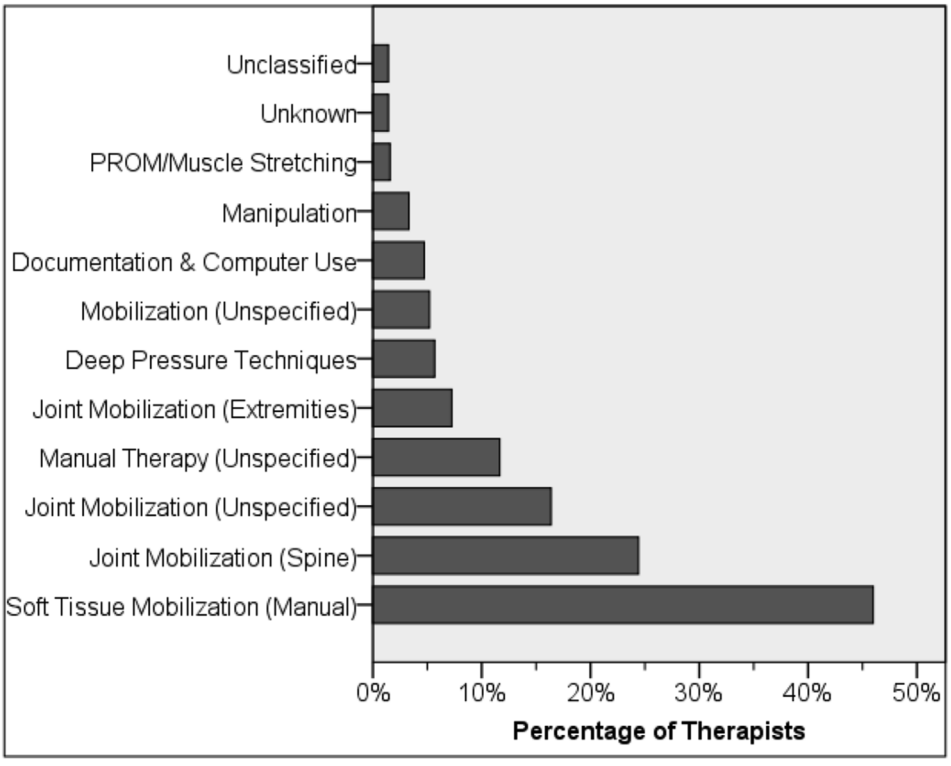

Fig. 1. Causes of Pain Categories with less than 1% responses are omitted.

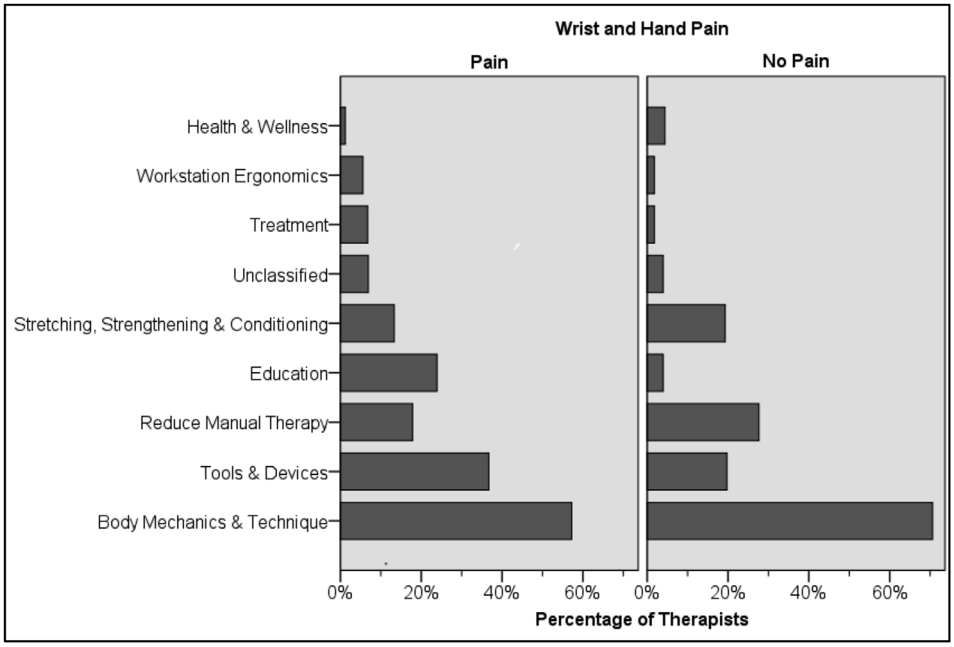

Fig. 2. Prevention of pain.

2.2. Qualitative results

2.2.1. Modifications

The qualitative categories and codes are defined in Appendix C. The most frequent category was modifications. Codes in this category referred to adjustments that the participants made to mitigate or prevent wrist and hand pain.

2.2.2. Modifications: body mechanics and technique

The most common code under modifications was body mechanics and technique. Participants described changes they made to the way they perform manual techniques:

> "So, I've been working pretty heavily on my body mechanics trying to make sure my thumbs aren't over flexed or over extended, my arms and wrists aren't over flexed or over extended, so I've been trying to keep as neutral as possible …"

> "…I have to think about altering my mechanics instead of you know, pushing with my end range thumb extension, I would have to put my hand over the area and just you know, figure out other ways …"

> "I guess we talk about body mechanics in school, but we don't really know until you're in the field what that's all about."

> Modifications: Less Manual Therapy

> Other therapists noted that performing less manual therapy, especially by encouraging patient independence, could be an important strategy:
> *"…eventually pick and choose when to use your mobilization"*

> "I think the only solution I can come up with is to limit … and pick a certain amount of patients per day that you're going to do that manual on."

2.3. Professional expectations

Codes in this category referred to the high expectations that participants had for themselves and their perceptions of the high expectations that patients had for them.

2.3.1. Professional expectations: patient expectations

Most of the discussions about perceptions of patient expectations were related to manual therapy, particularly soft-tissue mobilization:

> "So, I'm often struggling against that idea that I'm just here to kneed you into a pulp, then you do a couple of this and few things and go home"

> "One of the things I see, which is at least true in my practice is that patients come in, and they want manual. But their idea of manual is a massage"

Participants also reported that patients expected high levels of hands on care:

> They will come in and say, "oh you're not touching me." And you know I'm trying to work on range and strength. And he'll go "oh, you're missing a component."

Several participants commented that they were able to temper patient expectations for manual therapy, but noted that it was still a challenge:

> I try to teach them … that I may not always put my hands on you, per se, it's also about you helping yourself too. It's 50/50, I try to establish that from the beginning, so they know that they have to work too, it's not just passive treatment. And that's what has gotten me through a lot of saving my hands"

2.3.2. Professional expectations: personal expectations

Along with high expectations from patients, participants had very high expectations for themselves. They reported expectations that they would work through pain, work long hours, and try to provide the very best care possible, even if they were in pain:

> "You want to do the best for your patient otherwise we wouldn't be in this field."

> "So, you know we beat ourselves up when we treat our patients, because that's what comes first."

2.3.3. Professional expectations: longevity

Clinical and professional longevity were a concern for many of the

participants. Participants had expected long careers but some were not sure how long they could continue to practice given the physical demands:

"I'm not ready to give up yet, but I definitely have those, you know I'm starting to think, 'how long am I going to be able to do this until I can't anymore?'"

"You don't realize that this profession is meant for younger people"

2.4. Maintenance and treatment

Codes in this category referred to a variety of activities therapists engaged in so that they could continue to work.

2.4.1. Maintenance and treatment: self/colleague treatment

Some participants sought out informal treatment from colleagues or treated themselves:

"…I sometimes try to do a manipulation, and sometimes I just need to smack my hand and see if it will kind of click itself back in, and sometimes it works and sometimes it doesn't."

"We don't get treated, we're grabbing a co-worker and are like can you do this for me?"

2.4.2. Maintenance and treatment: therapeutic exercise

"The feeling gets tight, I try to stretch it out"

"…I've been trying to strengthen myself at the gym …"

3. Discussion

The purpose of this study was to determine the prevalence and impact of wrist and hand pain in orthopaedic PTs and to identify the most problematic job tasks. The annual prevalence of wrist and hand pain (75%) was higher than the rates reported by Cromie et al. (2000), Campo et al. (2008), and most of the rates summarized in systematic reviews by Gyer, Micheal and Inklebarger (Gyer et al., 2018) and Viera et al. (Vieira et al., 2016) Studies examining only manual therapists have reported similar or higher rates however, particularly for thumb pain. In the current study, prevalence of thumb pain (52.5%) was close to the annual prevalence of thumb pain found by Rossettini et al. (2016) (49.3%), but lower than the lifetime prevalence found by Wajon and Ada (83%) (Wajon and Ada, 2003b). Response rates, case definitions, and standards for work-relatedness varied widely across studies complicating the comparison of rates and severity levels.

The association between manual therapy and wrist and hand pain was consistent with previous studies (Cromie et al., 2000; Campo et al., 2008; Bork et al., 1996; Darragh et al., 2009, 2012). Among manual therapies, soft-tissue mobilization was perceived to be the most problematic technique. It was identified as the most difficult task to complete while in pain and it was the most frequently mentioned risk factor. These results were consistent with Campo et al. (2008) who found higher odds of wrist and hand pain from soft-tissue mobilization compared to passive range of motion or joint mobilization.

One preventive strategy would be to use soft-tissue mobilization in a limited capacity as part of a multi-modal approach, only when truly indicated and when supported by current evidence. Systematic reviews and meta-analyses have resulted in evidence of mostly short-term benefits for neck, shoulder and low back pain (van den Dolder et al., 2014; Kong et al., 2013; Kumar et al., 2013; Furlan et al., 2015). Clinical practice guidelines for neck and low back pain published by the Academy of Orthopaedic Physical Therapy do not include recommendations for massage or soft-tissue mobilization (Delitto et al., 2012; Blanpied et al., 2017). If soft-tissue mobilization is used, PTs can consider tools. Instrument assisted soft-tissue mobilization (IASTM) tools were the most frequently recommended type of tool by study participants. These tools are metal instruments designed to release myofascial restrictions. Research on these devices has been limited and the results have been mixed (Schaefer and Sandrey, 2012; Cheatham et al., 2016; Laudner et al., 2014; Markovic, 2015).

Therapists in the survey and the focus groups identified changes in body mechanics and technique as the most important way to prevent and/or mitigate wrist and hand pain. This is consistent with previous studies (Cromie et al., 2000; Holder et al., 1999). There is limited research on the potential of body mechanics for manual therapy, but improved body mechanics should help, particularly to prevent thumb pain. One of the key joints of the thumb is the carpometacarpal (CMC) joint and CMC laxity is a risk factor for osteoarthritis (Jonsson et al., 1996). According to Atkinson and Maher (Atkinson and Maher, 2004/10), longitudinal loading of the thumb in retroposition results in adverse biomechanics at the CMC joint. This can occur during techniques like PA cervical joint mobilization, but thumb biomechanics can be improved by keeping the thumb in a more opposed position. Hsu, Hsu, and Su (Hu et al., 2016) found that experienced PTs kept their CMC joints in more flexion than inexperienced therapists and recommended supporting the thumb with the index finger during PA glides. The metacarpal and metacarpophalangeal (MCP) and interphalangeal (IP) joints are subject to adverse loading as well. Wajon, Ada, and Refshauge (Wajon et al., 2007) found that PTs without thumb pain were able to maintain thumb metacarpophalangeal and interphalangeal alignments better than PTs with pain. When therapists are unable to maintain alignments, particularly at the thumb, taping or bracing may help (Walsh et al., 2011). We would summarize these recommendations by telling therapists to keep their thumbs reinforced, close to the palm, and to avoid extreme angles throughout the wrist and hand.

Beyond body mechanics, a variety of other strategies should be considered. These include variation of techniques, consideration of workload, patient load and patient mix, matching techniques to anthropometrics, and use of manual techniques only when clinically indicated.

We found associations between increased age, decreased experience, female gender, and wrist and hand pain. Several studies have highlighted the effect of limited experience (Cromie et al., 2000; Glover et al., 2005; West and Gardner, 2001). Inexperienced therapists may use too much force, too many manual techniques, and/or poor technique. Participants in the current study frequently cited the need for more injury prevention content in entry-level education. This would help to prevent wrist and pain in recent graduates. Women had higher odds of wrist and hand pain than men. Although the reasons for the increased risk were unclear, we were able to control for confounding factors (such as setting, workload, age, experience, and volume of manual therapy) that may have influenced the effect of gender in previous studies (Cromie et al., 2000; Glover et al., 2005; Rossettini et al., 2016; McMahon et al., 2006). Anthropometric differences or ligamentous stability may be important factors to consider. For prevention, female therapists with joint hypermobility should be especially careful when applying manual techniques and should consider the use of bracing or altering techniques (such as reinforcing thumbs) to support lax joints. The same advice would hold for male therapists with laxity.

3.1. Unique insights from the focus groups

The focus groups revealed several insights that were not captured in the survey. According to focus group participants, expectations played a major role in the development and perpetuation of pain. Expectations for manual therapy can be challenging to manage, but PTs should try to perform manual therapy only when it is indicated. This should be accompanied by patient education about the importance and efficacy of a multimodal approach to treatment that may incorporate other, non-manual therapy interventions. Some participants reported managing expectations for manual therapy successfully and felt that it was a key

factor in the mitigation of or prevention of wrist and hand pain. Any injury prevention program for PTs should include more than just body mechanics and should teach PTs and PT students how to manage patient expectations.

3.2. Future studies

We recommend the development and testing of a formal wrist and hand pain prevention program for PTs and PT students. We plan to develop and test a web-based intervention for usability. We then plan to examine the effect of this program on wrist and hand pain within a large health system with multiple outpatient clinics. We have outlined several strategies that would be relatively easy to implement. Any program should also include a review of the rates of and risks for pain and a review of the relevant biomechanics.

3.3. Limitations

The prevalence of wrist and hand pain was higher than some previous estimates. This may have been due to sample characteristics because the participants primarily worked in outpatient settings where manual therapy was a frequent intervention. The rate may also have been overestimated because of response bias. Physical therapists with wrist and hand pain may have been more likely to respond to the survey. Recall bias, where participants with wrist and hand pain may have recalled their exposures differently was another potential limitation. Temporal issues may have resulted from participants changing their work habits after experiencing wrist and hand pain. This would have resulted in underestimation of some risk factors. The response rate, though reasonable for an online survey, still included only 5.7% of Academy PT members so the sample could not be assumed to have been representative. As a mixed-methods study designed to capture insights that may not have been revealed by previous studies however, we were able to capture a broad range of suggestions and insights. Finally, because the same two investigators coded the open-ended survey comments on prevention and the focus groups, analysis of the qualitative data could have been influenced by the open-ended question analysis. The two investigators discussed the key differences between survey responses and focus group comments but did not ignore the overlap between the two. This was part of the integration strategy.

4. Conclusion

Wrist and hand pain are prevalent in orthopaedic PTs. The primary risk factor is the performance of manual therapy techniques and prevention programs are needed. Prevention programs should be based on a variety of straightforward strategies that should reduce the risk and impact of wrist and hand pain.

Conflicts of interest

None declared.

Ethical approval

The materials and methods of this study were reviewed and approved by the Institutional Review Board of Mercy College. All participants were required to give informed consent prior to participation.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2019.05.009.

APPENDIX B
Open Ended Survey Coding – Preventive Strategies

Code	Codes (% cases, % codes)*	Definition	Representative Quotes
Body Mechanics and Technique	501 (52%, 37%)	Improved or body mechanics or changes in technique. The terms mechanics, body mechanics, form, technique, proper technique, improved technique, ergonomics, or using less force were commonly used. This code also included changes such as using a different hand or reinforcing a thumb. Variation of techniques or use of alternative techniques were also included under this code.	"Taking time to ensure proper body mechanics and joint positioning." "Altering techniques and positioning of therapist and/or patient." "Keeping focus on my own body mechanics when performing manual interventions." "Vary technique. Neutral positioning."
Tools & Devices	263 (27%, 19%)	Use of tools such as IASTM tools, straps, mobilization wedges, splints and braces. This code included specific techniques such as Graston or IASTM. Comments related to dry needling were coded with this code. This code did not include use of adjustable treatment tables (coded under body mechanics).	"More use of straps and assisted devices to help with manual therapy." "By the use of tools and devices to assist with manual therapy techniques …" "Use of IASTM tools." "Learning alternate techniques with equipment such as mobilization wedges, belts …"
Education	151 (16%, 11%)	Entry-level or continuing education, that included training to prevent wrist and hand pain. This included cases where participants indicated the need for knowledge about injury potential during training. When the specific type of education was written (e.g. better body mechanics training in entry-level education), both categories (body mechanics and education) were coded.	"More attention to this subject in school." "This needs to be addressed in PT school." "More warnings while in PT school-

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APPENDIX B (*continued*)

Code	Codes (% cases, % codes)*	Definition	Representative Quotes
			cover safe mechanics in school." "More education in school & with current practicing therapists with CEUs."
Reduce Manual Therapy	169 (21%, 12%)	Using less manual therapy. Strategies included changing the case mix, spacing patients out, using fewer techniques, avoiding techniques, working less, changing jobs or settings, and/or teaching patients to be more independent with treatment by having them perform more therapeutic exercise or to perform manual therapy on themselves.	"Perform less manual therapy techniques." "Work limited clinical hours." "By avoiding certain techniques." "More time in between patients to recover …" "Less soft-tissue mobilization …"
Stretching, Strengthening and Conditioning	123 (13%, 9%)	Performing strengthening, stretching, aerobic exercise, conditioning or any combination thereof. Some of the comments referred to 'therapeutic exercise.' This code did not include patient interventions. When participants referred to having patients perform more therapeutic exercises, it was coded elsewhere. This category also did not include wellness strategies like yoga, diet, sleep, and meditation.	"Strengthening and regular self-mobility work." "Wrist and thumb strengthening and stretching …" "I exercise regularly …" "Stretches and strength training"
Unclassified	50 (5%, 4%)	Responses that could not be coded with existing codes. The comments often indicated the therapist did not know how wrist and hand pain could be prevented.	"It can't be prevented." "Good question" "Unknown" "No specific reason" "Youth"
Treatment	44 (5%, 3%)	Seeking treatment from a healthcare provider, a colleague or treating themselves. Most comments referred to informal treatment. This code did not include strengthening, conditioning or therapeutic exercise after injury. This code also did not include several comments where the PT referred to having surgery which was referenced in comments as an outcome rather than a preventive strategy.	"Listen to your body and get intervention right away." "Provide time for therapists to receive regular treatment for themselves." "Appropriate self-care, traction to hand joints …" "Seek treatment from coworkers sooner."
Workstation Ergonomics	37 (4%, 3%)	Computer set-up, documentation demands, desk use, and/or writing. The code did not include aspects of the patient care work-area such as adjustable treatment tables. Comments that suggest doing less computer work or documentation received this code.	"Limit computer time." "…workstation set-up" "Less written documentation and more dictation" "Find a way to do way less typing and writing for documentation purposes."
Wellness and Health	17 (2%, 1%)	Strategies such as yoga, nutrition, meditation, sleep, etc. Comments related to rest were included if they referred specifically to sleep. This code did not include comments where PTs indicated they took rest breaks at work. This code also did not include comments related to PTs personal performance of exercise which was categorized elsewhere.	"…Good diet. Good rest. " "…yoga." "Maintain general health."

*Each case was a response from one participant. Comments from some cases included multiple prevention strategies. Those were given multiple codes but not more than one of each.

APPENDIX C
Qualitative Analysis of Focus Group Transcripts

Category	Code	Units Coded (% of units)	Description	Representative Quotes*
Impact of Life	ADLs and IADLs	14 (5%)	Impacts of wrist and hand pain on activities of daily living and instrumented activities of daily living including mobility, sleep, driving, cooking, cleaning, house care, texting, and childcare, etc.	"I have two young kids, sometimes when I pick my daughter up I get a sharp like jab then it goes away." "I don't clean my house anymore." "I'm 40 years old I shouldn't need a jar opener, but I use it!"
	Recreational Activities	4 (1%)	Impacts of wrist and hand pain on activities such as gardening or swimming	"I have a garden at home, and if I do some more farming I will feel it the next day." "Swimming"
Maintenance and Treatment	Self/Colleague Treatment	28 (10%)	Informal treatment by colleagues or self-treatment. Treatment may have included physical agents, manual therapy, dry needling, and/or unspecified physical therapy care. This code did not include the performance of therapeutic exercises.	"We don't get treated, we're grabbing a co-worker and are like can you do this for me? " "…we're treating one of my colleagues right now me and my boss, she has neck pain." "We do dry needling, stick some needles in it and make it feel better."
	Bracing and Taping	14 (5%)	Use of a brace or taping to prevent pain or to mitigate the impact of pain. The participant may have referred to general taping or more specific techniques such as Kinesio Taping.	"I've tried some KT taping, it's temporary but it does allow me to get through the day." "I've done bracing." "…sometimes I would have to put a thumb spica on."
	Therapeutic Exercise	11 (4%)	Use of stretching and/or strengthening either preventively or for rehabilitation of wrist and hand pain. Strengthening could have	"The feeling gets tight, I try to stretch it out." " ….I've been trying to strengthen myself at the gym, really my wrist flexors …"

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APPENDIX C (*continued*)

Category	Code	Units Coded (% of units)	Description	Representative Quotes*
			been achieved through resistive exercise or developed through a gradual increase in workload.	"Like I guess going to the gym, you want to make sure you're strong enough so that you're not going to injure yourself."
	Medication and Supplements	4 (1%)	Over the counter medications, supplements, vitamins, or topical medications not prescribed by a healthcare practitioner.	" ….I do arnica where sometimes I just rub it on my hands before I go to bed at night." "Advil and bio-freeze" "I … kicked up on my vitamin D thinking that maybe my joint pain was coming from a lack of vitamin D, and that did help over the following years."
	Injections	3 (1%)	Injections performed by physicians to treat wrist and hand pain. This code did not include dry needling.	"I have pain …. that was treated with injections." "I did go to my local orthopedist who gave me the cortisone injection …"
Risk Factors	Manual therapy (unspecified)	18 (6%)	Manual therapy (general) as a risk factor for wrist and hand pain. May also have included ergonomic characteristics of manual therapy such as repetition and awkward postures. This code included joint mobilization (unspecified body region or extremities) but not soft-tissue mobilization or spinal manual therapy.	"I would say the same thing, a lot of repetitive manual things. Anything manual." "the most part I feel it like when I'm doing manual work." "…the setting I work in, I do a lot of manual therapy, like a lot."
	Spine	10 (3%)	Spinal techniques such as spinal posterior to anterior mobilization as a risk factor for wrist and hand pain. This code included lumbar, thoracic and cervical techniques. For some cervical techniques, the difficulties holding or working with the head were mentioned.	"And it depends on how many spinal patients I have at one time, and I remember when this first started I had probably 75% of my caseload at the time was spine. I hate spine." "But the most painful part is probably treating the head, the head is heavy." "would say for me, it would be performing an OA release …."
	Soft-tissue mobilization	9 (3%)	Soft-tissue mobilization or massage primarily as risk factor for wrist and hand pain. This code did not include instances where the participants were personally treated with soft-tissue mobilization.	"Soft tissue, trigger points, would probably trigger it." "For me, it's just soft tissue, cause it's the thumb for me. Everything else, I can get around, soft tissue is kind of hard for me to get around." "mostly during STM, you know when I was doing massage, soft-tissue working."
	Predisposing Conditions	9 (3%)	Injuries or conditions that were unrelated to work. These injuries and conditions either caused wrist and hand pain independently of work or predisposed the therapist to work-related wrist and hand pain.	"I do have a little bit of arthritis in this pinky, but I can't blame work on that." "I would say the years of doing martial arts too- falling on an outstretched arm-hand." "Well I do have, since I was a kid, I've always had a certain amount of laxity- ligamentous laxity …"
	Documentation and EMR	15 (5%)	References to EMR or documentation. This code applied to comments suggesting that EMR increased the risk for wrist and hand pain as well as comments that suggested EMR reduced the risk for wrist and hand pain.	"I do agree that I think a lot of it is from the laptop work that I have to do." "I was working more and more on the EMR a lot of the wrist pain was happening …" "Don't you get pain writing? I mean again it's that pincer grip I get pain sometimes. Shake it off and keep writing, we do EMR, but we do have to write things."
Modifications	Body mechanics and technique	41 (14%)	Changing body mechanics, positioning and/or posture in response to wrist and hand pain or to prevent it. This code included any observation that resulted in changes to body mechanics. This code also included changes in technique such using other sides, using elbows, altering hand placement or using less force.	"And again, see with body mechanics, positioning, changing what I'm doing, sometimes changing what I do with the patient to avoid mobilizing myself when I don't need to be." "For me it would be like changing technique a little bit with soft tissue." "I've been trying not to use my thumbs too much."
	Less manual therapy	24 (8%)	Fewer manual techniques are performed either in response to wrist and hand pain or to prevent wrist and hand pain. This code included careful selection of techniques and outsourcing care to colleagues. This code also included efforts to promote patient independence either through teaching patients self-applied manual techniques or by having them perform therapeutic exercise instead of manual therapy. This code did not include managing expectations for manual therapy and soft-tissue mobilization by patients.	"I think the only solution I can come up with is to limit, or you know, and pick a certain amount of patients per day that you're going to do that manual on." "Also, you want to think about treating not just to treat, get rid of the fluff, did you really have to do these manual techniques, or can you get away with just patient self-generated exercises or mobilizations." "On Friday is less manual technique. Starting Thursday my hands are kind of falling apart, so I save my thumbs, if I want to do something with my hands over the weekend. So, on Friday, I try to not do too much manual with my thumb."
	Rest	5 (2%)	Rest as a strategy for prevention or mitigation of wrist and hand pain. This code also included references to vacations and the effect they could have on wrist and hand pain.	"I think rest definitely helps." "Rest definitely helps." "So, we need more vacation time."
Pain	Thumb	8 (3%)	The participant referred specifically to the thumb as a source of pain.	"Mine was more at the basal joint thumb …" "…I've been, lucky so far, be honest with you … for me … it's just my thumb." "…but I know the thumb is definitely from work."
	Non-Thumb	4 (1%)	Refers to other regions of pain aside from Thumb. Includes epicondylitis which was not part of the survey.	"I have epicondylitis in both elbows" "Actually, I think I had epicondylitis first …"
Professional Expectations	Patient Expectations	25 (9%)	Refers to patient expectations for manual therapy, especially soft-tissue mobilization. This code also included comments that were related to the importance of setting and limiting expectations for manual therapy by patients.	"One of the things I see, which is at least true in my practice is that patients come in, and they want manual. But their idea of manual is a massage." "And they'll say "Oh you're not doing it." Well I'm not doing

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APPENDIX C (*continued*)

Category	Code	Units Coded (% of units)	Description	Representative Quotes*
				it today, maybe next time. I think educating the patient, even though some of them are going to bark at me, complain." "Every once in a while, I'll get somebody and … I'll just explain to them, 'look, you need to go back to your doctor and get a script for massage therapy and hopefully your insurance covers it.' Because I mean some people just refuse and that's all they want."
	Personal Expectations	24 (8%)	The expectations that therapists had for themselves. These included working through pain, working under time pressure, working long hours, placing patients' needs above their own, and taking pride in their manual therapy expertise. This code included descriptions of passion or love for the profession that allowed them to continue despite having wrist and hand pain. This code also included negative feelings or discouragement in cases where participants were unable to treat patients the way they wanted to because of wrist and hand pain.	"So, you know we beat ourselves up when we treat our patients, because that's what comes first." "I still work as many hours as before because I'm self-employed." "…because you want to treat your patients the best that you can, and sometimes I put my patients well before myself, and we probably all do." "There is a definite emotional component to this, because after thirty years of doing what you love doing and you still love doing what you do everyday, to not be able to do it the way you used to do it, you know it's a little emotionally upsetting."
	Longevity	19 (7%)	The impact of wrist and hand pain upon the ability to work a full career. May include comments related to retirement and concerns about the capacity to work until that point. This code also included discussion of changing practice focus or even professions.	" ….I'm starting to think how long am I going to be able to do this until I can't anymore?" "I try not to think about it. I'm just going as long as I can, but in the back of my head I'm like yeah, it's not going to be forever." "I'm only 3 years into my career right now and I have a long way to go."

*Some quotes have been truncated (with the essential meaning intact) so that they can be displayed in the table.

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